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Title: ABD-WFM-001-Rev 3.0, Basis for Interim Operation for Technical Area 54, Area G

Author(s): Walker, Sharon Ann

Intended for: reference, contract bidding

Issued: 2016-08-04
Basis for Interim Operation for Technical Area 54, Area G

<table>
<thead>
<tr>
<th>Authorizing Signatures:</th>
<th>Signature</th>
<th>Date</th>
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<tbody>
<tr>
<td>EWMO Engineering Manager</td>
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<tr>
<td>Julia E. Minton-Hughes</td>
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<td>11/10/2014</td>
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<tr>
<td>Safety Basis Division –</td>
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<tr>
<td>Deputy Division Leader</td>
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<td>James L. Tingey</td>
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<td>EWMO</td>
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<tr>
<td>Acting Facility Operations Director</td>
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<tr>
<td>Rick A. Alexander</td>
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<td>11/13/14</td>
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Derivative Classifier

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<thead>
<tr>
<th>Classifier</th>
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<tbody>
<tr>
<td>KAREN J McHugh</td>
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<td>11/10/14</td>
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Classified as: _Unclassified_ _UCNI_ _OUO_
## Revision Log

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description of Change</th>
<th>Date Approved</th>
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<tbody>
<tr>
<td>1.0</td>
<td>Initial issue of BIO</td>
<td>3/1/2012</td>
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<td>90-day resubmittal, including changes required by Conditions of Approval (COA), and Directed Actions (DA):</td>
<td>7/19/2012</td>
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<tr>
<td>1.1</td>
<td>Elevated the 3-inches of overburden control to a SAC, appropriate to the amount of risk it is preventing or mitigating, and addressed the change in Chapters 3, 4, and 5 (COA #1).</td>
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<td></td>
<td>Added new DBA13, acetylene flashback explosion, in Chapter 3 to support the existing acetylene flashback arrestor SAC. (COA #3)</td>
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<td></td>
<td>Updated references to current documents. (DA#1)</td>
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<td></td>
<td>Additional changes to incorporate previous page changes from the DSA/TSR:</td>
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<td></td>
<td>Added description, analysis, and controls for HE-RTR process area in Chapters 2, 3, 4, and 5 (as changed in DSA Rev 0.4 and TSR Rev 0.30).</td>
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<td></td>
<td>Clarified minor movement during unvented drum handling and transport in Chapters 4 and 5(as changed in TSR Rev 0.31).</td>
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<td>Clarified notes about minimum staffing in Chapter 5 (as changed in TSR Rev 0.31)</td>
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<td>Clarified overburden requirement for waste in pits or trenches that is not counted as exposed. (as changed in TSR Rev 0.31, and required by COA #1)</td>
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<td>Additional clarifications required to implement the BIO and TSR, or to allow improved operational efficiency:</td>
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<td></td>
<td>Modified sealed sources description to include those meeting the Special Form Requirements of 49 CFR 173.469 to Chapter 2.</td>
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<td>Added description of storage area for equipment awaiting reuse or disposition to Chapter 2.</td>
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<td></td>
<td>Clarified the meaning of Low Activity Area, Defined Area, Tritium Area, and Transport Vehicles, and corrected the mislabeled Hazardous Material and Waste Management program and other control names in Chapters 3 and 4 to be more consistent with terms used in the CHA.</td>
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<td></td>
<td>Clarified that specified areas within Building 54-412 may be defined</td>
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<td>1.1, cont’d</td>
<td>areas in Chapters 3, 4 and 5.</td>
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<td>Clarified handling, transport and minor movement in Chapters 3, 4 and 5.</td>
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<td></td>
<td>Provided a clear distinction between the Stationary Fire Waste SAC and the SMP for Hot Work and Ignition Source Control in Chapter 3.</td>
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<td></td>
<td>Clarified that the safety function of the acetylene cylinder control is to prevent a flashback explosion in chapters 3 and 4.</td>
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<td></td>
<td>Clarified Pole Mounted Transformer Distance Control to apply to all storage areas and to transformers containing flammable/combustible liquids in Chapters 3, 4 and 5.</td>
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<td>Modified the attribute and safety function of controls to ensure consistency with the CHA in Chapters 3, 4 and 5.</td>
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<td>Clarified that the LAA MAR limit applies to waste stored above ground as well that in pits/shaft in Chapters 3 and 4.</td>
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<td>Clarified attribute of TRU waste containers to remove good and unimpaired condition from the sound integrity text in Chapters 3, 4 and 5.</td>
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<td>Added performance criteria to Vehicle Barriers – High Risk location to require restricted access to the road approaching the high risk location when the vehicle barriers require location, repair, or maintenance in Chapters 4 and 5.</td>
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<td>Added applicability to performance criteria in Table 4-1.</td>
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<td>Clarified performance criterion for the Pipe Overpack Containers in Chapter 4.</td>
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<td>Clarified that MAR limits for storage area or process area include intermingled low-level or mixed waste containers in chapters 4 and 5.</td>
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<td>Identified equipment that is procured, installed and maintained in accordance with standard industrial practices in Chapters 4 and 5.</td>
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<td>Clarified that tritium areas are identified for the storage of non-TRU tritium containers in Chapter 4.</td>
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<td>Clarified applicability of transient combustible control in Chapters 4 and 5.</td>
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<td>Clarified that the Container Lifts &gt;4 ft apply to greater than 4 ft above the ground surface directly below the TRU waste container in Chapter 4.</td>
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<td>Added control description and functional requirement that payloads to be lifted &gt;12 ft contain &lt; 925 PE-Ci to MLU Payload Lifts in Chapter 4.</td>
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<td>1.1, cont’d</td>
<td>Clarified Retrieval Area Unvented Drum Isolation Requirement and Stacking Prohibition to allow the drum to be immediately placed into an overpack/doublepack in Chapter 4.</td>
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<td>Clarified activities allowed in Warm Standby Mode in Chapter 5.</td>
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<td>Clarified MAR inventory for LLW, MLLW, and Tritium on a Transportation Vehicle in Chapter 5.</td>
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<td>Clarified applicability of TRU Waste Drum Doublepack control to allow temporary removal of a drum from a double pack during characterization in Chapter 5.</td>
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<td>Clarified Mode Applicability of SACs in Chapter 5.</td>
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<td>Clarified Minimum Staffing Requirements in Chapter 5.</td>
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<td>Added Mode Applicability to Design Features in Chapter 5.</td>
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<td></td>
<td>Corrected miscellaneous spacing, punctuation, grammar, and capitalization errors, deleted unused acronyms, and updated revision number and date in header and footer on all pages.</td>
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<td>2.0</td>
<td>Annual Update, including the following.</td>
<td>Aug. 1, 2013 (letter SO:40BJ-522279)</td>
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<tr>
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<td>Changes to reflect decrease in inventory projection or operational need:</td>
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<td>Reduced TRU MAR inventory (total above-ground site limit and waste composition to July 2013 projection in Chapters 3, 4 and 5.</td>
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<td>Reduced TRU storage area MAR limit in Chapters 3, 4 and 5.</td>
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<td>Reduced tritium (individual area and site total) MAR limits in Chapters 3, 4 and 5.</td>
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<td>Replaced individual LLW area (exposed) MAR limits with a single (reduced) site limit in Chapters 3, 4 and 5.</td>
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<td>Changes required to support 3706 Campaign:</td>
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<td>Increased SSSR MAR limit in Chapters 3, 4 and 5 to match approved DSA and to provide a limit for MAR staged in closed containers. Also added new SAC for Stationary Fire Watch During SSSR Activities to be consistent with recent DSA submittal.</td>
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<td>Additional changes required to improve the confidence level for implementation:</td>
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<td>In Chapters 3, 4 and 5, revised the process area MAR limit to also include both an area limit for HE-RTR and a total site limit, and prohibit the collocated storage in a dome or building with an SSSR area.</td>
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<td>Revised applicability of the thermal separation distance control in Chapters 3, 4 and 5.</td>
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<td>Revised applicability of the transient combustible control in Chapters 3, 4 and 5.</td>
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<td>Changed de minimus transient fuel package definition from $\leq 10$ lbs to $\leq 20$ lbs in Chapters 4 and 5.</td>
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<td>Revised release locations for some design basis accidents using X/Q values for those locations in Chapter 3.</td>
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<td><strong>Changes required to respond to previous comments Field Office and DNFSB comments, SER Conditions of Approval, or provide clarification:</strong></td>
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<td>In Chapter 3, quantified the Design Basis Accident 13 for acetylene explosion, identified the bounding event from the CHA, and revised the control for acetylene cylinders to prohibit their use or storage within 50 ft of a defined area when MAR is present. This control change replaced the flashback arrestor requirement and was carried forward to Chapters 4 and 5. These changes were required to address DOE SER Condition of Approval (COA) # 4 and related DOE SER Appendix A Comment. The flashback arrestor requirement is retained as an uncredited defense-in-depth item in the CHA.</td>
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<td>Added a table in Chapter 3.3 to summarize all controls credited in the CHA as safety-significant for the worker, and deleted the redundant CHA control summary tables from Appendix 3H.</td>
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<td>Incorporated the following changes in accordance with the actions described in SO:26CK-487519, <em>Response to DNFSB Issues:</em></td>
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<td>• In Chapter 3, decreased the tritium deposition velocity to 0.0 cm/s, and increased the damage ratio for high-activity tritium containers to 1.0 for fire accidents.</td>
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<td>• In Chapter 3 and Appendix 3H, clarified that sealed sources not certified to resist the release of radiological material under accident conditions will be tracked and counted against the site MAR limits for TRU waste.</td>
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<td>• In Appendix 3H (CHA) included a propane flame jet fire event and linkage to the bounding fire accident scenario in Chapter 3.</td>
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<td>In Chapters 3, 4 and 5, addressed reference and consistency errors identified in Field Office comments on BIO Rev. 1.0 and 1.1.</td>
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<td>In Chapter 3 including Appendix 3H (CHA), removed risk reduction credit for the SMP elements associated with inclement weather, secure transport, speed limits, non-high risk vehicle barriers, compressed gas cylinders, forklift recharging, overpack of degraded containers, drum banding, combustible pallets, good housekeeping (removed for</td>
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<td>consequence reduction only), and contamination controlled environment. These changes partially address DOE SER Appendix A Comment.</td>
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<td>Deleted Appendices 3B and 3F because the information was no longer required or was duplicated by information contained elsewhere in the BIO.</td>
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<td>Clarified the area boundary marking for defined areas in Chapters 4 and 5.</td>
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<td>In Chapters 3, 4 and 5, revised the Drum Venting System controls to reflect approved DSA Rev. 0.8.</td>
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<td>Reformatted references throughout, as appropriate.</td>
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<td><strong>Changes required to incorporate USQD related updates:</strong></td>
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<td>In Chapter 2, revised Sections 2.4.5, 2.5.7, 2.7.2, 2.7.4 and 2.7.5 to incorporate changes associated with approved USQDs.</td>
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<td><strong>Additional changes made in response to DOE safety basis review team comments:</strong></td>
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<td>Chapter 2 section 2.7.2 Fire Protection—clarified Exemption Request status regarding alternative controls selected for prevention/mitigation of a fire</td>
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<td>Chapter 3 Acronyms and throughout chapter—modified TEDE to TED</td>
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<td>Chapter 3 section 3.3.1.2.2 Consequence Category Estimates, Table 3-3—revised Process Area MAR limits</td>
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<td>Chapter 3 section 3.3.1.2.4 Control Description and Type—deleted SMP and AC discussions regarding credit</td>
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<td>Chapter 3 section 3.3.2.1.4 Combustible/Flammable Materials, Acetylene—clarified use of acetylene gas during maintenance</td>
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<td>Chapter 3 section 3.3.2.3.2 Defense-In-Depth—clarified that credited controls are protected in the TSRs</td>
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<td>Chapter 3 section 3.3.2.3.2.1 General, Table 3-6—amended table regarding Process Areas and MAR limits;</td>
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<td>Chapter 3 section 3.3.2.3.2.1 General, B.2 Lightning Protection System—deleted maintenance of LPS</td>
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<td>Chapter 3 section 3.3.2.3.2.1 General, N. Certified Sealed Sources—count sealed sources as MAR.</td>
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<td>Chapter 3 section 3.3.2.3.2.2 Fire, Table 3-7 and following text—clarified safety functions of fire protection controls and hot work</td>
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<td>Chapter 3 section 3.3.2.3.2.3 Deflagration, Table 3-8 and following text (item B)—corrected control title</td>
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<td>Chapter 3 section 3.3.2.3.2.4 Loss of Confinement—clarified item E, Fire Protection Program-Non-Combustible Pallets</td>
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<td>Chapter 3 section 3.3.2.3.5 Summary, Table 3-14a—clarified safety functions of Fire Protection Controls, and corrected SMP title</td>
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<td>Chapter 3 section 3.4 ACCIDENT ANALYSIS—deleted DBA 4B, (including associated Tables 3-62, 3-63, and 3-64)</td>
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<td>Chapter 3 section 3.4.1.5.1 MAR Assumptions—clarified Non-certified Sealed Sources discussion</td>
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<td>Chapter 3 section 3.4.1.5.4 Aircraft Accident —updated reference for aircraft crash frequency</td>
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<td>Chapter 3 section 3.4.2.1 DBA No. 1A—clarified assumption that MAR limits prohibit TRU waste Storage Areas in a dome or building that houses an SSSR Area</td>
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<td>Chapter 3 section 3.4.2.2 Summary of the Safety SSCs, SACs, and TSR Controls (for all DBAs) retitled TSR summary tables, clarified Fire Protection control safety functions, and deleted entries for SMPs that were not credited with risk reduction.</td>
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<td>Chapter 3 section 3.4.2.7.4 DBA 3 —modified a control description and added mitigated consequences for a 22,000 PE-Ci fire.</td>
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<td>Chapter 3 section 3.4.2.10—modified DBA No. 4C to increase the highest MAR analyzed, and clarify the effect of the Radiation Protection Program</td>
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<td>Chapter 3 section 3.4.2.12 DBA No. 4E —clarified the Transient Combustible controls and the Thermal Separation Distance regarding fire involvement and retitled Table 3-79</td>
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<td>Chapter 3 section 3.4.2.19 DBA No. 8 —clarified MAR limit Assumption, deleted obsolete text, and elevated Radiological Inventory Management control to an SC Function</td>
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<td>Chapter 3 section 3.4.2.20 DBA No. 9 —revised analysis to increase damage ratio for impact to highest MAR containers, and increase the accident consequences.</td>
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<td>Appendix 3E—updated reference and summarized results of April 2013 Aircraft Impact Frequency Calculation</td>
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<td>Appendix 3H, Part 1, section 4.1.1 AGTRU/BGTRU BASE ASSUMPTIONS—#12 clarified as non-combustible pallets, #16 clarified the use of pipe overpack containers with sealed sources, and #17 clarified counting of sealed sources as MAR</td>
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<td>Appendix 3H, Part 1, section 5.2.3 MITIGATED HAZARD ANALYSIS/CONTROL STRATEGY DEVELOPMENT—deleted SMP/AC credit discussion</td>
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<td>Appendix 3H, Part 1, section 5.2.4.4 Fire Protection Program elements—corrected ignition control title and added flashback arrestors for acetylene cylinders</td>
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<td>Appendix 3H, Part 1, section 5.2.4.6 Maintenance Program—clarified purpose and scope and deleted LPS requirements</td>
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<td>Chapter 4 section 4.5 SPECIFIC ADMINISTRATIVE CONTROLS—changed control title and deleted DBA 4B from section references in Table 4-3</td>
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<td>Chapter 4 section 4.5.1.2 Specific Administrative Control Description—clarified above ground MAR in Low Activity Area; clarified amount of MAR allowed in Process Areas</td>
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<td>Chapter 4 section 4.5.2 Thermal Separation Distances—clarified safety function and added Process Areas to SAC description</td>
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<td>Chapter 4 section 4.5.4 Control of Transient Combustibles – Fuel Package Limit—clarified safety function</td>
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<td>Chapter 4 section 4.5.5 Combustible/Flammable Liquid Controls in Defined Areas and Associated Thermal Separation Distance—revised control description, functional requirements, and evaluation to exclude Low Activity Areas</td>
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<td>Chapter 4 section 4.5.6 Above Ground Unvented TRU Waste Drums – updated control title</td>
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<td>Chapter 4 section 4.5.19 Stationary Fire Watch during Hot Work Control—clarified hot work in control description</td>
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<td>Chapter 4 section 4.5.24 Stationary Fire Watch During SSSR Activities—clarified control description and evaluation to include continuous stationary fire watch whenever TRU waste is exposed and that the stationary fire watch is a trained individual</td>
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<td>Chapter 5 section 5.5.1.1 Radiological Inventory Management (LCO 3.1.1-3.1.6/SAC)—clarified inclusion of sealed sources in inventory and limitations of radiological waste inventory. Also added SRs 4.1.4.3, 4.1.4.4, and 4.1.6.3, and deleted previous SR 4.1.4.6.</td>
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<td>Chapter 5 section 5.5.1.3 Thermal Separation Distances (LCO 3.2.1/SAC)—clarified Defined Areas to include Process Areas as applicable to LCO and surveillance requirements</td>
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<td>Chapter 5 section 5.5.1.6 Combustible/ Flammable Liquid Controls in Defined Areas and Associated Thermal Separation Distance (LCO 3.3.1/SAC)—excluded Low Activity Areas from LCO applicability</td>
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<td>Chapter 5 section 5.5.2.1.1 Stationary Fire Watch during Hot Work – Specific Administrative Control—clarified hot work in Basis</td>
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<td>Chapter 5 section 5.5.2.1.17 Stationary Fire Watch During SSSR Activities—clarified control description and Basis to include continuous Stationary Fire Watch in SSSR process area whenever TRU waste is exposed and that Stationary Fire Watch is a trained individual</td>
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<td>Chapter 5 section 5.5.2.2.6 Fire Protection Program—revised first element title and added element for the use of flashback arrestors on acetylene gas cylinders</td>
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<td>Chapter 5 section 5.5.2.2.8 Maintenance Program—clarified description and deleted LPS</td>
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<td>Additional changes:</td>
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<td>Chapter 2 section 2.5.6.1.3 High-Efficiency Neutron Counter Systems—added “Two HENC systems and one Super HENC system are employed at Pad 10...”</td>
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<td>Chapter 5 section 5.5.2.2.17 Minimum Staffing— Modified Table 5.3 wording to more closely align with currently approved and implemented Area G TSR (Rev 0.33). No increase or reduction in required staffing.</td>
<td>Feb. 19, 2014 (letter SO:40BJ-555924)</td>
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2.1 Submitted but not approved by DOE

2.2 Submitted but not approved by DOE

2.3 Chapter 2 Section 2.5.1.1 Access Control—clarified discussion regarding use of other approved Type B containers

Chapter 2 section 2.5.1.4 Transport Between RANT / Area G – updated text to reflect the escort requirements specified in the TSR
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<td>Chapter 2 section 2.5.5.4  TRU Sort, Segregate, Size Reduction, and Repackaging Activities – revised to include exception which allows for opening of TRU waste containers with bolted lids/flanges</td>
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<td>Chapter 2 – added new section 2.5.5.5  Opening Sealed Containers With Bolted Lids/Flanges During SSSR Activities - to address opening of sealed inner containers with bolted lids/flanges during SSSR</td>
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<td>Chapter 2 Section 2.5.6.2.1 Headspace Gas Sampling - clarified discussion regarding use of other approved Type B containers</td>
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<td>Chapter 2 Section 2.5.7 TRU Waste Shipments to WIPP – TRUPACT-II and HALFPACT Loading Operations– Renamed section and clarified discussion regarding use of other approved Type B containers</td>
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<td>Chapter 3 section 3.3.2.3.2.1 General – added new Item O which identifies controls for opening sealed containers with bolted lids/flanges during SSSR activities</td>
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<td>Chapter 3 Table 3-8  Supporting Controls Unique to Deflagration Event Risk Reduction – revised to include exception for opening of inner containers with bolted lids/flanges with additional controls</td>
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<td>Chapter 3 section 3.3.2.3.3 Worker Safety – corrected referenced section number</td>
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<td>Chapter 3 Table 3-14a  Summary of Safety Significant Controls – added new suite of deflagration controls for opening sealed containers with bolted lids/flanges during SSSR activities</td>
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<td>Chapter 3 Table 3-14b Summary of Controls in Hazard Analysis Contributing to Overall Defense-In-Depth per Accident Type – added the new deflagration controls that were summarized in table 3-14a</td>
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<td>Chapter 4 Table 4-1 Summary of Credited SSCs—clarified performance criteria for Type B containers</td>
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<td>Chapter 4 Section 4.3.3 Type B Containers—revised to acknowledge the use of other types of approved Type B containers</td>
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<td>Chapter 4 Table 4-3 Summary of Specific Administrative Controls – added new SAC for Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities</td>
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<td>Chapter 4 section 4.5.1.2 Specific Administrative Control Description – corrected reference to a section in Chapter 3</td>
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<td>Chapter 4 section 4.5.2.2 Specific Administrative Control Description – clarified column headings for SSSR thermal distance control</td>
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<td>Chapter 4 section 4.5.4.5 Controls (TSR) – changed SR frequency to shiftly to match the TSR wording for the transient combustible surveillance</td>
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<td>Chapter 4 section 4.5.7.2 Specific Administrative Control Description – revised description of Minor Movements to be consistent with TSR</td>
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<td>Chapter 4 section 4.5.7.3 Functional Requirements – deleted retrieval of below-ground waste from LCO exception</td>
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<td>Chapter 4 section 4.5.12.4 Specific Administrative Control Evaluation –</td>
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<td></td>
<td>deleted incorrect statement regarding use of rolling roadblock escort</td>
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<td>Chapter 4 section 4.5.13.2 Specific Administrative Control Description – added LAA exclusion from the refueling location control</td>
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<td>Chapter 4 section 4.5.21.2 Specific Administrative Control Description – included exception as allowed by the control described in section 4.5.25</td>
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<td>Chapter 4 section 4.5 Specific Administrative Controls – added new SAC 4.5.25 Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities</td>
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<td>Chapter 5, multiple sections – corrected numbering of several SRs</td>
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<td>Chapter 5 section 5.5.1.2 TRU Waste Drum Doublepack (LCO 3.1.7/SAC) – clarified that doublepacking is not required for POCs and SSSR activities.</td>
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<td>Chapter 5 section 5.5.1.3 Thermal Separation Distances (LCO 3.2.1/SAC) – clarified column headings for SSSR thermal distance control</td>
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<td>Chapter 5 section 5.5.1.7 Above-Ground Unvented TRU Waste Drums (LCO 3.4.1/SAC) – clarified exception statement regarding LCO 3.4.1 and replaced the missing exclusion for drum venting process areas</td>
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<td>Chapter 5 section 5.5.1.8 Unvented TRU Waste Drum Handling and Transport (LCO 3.4.2/SAC) – revised discussion of minor movements and drum lid restraints to be consistent with changes to TSR</td>
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<td>Chapter 5 Table 5-2 Minimum Refueling Separation Distances – added applicability footnote</td>
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<td>Chapter 5 section 5.5.1.9 Vehicle/Equipment Safety Control – Refueling Location – Clarified applicability of SR when establishing a defined area</td>
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<td>Chapter 5 section 5.5.2.1.12 Prohibitions on Opening Sealed Inner TRU Waste Packages Discovered within a TRU Waste Container during SSSR Activities – revised Control Description to include exception as allowed by the control described in Section 5.5.2.1.18</td>
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<td>Chapter 5 section 5.5.2.1 Specific Administrative Controls – added new section 5.5.2.1.18 Controls for Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities</td>
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<td>Chapter 5 Section 5.6.3 Type B Containers- revised to include callout to Model 10-160B container and to clarify applicability of control to all approved Type B containers</td>
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<td>R3.0</td>
<td>Annual Update, including the following descriptive changes (associated with negative USQDs completed during the period), clarifications, and correction of typographical or formatting errors. Executive Summary, section E.4 Safety Analysis Overview – corrected a miscount of HA events. No events were added or removed in this revision. The correct number of HA events is 420. Chapter 1, section 1.6.1 Wildland Fire – included the 2011 Las Conchas fire in the list of fires that threatened LANL facilities, addressed the transport of burning embers and added new reference document in section 1.9.</td>
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<td>Chapter 2, section 2.5.6.1.3 High-Efficiency Neutron Counter Systems – added description of the mobile ISOCS large container counter, and added the acronym to the list in the front matter</td>
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<td>Chapter 2 section 2.5.7 TRU Waste Shipments – Type B Loading Operations – corrected text formatting</td>
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<td>Chapter 2, section 2.7.3 Lightning Protection – updated text to reflect the LPS change to a non-catenary system for 54-153 and 54-183</td>
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<td>Chapter 2, section 2.8.1 Electrical Service – updated text about the transformer on Pad 10</td>
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<td>Chapter 3, section 3.3.1.2.2 Consequence Category Estimates – clarified worker consequence estimation method</td>
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<td>Chapter 3, section 3.3.2.1.4 Combustible/Flammable Material – corrected the examples for organic solvents, reactive material, and Class 1 oxidizers</td>
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<td>Chapter 3, section 3.3.2.3.1 Planned Design and Operational Safety Improvements – deleted the text about the Pad 10 transformer for which work has been completed, and modified the text describing the monitoring of MAR assumptions</td>
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<td>Chapter 3, Table 3-5 Terms and Definitions – added SSSR Area to the types of areas included in the High-Risk Location definition</td>
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<td>Chapter 3, section 3.3.2.3.2.1 General – corrected the statement about the total Area G Process Area MAR limit. 4,000 PE-Ci is the limit for the Pad 10 Process Area; other Process Areas are limited to 1,100 PE-Ci each.</td>
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<td>Chapter 3, section 3.3.2.3.2.2 Fire, item D – changed “less than 10 ft” to “more than 9 ft” to correct the statement about combustible material separation distance to prevent ignition. Clarified the exclusion for packaging and shipping material.</td>
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<td>Chapter 3, section 3.3.2.3.2.2 Fire, item F – added example of the large water truck as a type of fueled vehicle whose speed is influenced by the required escort.</td>
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<td>Chapter 3, section 3.3.2.3.2.4 Loss of Confinement, items A.1 and B.1 – noted that the speed of the water truck is limited by the escort that is required due to its &gt; 100 gal fuel supply</td>
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<td>Chapter 3, Table 3-14a - Added control: Radiological Inventory Management – Waste is located in defined areas</td>
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<td></td>
<td>Chapter 3, Table 3-14b - Added control: Radiological Inventory Management – Waste is located in defined areas</td>
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<td>Chapter 3, section 3.4.1.5.5 General Assumptions – in the Vehicle Barrier paragraph, noted that the speed of the water truck is limited by the escort that is required due to its &gt; 100 gal fuel supply</td>
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<td>Chapter 3, section 3.4.2.3.4 Comparison to the Evaluation Guideline for DBA 1C – added the water truck as an example of large fueled vehicles whose speed is influenced by the required escort</td>
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<td>Chapter 3 section 3.4.2.7.4 Comparison to the Evaluation Guideline – renumbered Table 3-57a to Table 3-57 and Table 3-58b to Table 3-58</td>
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<td>Chapter 3, section 3.4.3.1.4 Comparison to the Evaluation Guideline, Conclusion – corrected a typographical error in the dose spill term. The correct value is 5.98E+01.</td>
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<td>Appendix 3G, DOE-STD-5506 Preferred and Alternate Controls Assessment – Clarified text about vehicle barriers, high risk locations, and escort requirements to limit the risk of vehicle impacts. Added “stationary” before “fire watch”.</td>
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<td>Appendix 3H, section 5.2 Hazard Analyses - clarified worker consequence estimation method</td>
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<td>Appendix 3H, Hazard Event AGTRU-3-003 – expanded the description to address the water truck and listed the existing requirement for escort of vehicles with &gt;100 gal flammable liquid fuel capacity, which helps to enforce the speed limit for the escorted vehicle.</td>
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<td>Chapter 4, Table 4-1 Summary of Credited SSCs – deleted an unnecessary (metal and non-metal) phrase when referring to compliant TRU waste containers in the Control column</td>
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<td>Chapter 4, sections 4.3.1.2 System Description, and 4.3.1.4 System Evaluation (for Vehicle Barriers) – added the water truck as an example of a truck that is escorted due to fuel capacity greater than 100 gal. Added reference to the vehicle barrier impact calculation.</td>
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<td>Chapter 4, section 4.5.1.2 Specific Administrative Control Description – added control description for requirement that all above-ground MAR be located inside a defined area appropriate to the waste and container type.</td>
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<td>Chapter 4, section 4.5.1.5 Controls (TSR) – added surveillance for requirement that all above-ground MAR be located inside a defined area appropriate to the waste and container type</td>
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<td>Chapter 4, sections 4.5.19.4 Specific Administrative Control Evaluation and 4.5.19.5 TSR Controls for Stationary Fire Watch during Hot Work Control – added “stationary” before “fire watch” throughout</td>
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<td>Chapter 4, sections 4.5.24.4 Specific Administrative Control Evaluation Stationary Fire Watch During SSSR Activities – added “stationary” before “fire watch” throughout</td>
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<td>Chapter 4, section 4.6 References – updated the WIPP WAC reference and added a reference for the vehicle barrier impact calculation</td>
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<td>Chapter 5, Acronyms and Abbreviations – deleted FW, fire watch</td>
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<td>Chapter 5, Stationary Fire Watch during Hot Work – Specific Administrative Control - added “stationary” before “fire watch” where it was missing in the Control description basis.</td>
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<td>Chapter 5, Table 5-3 - replaced the on-call Fire Watch with Stationary Fire Watch.</td>
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<td>Chapter 5, section 5.5.1.1, Radiological Inventory Management – added description of a TSR requirement for control that all above-ground MAR be located inside a defined area appropriate to the waste and container type</td>
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<td>Chapter 5, section 5.6.1 Vehicle Barriers at High-Risk Locations – added the water truck as an example of a large truck that is escorted due to fuel capacity greater than 100 gal. The required escort helps to limit the truck speed.</td>
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<td>Chapter 5, section 5.8 References – updated the WIPP WAC reference</td>
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## Acronyms and Abbreviations

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<tr>
<td>BDBA</td>
<td>Beyond Design Basis Accident</td>
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<tr>
<td>BIO</td>
<td>Basis for Interim Operations</td>
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<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>CMP</td>
<td>Corrugated Metal Pipe</td>
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<td>DBA</td>
<td>Design Basis Accident</td>
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<td>DOE</td>
<td>U.S. Department of Energy</td>
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<td>HA</td>
<td>Hazards Analysis</td>
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<td>Hazard Category</td>
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<td>HW</td>
<td>Hazardous Waste</td>
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<td>LANL</td>
<td>Los Alamos National Laboratory</td>
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<td>LANS</td>
<td>Los Alamos National Security</td>
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<td>LLW</td>
<td>Low-Level Waste</td>
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<td>MAR</td>
<td>Material-At-Risk</td>
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<td>MEOI</td>
<td>Maximally Exposed Offsite Individual</td>
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<td>MLLW</td>
<td>Mixed Low-Level Waste</td>
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<tr>
<td>NDA</td>
<td>Nondestructive Assay</td>
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<td>NDE</td>
<td>Nondestructive Examination</td>
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<td>RANT</td>
<td>Radioassay and Nondestructive Testing Facility</td>
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<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<td>SAC</td>
<td>Specific Administrative Controls</td>
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<td>SMP</td>
<td>Safety Management Program</td>
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<tr>
<td>SSC</td>
<td>Systems, Structures, or Components</td>
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<td>TRU</td>
<td>Transuranic</td>
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<td>Technical Safety Requirements</td>
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<td>Waste Acceptance Criteria</td>
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<td>WDP</td>
<td>Waste Disposition Project</td>
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<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
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EXECUTIVE SUMMARY

This Basis for Interim Operations (BIO) is written for the Los Alamos National Laboratory (LANL) Waste Disposition Project (WDP) for Technical Area (TA)-54, Area G nuclear waste management operations. The purpose of this document is to demonstrate an acceptable level of safety in compliance with Title 10, Code of Federal Regulations (CFR) Part 830, Nuclear Safety Management. Subpart B, Section 830.202, Safety Basis Requirements, sub-section (a), Safety Basis [CFR 2008] requires that the contractor, responsible for a Hazard Category (HC)-1, -2, or -3 U.S. Department of Energy (DOE) nuclear facility, establish and maintain the safety basis of the facility. TA-54, Area G is categorized as a DOE non-reactor HC-2 facility for all surface and underground retrieval operations.

E.1 FACILITY BACKGROUND AND MISSION

TA-54, Area G has been used for radiological waste disposal and storage since 1957 and is expected to remain active until 2015. To accommodate the radiological waste disposal needs of LANL, further development of the LANL site is planned. This includes the use of existing facilities or mobile/temporary structures to characterize, remediate, decontaminate, reduce the volume of, and store radiological waste.

Operations at TA-54, Area G are focused on activities to receive, process, store, ship, and/or dispose of LANL’s newly generated low-level waste (LLW), mixed low-level waste (MLLW), hazardous waste (HW), tritium-contaminated waste, and transuranic (TRU) waste, as well as to prepare legacy waste items for shipment to offsite treatment, storage, and disposal facilities. TRU waste is shipped to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. The latter activity is critical to meet the New Mexico Consent Order [NMED 2008] to close TA-54, Area G by 2015. Therefore, TA-54, Area G is considered a limited-life facility.

E.2 FACILITY OVERVIEW

TA-54, Area G is the primary site at LANL for the disposal of LLW and tritium-contaminated waste, and for the storage of MLLW, HW, tritium waste, tritium-contaminated waste, and TRU waste. The TA-54 Area G facilities shown in Chapter 1, Figure 1-3, are situated in the middle of TA-54 on Mesita del Buey. The LLW to be disposed of includes radiologically contaminated asbestos, bio-organics, beryllium, and small amounts of polychlorinated biphenyls (PCBs). The HW and MLLW are stored in arrays that are easily inspected in a Resource Conservation and Recovery Act (RCRA)-permitted storage area, except for small amounts of tritium waste and higher activity tritium-contaminated LLW and MLLW that are stored in specific, commercially constructed steel chemical storage units on a RCRA-permitted pad. The TRU waste destined for WIPP is also stored in easily inspected arrays that allow for inspections of container integrity as well as RCRA-required inspections. Radiological wastes with significantly high dose rates that pose an unacceptably high exposure hazard to workers are placed in shafts for storage and/or disposal to meet As Low as Reasonably Achievable requirements.

Operations associated with waste management at TA-54, Area G and subject to this BIO include radiological waste receipt, handling, repackaging, storage, container inspection, decontamination, waste characterization/verification (both intrusive and non-intrusive), venting and purging, size reduction, disposal, retrieval of legacy waste, environmental monitoring, transport operations between the TA-54 Radioassay and Nondestructive Testing Facility (RANT) and Area G along Mesita del Buey Road, and other operations to disposition the waste.

The LLW, MLLW, HW, tritium waste, tritium-contaminated waste, and TRU waste are managed according to applicable regulations. In accordance with RCRA, all mixed waste received is stored within
RCRA-permitted storage areas. Retrievably stored TRU wastes at Area G, if acceptable under the WIPP Waste Acceptance Criteria (WAC), will be prepared for eventual shipment to WIPP. TRU waste not meeting the WIPP WAC, tritium waste, tritium-contaminated waste, and MLLW with no treatment path, will be held in storage at Los Alamos National Laboratory (LANL) until process activities are developed to treat or prepare this waste for acceptance at WIPP or another treatment, storage, and disposal facility.

E.3 FACILITY HAZARD CATEGORIZATION

According to Section 3.0 of DOE-STD-1027-92 [DOE 1997], the radiological material quantities involved in TA-54, Area G operations exceed the threshold quantities for a Hazard Category (HC)-2 non-reactor nuclear facility. Because the facility exceeds this threshold quantity, TA-54 Area G is classified as a HC-2 non-reactor nuclear facility. The above-ground inventory consists of approximately 15,000 TRU waste containers with a total radiological content of approximately 57,000 Plutonium-239 Equivalent Curies (PE-Ci), predominantly in plutonium isotopes. The below-ground inventory is approximately 5,000 containers with 110,000 PE-Ci, also predominantly in plutonium isotopes. Retrieval of buried waste is managed to limit the above-ground inventory to 57,000 PE-Ci.

E.4 SAFETY ANALYSIS OVERVIEW

The TA-54, Area G mission has traditionally been as a LLW, MLLW, HW, tritium waste, tritium-contaminated waste, and TRU waste disposal or storage facility. To support a New Mexico Consent Order requirement, TRU waste operations at TA-54, Area G must be completed by 2015. The major undertaking at TA-54, Area G is to remediate or process, as necessary, the 20,000+ waste containers in above- and below-ground storage. Because of the limited life of TA-54, Area G as a TRU waste storage facility, this BIO has been prepared. The DOE-STD-3011-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents [DOE 2002], is used as the safe harbor for the preparation of this BIO and is consistent with DOE-STD-3009-94, Change Notice (CN) 3, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis [DOE 2006]. The approach to the development of this BIO is in accordance with 10 CFR 830, Nuclear Safety Management [CFR 2008].

The safe disposition or processing of the nuclear waste containers is described in the TA-54, Area G BIO. As per DOE-STD-3011-2002 [DOE 2002], a graded approach to the DOE-STD-3009-94, CN3 [DOE 2006], is followed in the development of the document. Chapters 1 through 4 fully comply with the requirements of DOE-STD-3009-94, CN3, and a graded approach is taken in the discussion of the derivation of the Technical Safety Requirements (TSRs) and in the description of Safety Management Programs (SMPs).

The hazard and accident analysis addresses the following TA-54, Area G facilities and operations:

- LLW operations
- MLLW, HW, and TRU waste storage, processing, and transport operations
- Tritium waste and tritium-contaminated waste storage
- Nondestructive evaluation/nondestructive assay (NDE/NDA) facilities and waste characterization
- Sort, segregate, size reduction, and repackaging
- Mobile loading operations
• Under-ground retrieval of the contents of Trenches A through D, Pit 9, and corrugated metal pipes (CMPs)

The principal hazard analyzed at TA-54, Area G is the radiological constituents in waste. Other hazards include the radioactive sources used in NDE/NDA operations, hazardous materials, flammable gases and fuels, and combustible material. The quantities of hazardous material present are estimated based on process knowledge. None of the HW constituents associated with mixed waste is likely to be of a particulate form, or, if subjected to energy sources present at TA-54, Area G, is capable of generating a particulate form.

The hazard and accident analysis used the methodology outlined in DOE-STD-5506-2007 [DOE 2007] for accidents with TRU waste. Guidance in DOE-STD-3010-94, CN3 [DOE 1994], was followed in the hazard and accident analyses for LLW and tritium-contaminated waste streams. Section 4.3 of DOE-STD-5506 provides general algorithms to define the bounding material-at-risk (MAR) impacted in postulated scenarios, based on the number of containers impacted and on the estimated statistical 95\textsuperscript{th} upper tolerance limits (UTL) of the inventory. The algorithms depend on whether the waste containers have a limited characterization, i.e., one based on process knowledge, or have full characterization to meet the WIPP WAC. The radiological content of TRU waste containers at Area G is estimated based on both process knowledge and NDE/NDA. Waste generator NDE/NDA of TRU waste containers is required for waste container transport from a waste generator location to Area G. However, waste containers destined for WIPP undergo further characterization to confirm WIPP compliance. Thus the Limited Characterization algorithm is used to define MAR for the postulated scenarios in the hazard and accident analysis because it bounds available characterization data for TRU waste containers received at Area G; it is probably over-conservative, given LANL transportation requirements on the characterization of waste container contents. Once Trenches A through -D containers become part of the above-ground inventory, the Limited Characterization algorithm is appropriate to use because of possible uncertainties in exact waste and MAR compositions within these containers.

The Hazard Analysis (HA) identified 420 hazard events involving fire, deflagrations, loss of confinement/containment, exposure, criticality, external hazards, or natural phenomena. Most of the hazard events were mitigated by a combination of engineered structures, systems, and components (SSCs); specific administrative controls (SACs); and safety management programs (SMPs). Control selection for twelve of the 420 HA events, listed in Table ES-1, consisted of only SMPs. Table ES-1 is accompanied with commentary on the decision to select only SMPs.

The Area G above-ground inventory projected for July 2013 and the Pit 9 underground inventory of June 2009 were used to determine bounding MAR. These data bound the inventory fluctuations from the receipt of newly generated waste, shipments of current Area G TRU waste, and underground retrievals of corrugated metal pipes with cemented waste and TRU waste containers at Pit 9. Retrieval of TRU waste from Pit 9 and CMPs is scheduled to begin within a year of the implementation of this BIO.

The retrieval of underground waste from Trenches A-D is to occur in approximately two years. The above-ground storage of Trenches A-D waste containers may skew the above-ground inventory statistics because several of the drums in Trenches A-D have MAR values greater than 200 PE-Ci. This will affect the mean at the 95\textsuperscript{th} UTL. Current TA-55 waste packaging strategies to increase the average MAR within a TRU waste container will also affect the mean at the 95\textsuperscript{th} UTL. The above-ground storage time of these containers and their number may impact the inventory statistics.

To account for these potential impacts, the hazards and accident analysis are developed with several conservatism. In addition, a TSR-specific administrative control requires an evaluation of the impact of
retrieved Trenches A through D drums on the above-ground inventory and corresponding statistics before their retrieval. If drums planned for retrieval are determined to result in an above-ground inventory that would result in accident consequences not bounded by the current Area G BIO, then the retrieval plan will be modified to ensure that the accident analysis remains bounding. Annual above-ground inventory verification will further ensure that the analysis in the Area G BIO remains valid. Twenty-four Design Basis Accidents (DBAs) were identified; these involve liquid-fuel fires, propagating fires, deflagrations, explosions external to waste containers, container impacts, exposures, external facility hazards, and natural phenomena. A beyond-design-basis accident (BDBA) involved a high-speed impact to waste containers with a fuel pool fire. Table ES-2 shows a summary of the results of the public consequences from the DBA analysis in Section 3.4 of the BIO. Table ES-3 shows a summary of the results of the collocated worker consequences, also performed in Section 3.4 of the BIO.

Systems, structures, or components (SSCs), Specific Administrative Controls (SACs), Administrative Controls, and SMPs were identified to prevent and/or mitigate the risk to the worker, collocated worker, and the public. Controls for a limited-life facility were selected based on the guidance in DOE-STD-3009-94, CN3 [DOE 2006] in alignment with the preferred and alternate control guidance suggested in DOE-STD-5506-2007 [DOE 2007]. The safety analysis identified three safety-class and one safety-significant SSC, and twenty-seven SACs that reduce the public risk ranking of the DBAs to an acceptable or marginally acceptable level.

The hazard and accident analysis identified several vehicle accidents with an impact and/or fuel spills and subsequent fuel pool fires that resulted in a high consequence to the public. The safety-class SSC vehicle barriers at high-risk locations reduce the likelihood of a vehicle impact and/or fuel pool fire affecting stored waste. Other high-consequence vehicle accidents were identified for which no engineered controls could be selected. For these accidents, a combination of SACs and elements of the Training, Vehicle Safety, and Maintenance SMPs were credited to reduce the consequence or frequency of the accident scenarios.

For the majority of the scenarios in the hazard and accident analysis, the safety-significant SSC waste container is credited for its structurally sound, non-combustible construction.

In the accident analysis for TRU waste, the following is cited from the DOE-STD-5506-2007, Section 6.3 on the use of the parameters set forth in Table 6.3-1, *Uncertainties Associated with Source Term and Consequence Analysis Factors* [DOE 2007]:

*In many cases, having an unmitigated MOI dose less than 10 rem (<40% of the EG) based on the recommended values above (Table 6.3-1) should still represent a reasonably low risk to [the] public and workers (assuming an adequate set of preventive and/or mitigative controls are implemented in the operation of these facilities). Thus, it is reasonable to expect that for existing facilities using the assumptions provided in this Standard, an unmitigated MOI greater than 10 rem should be considered sufficient to challenge the EG.*

Thus a public dose consequence greater than 10 rem was used as the criteria for the selection of safety-class controls in accidents involving TRU waste.

Safety-class or safety-significant controls were not identified for accidents involving LLW or tritium-contaminated waste.
E.5 ORGANIZATIONS

Los Alamos National Security (LANS), LLC, manages and operates the Laboratory under contract to the DOE. The WDP has primary responsibility for the TA-54, Area G operations. The BIO was developed under the direction of the LANS Safety Basis Division, using a variety of professional resources within the WDP organization.

E.6 SAFETY ANALYSIS CONCLUSIONS

The BIO process has described and analyzed the TA-54, Area G site and its LLW, MLLW, HW, tritium waste, tritium-contaminated waste, and TRU waste operations. The BIO has identified associated hazards and the conditions and hazard controls necessary to protect the worker, the public, and the environment. The established safety basis demonstrates that TA-54, Area G employs the necessary controls to provide an acceptable level of safety compliant with 10 CFR 830, Subpart B [CFR 2008].

There are no limits, established explicitly or implicitly in this BIO, that create a Margin of Safety that is being relied upon for ensuring compliance with 10 CFR 830 and that would be addressed in an Unreviewed Safety Question Determination in accordance with that Rule.

E.7 DOCUMENTED SAFETY ANALYSIS ORGANIZATION

This BIO consists of six chapters and a set of TSRs that are prepared in conformance with a graded approach as provided in DOE-STD-3011-2002 [DOE 2002] and DOE-STD-3009-94, CN3 [DOE 2006] for a limited-life facility.
E.8 REFERENCES


NMED 2008 Compliance Order of Consent, New Mexico Environment Department, Santa Fe NM, June 2008.


The events listed in Table ES-1 represent those accidents with at least Moderate consequences to the public or collocated workers that are mitigated with SMPs only. This is a small number of events representing less that 3% of the total number of HA scenarios. These events represent the total list of events for which a SSC or SAC could not be credited, as no reasonable control or element of a SMP could be applied.

<table>
<thead>
<tr>
<th>HA ID</th>
<th>Scenario</th>
<th>Credited SMPs*</th>
<th>Frequency</th>
<th>Consequence / Risk Rank</th>
<th>Unmitigated</th>
<th>Mitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGTRU-3-008</td>
<td>Flammable gas (VOCs, hydrogen, propane cylinder etc.) accumulate above LFL into the cask leading to a deflagration impacting the TRU waste containers resulting in a release of radiological material.</td>
<td></td>
<td>X</td>
<td>EU</td>
<td>EU</td>
<td>M III</td>
</tr>
<tr>
<td>BGTRU-3-029</td>
<td>TRU waste container (non-drum) collapses resulting in the release of radiological material.</td>
<td>X X</td>
<td>A</td>
<td>A</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-016</td>
<td>Worker handling an open TRU waste container during remediation inadvertently tips the container over causing a release of radiological material.</td>
<td>X X</td>
<td>U</td>
<td>EU</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-002</td>
<td>A vehicle traveling &lt; 10 mph impacts TRU waste containers (FRPs) from Pit 9 resulting in a release of radiological material.</td>
<td>X X X X</td>
<td>A</td>
<td>A</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-003</td>
<td>A vehicle/ equipment traveling at &gt; 10 and &lt; 35 mph impacts TRU waste containers from Pit 9 results in a release of radiological material.</td>
<td>X X X X</td>
<td>A</td>
<td>A</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-004</td>
<td>A vehicle/ equipment traveling at &gt; 10 mph and &lt; 35 mph impacts TRU waste containers from Pit 9 being transported results in a release of radiological material.</td>
<td>X X X X</td>
<td>A</td>
<td>A</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-009</td>
<td>Multiple TRU waste containers from Pit 9 are breached/ crushed resulting in a release of radiological material.</td>
<td>X X</td>
<td>U</td>
<td>EU</td>
<td>M II</td>
<td>M II</td>
</tr>
<tr>
<td>BGTRU-3-011</td>
<td>Vehicle transporting multiple Pit 9 TRU waste containers at &lt; 10 mph impacts TRU waste containers resulting in a release of radiological material.</td>
<td>X X X X</td>
<td>A</td>
<td>A</td>
<td>M II</td>
<td>M II</td>
</tr>
</tbody>
</table>
Table ES-1 – List of HA Events Crediting only SMPs

<table>
<thead>
<tr>
<th>HA ID</th>
<th>Scenario</th>
<th>Credited SMPs*</th>
<th>Frequency</th>
<th>Consequence / Risk Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unmitigated Mitigated</td>
<td>Unmitigated Mitigated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M  T1  E  T2  RPP</td>
<td></td>
<td>P  CW  W  P  CW  W</td>
</tr>
<tr>
<td>BGTRUPIT-3-012</td>
<td>Pit 9 waste face collapses resulting in a release of radiological material.</td>
<td>X  X  X  X</td>
<td>U  U</td>
<td>M II  M II  H I  L III  L III  L III</td>
</tr>
<tr>
<td>BGTRUPIT-3-013</td>
<td>Vehicle transporting multiple Pit 9 TRU waste containers &gt; 10 and &lt; 35 mph impacts Pit 9 TRU waste resulting in a release of radiological material.</td>
<td>X  X  X  X</td>
<td>A  A</td>
<td>M II  M II  H I  L III  L III  L III</td>
</tr>
<tr>
<td>BGTRUPIT-3-017</td>
<td>Vehicle impacts a Pit 9 remediation activity at &gt; 10 mph and &lt; 35 mph resulting in a release of radiological material.</td>
<td>X  X  X</td>
<td>U  EU</td>
<td>M II  M II  H I  L IV  L IV  M III</td>
</tr>
<tr>
<td>BGTRUPIT-3-020</td>
<td>Pit 9 TRU waste containers are breached by excavation equipment resulting in a release of radiological material.</td>
<td>X  X  X  X</td>
<td>A  A</td>
<td>M II  M II  H I  L III  L III  L III</td>
</tr>
</tbody>
</table>

*M = Maintenance Program; T1=Training and Qualification Program/Qualifications; E=Emergency Preparedness; T2=Hazards Recognition; RPP=Radiation Protection Program; A=Anticipated; U=Unlikely; EU=Extremely Unlikely; BEU=Beyond Extremely Unlikely; H=High Consequences; M=Moderate Consequences; L=Low Consequences; I/II/III=Risk Rankings

BGTRUCSK-2-008 involves accumulation of a flammable gas in a cask. The accumulation cannot be prevented in the cask, and the initiating spark cannot be prevented if the removal of the cask concrete lid is the initiator. This is considered an Extremely Unlikely event as removal of the concrete cap is not expected to create a sparking condition and so the controls as SMPs Maintenance Program and Training and Qualification Program are deemed appropriate to reduce the frequency of the event to BEU.

AGTRU-3-029, BGTRUCSK-3-016, BGTRUPIT-3-002, BGTRUPIT-3-003, BGTRUPIT-3-004, BGTRUPIT-3-009, BGTRUPIT-3-011, BGTRUPIT-3-012, BGTRUPIT-3-013, BGTRUPIT-3-017, and BGTRUPIT-3-020 all involve accidents that cannot be prevented by DF or SACs. Vehicles or manhandling containers operations must be in proximity of the waste to remove dirt, or move containers. Controls that prevent the accident would essentially have to prevent the work. Controls as SMPs Maintenance Program and Training and Qualification Program are deemed appropriate to reduce the frequency of the events.
Table ES-2 – Summary DBA Analysis – Maximally Exposed Offsite Individual (MEOI) Dose Consequences

<table>
<thead>
<tr>
<th>Section No.</th>
<th>DBA No.</th>
<th>Event No.</th>
<th>Title</th>
<th>Frequency Unmitigated/ Mitigated</th>
<th>MEOI Unmitigated Dose (rem)</th>
<th>MEOI Mitigated Dose (rem)</th>
<th>Risk Rank Unmitigated / Mitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4.2.1</td>
<td>1A</td>
<td>AGTRU-1-025</td>
<td>Vehicle Accident With Fuel Pool Fire</td>
<td>EU/BEU</td>
<td>1.45E+01</td>
<td>2.22E+00</td>
<td>II/IV</td>
</tr>
<tr>
<td>3.4.2.2</td>
<td>1B</td>
<td>AGTRU-1-044</td>
<td>Fuel Pool Fire From Container Leak</td>
<td>U/BEU</td>
<td>2.05E+01</td>
<td>1.11E+00</td>
<td>I/IV</td>
</tr>
<tr>
<td>3.4.2.3</td>
<td>1C</td>
<td>AGTRU-1-048</td>
<td>Refueling Vehicle Accident With Fuel Pool Fire</td>
<td>EU/BEU</td>
<td>2.21E+01</td>
<td>0</td>
<td>II/III</td>
</tr>
<tr>
<td>3.4.2.4</td>
<td>1D</td>
<td>BGTRUPIT-1-016</td>
<td>Fuel Pool Fire in Pit 9</td>
<td>U/BEU</td>
<td>1.45E+01</td>
<td>9.41E+00</td>
<td>I/IV</td>
</tr>
<tr>
<td>3.4.2.5</td>
<td>2A</td>
<td>AGTRU-1-031</td>
<td>Vehicle Accident with Combustible Fire</td>
<td>U/BEU</td>
<td>2.46E+01</td>
<td>9.56E+00</td>
<td>I/III</td>
</tr>
<tr>
<td>3.4.2.6</td>
<td>2B</td>
<td>BGTRUCSK-1-003</td>
<td>Combustible Fire in Trenches</td>
<td>A/EU</td>
<td>3.60E+01</td>
<td>&lt; 1.0E+00</td>
<td>I/IV</td>
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<td>3.4.2.7</td>
<td>3</td>
<td>AGTRU-1-041</td>
<td>Large Combustible Fire</td>
<td>A/EU</td>
<td>1.44E+01</td>
<td>5.10 to 6.5 E+00</td>
<td>I/III</td>
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<tr>
<td>3.4.2.8</td>
<td>4A</td>
<td>AGTRU-2-028</td>
<td>Single Container Deflagration Caused by Shock</td>
<td>A/EU</td>
<td>1.13E+01</td>
<td>4.10E+00</td>
<td>I/III</td>
</tr>
<tr>
<td>3.4.2.10</td>
<td>4C</td>
<td>AGTRU-2-015</td>
<td>Single Container Deflagration Caused by Puncture</td>
<td>A/EU</td>
<td>1.15E+01</td>
<td>1.22E+00</td>
<td>I/III</td>
</tr>
<tr>
<td>3.4.2.11</td>
<td>4D</td>
<td>AGTRU-2-030</td>
<td>Single Container Deflagration During Transport</td>
<td>A/EU</td>
<td>1.15E+01</td>
<td>1.22E+00</td>
<td>I/III</td>
</tr>
<tr>
<td>3.4.2.12</td>
<td>4E</td>
<td>BGTRUCSK-2-011</td>
<td>Single Container Deflagration Caused by Fire in Proximity</td>
<td>A/EU</td>
<td>4.02E+00</td>
<td>1.07E+00</td>
<td>II/III</td>
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<tr>
<td>3.4.2.13</td>
<td>4F</td>
<td>BGTRUCSK-2-014</td>
<td>Container Deflagration Caused by a Forklift Puncture</td>
<td>A/EU</td>
<td>8.05E+00</td>
<td>2.14E+00</td>
<td>II/III</td>
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<tr>
<td>3.4.2.14</td>
<td>5A</td>
<td>AGTRU-2-007</td>
<td>Multiple Above-Ground Waste Container Deflagration</td>
<td>U/EU</td>
<td>1.32E+00</td>
<td>1.32E+00</td>
<td>II/III</td>
</tr>
<tr>
<td>3.4.2.15</td>
<td>5B</td>
<td>BGTRUCSK-2-007</td>
<td>Multiple Trenches A-D Waste Container Deflagration</td>
<td>EU/BEU</td>
<td>8.05E+00</td>
<td>8.05E+00</td>
<td>III/IV</td>
</tr>
<tr>
<td>3.4.2.16</td>
<td>6</td>
<td>BGTRUPIT-2-011</td>
<td>Below-Ground Waste Container Deflagration Caused by External Flame</td>
<td>EU/EU</td>
<td>2.19E+00</td>
<td>2.19E+00</td>
<td>III/III</td>
</tr>
<tr>
<td>3.4.2.17</td>
<td>7A</td>
<td>AGTRU-3-012</td>
<td>Vehicle Transporting Waste Impacts Storage Array</td>
<td>A/A</td>
<td>4.24E+00</td>
<td>2.88E-01</td>
<td>II/III</td>
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<td>3.4.2.18</td>
<td>7B</td>
<td>AGTRU-3-016</td>
<td>Crane Topples Onto Staged TRU Waste</td>
<td>A/EU</td>
<td>4.23E+00</td>
<td>4.23E+00</td>
<td>I/III</td>
</tr>
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<td>3.4.2.19</td>
<td>8</td>
<td>AGTRU-3-017</td>
<td>Crane Drops TRUPACT* Payload Assembly</td>
<td>A/EU</td>
<td>8.82E+00</td>
<td>4.23E-01</td>
<td>I/III</td>
</tr>
<tr>
<td>3.4.2.20</td>
<td>9</td>
<td>AGTRU-6-001</td>
<td>Aircraft Impacts TRU Waste in Area G with Follow On Pool Fire</td>
<td>EU/EU</td>
<td>4.23E+01</td>
<td>4.23E+01</td>
<td>II/II</td>
</tr>
<tr>
<td>3.4.2.21</td>
<td>10</td>
<td>AGTRU-6-002</td>
<td>External Fire Propagates to Area G</td>
<td>A/A</td>
<td>8.93E+01</td>
<td>&lt; 1</td>
<td>I/III</td>
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<td>3.4.2.21a</td>
<td>10a</td>
<td>AGTRU-7-002</td>
<td>Lightning Strikes Multiple TRU Waste Containers</td>
<td>A/BEU</td>
<td>1.72E+00</td>
<td>1.72E+00</td>
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<td>3.4.2.22</td>
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<td>AGTRU-7-005</td>
<td>High Wind Damages Multiple TRU Waste Containers</td>
<td>U/U</td>
<td>2.33E+01</td>
<td>2.33E-01</td>
<td>III/III</td>
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<td>3.4.2.23</td>
<td>12</td>
<td>AGTRU-7-007</td>
<td>Seismic Event Affects Area G With Follow On Fire</td>
<td>U/EU</td>
<td>4.56E+01</td>
<td>8.21E+00</td>
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<td>13</td>
<td>AGTRU-2-034a</td>
<td>Acetylene Gas Explosion</td>
<td>EU/BEU</td>
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<td>3.4.3.1</td>
<td>BDBA</td>
<td>--------</td>
<td>High Speed Vehicle Accident With Fuel Pool Fire</td>
<td>NA</td>
<td>1.45E+02</td>
<td>1.45E+02</td>
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</tr>
</tbody>
</table>

* TRUPACT = TRU Package Transporter
<table>
<thead>
<tr>
<th>Section No.</th>
<th>DBA No.</th>
<th>Event No.</th>
<th>Title</th>
<th>Frequency Unmitigated/Mitigated</th>
<th>Collocated Worker Unmitigated Dose (rem)</th>
<th>Collocated Worker Mitigated Dose (rem)</th>
<th>Risk Rank Unmitigated/Mitigated</th>
</tr>
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<tbody>
<tr>
<td>3.4.2.1</td>
<td>1A</td>
<td>AGTRU-1-025</td>
<td>Vehicle Accident With Fuel Pool Fire</td>
<td>EU/BEU</td>
<td>1.42E+02</td>
<td>2.17E+01</td>
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<td>Fuel Pool Fire in Pit 9</td>
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<td>3.44 to 6.34E+01</td>
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<td>AGTRU-2-015</td>
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<td>varies per MAR</td>
<td>&lt; 25 rem</td>
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<td>AGTRU-2-030</td>
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<td>9.74E+01</td>
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</tbody>
</table>
CHAPTER 1
SITE CHARACTERISTICS
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Acronyms and Abbreviations

AGL Above Ground Level
ASCE American Society of Civil Engineers
BIO Basis for Interim Operation
CFR Code of Federal Regulations
DOE U.S. Department of Energy
EG Evaluation Guideline
JCO Justification for Continued Operation
IBC International Building Code
LANL Los Alamos National Laboratory
LANS Los Alamos National Security, LLC
MCE Maximum Considered Earthquake
ML Richter Magnitude or Moment Magnitude
NNSA National Nuclear Security Administration
NPH Natural Phenomena Hazards
PC Performance Category
PGA Peak Ground Acceleration
PH Peak Horizontal
SSC Structures, Systems, and Components
SWEIS Site-Wide Environmental Impact Statement
TA Technical Area
CHAPTER 1 SITE CHARACTERISTICS

1.1 INTRODUCTION

This chapter describes the general site characteristics of the Los Alamos National Laboratory (LANL or the Laboratory) and gives specific descriptions for Technical Area (TA)-54, where Area G is located. The Laboratory is an existing site administered by the National Nuclear Security Administration (NNSA) within the U.S. Department of Energy (DOE) and operated by Los Alamos National Security, LLC (LANS). Operations at LANL began in 1943. Operations at Area G began in 1957.

1.2 REQUIREMENTS

The TA-54, Area G Basis for Interim Operation (BIO) was developed in accordance with Title 10 of the U.S. Code of Federal Regulations (CFR), Part 830, Nuclear Safety Management [CFR 2011], which requires the contractor responsible for a DOE nuclear facility to analyze the facility, the work to be performed, and the associated hazards; and to identify the conditions, safe boundaries, and hazard controls necessary to protect workers, the public, and the environment from adverse consequences. DOE G 421.1-2, Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830 [DOE 2001], was used as the basis for compliance with 10 CFR 830. DOE-STD-3011-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents [DOE 2002e], was followed in developing this BIO and will serve as the safe harbor as described in 10 CFR 830 [CFR 2011]. As per DOE-STD-3011-2002, a graded approach to the requirements of DOE-STD-3009-94, CN 3, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses [DOE 2006], is taken to develop this BIO. DOE Order 420.1B, Facility Safety [DOE 2005] was used to establish facility safety requirements related to nuclear safety design, criticality safety, fire protection, and Natural Phenomena Hazard (NPH) mitigation.

The following standards implement the NPH mitigation requirements of DOE O 420.1B:

- DOE-STD-1021-93 CN 1, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components [DOE 2002b]
- DOE-STD-1022-94 CN 1, Natural Phenomena Hazards Site Characterization Criteria [DOE 2002c]
- DOE-STD-1023-95 CN 1, Natural Phenomena Hazards Assessment Criteria [DOE 2002d]

1.3 SITE DESCRIPTION

The following sections describe the LANL site, with emphasis on TA-54, Area G, the site boundaries, and the areas beyond the boundaries that could be affected by the release of hazardous materials from Area G facilities or that could affect Area G and its operations.

1.3.1 GEOGRAPHY

1.3.1.1 Location

The Laboratory and the associated residential areas of Los Alamos and White Rock are located in Los Alamos County in north-central New Mexico, about 96.6 km (60 mi) north-northeast of Albuquerque and 33.5 km (25 mi) northwest of Santa Fe (Figure 1-1). The 111-km² (43 mi²) Laboratory site and
adjacent communities are situated on the Pajarito Plateau, a shelf about 16 to 24 km (10 to 15 mi) wide and 72 km (45 mi) long. Mesa tops range in elevation from about 2,400 m (7,800 ft) on the flanks of the Jemez Mountains to about 1,900 m (6,200 ft) at their eastern termination above the Rio Grande Valley.

The Laboratory is located at an altitude ranging between 1,800 m and 2,500 m (6,000 and 8,000 ft) on the eastern slopes of the Jemez Mountains. White Rock is located along White Rock Canyon of the Rio Grande. Both White Rock and the town of Los Alamos are run by Los Alamos County. TA-54, Area G is situated atop Mesita del Buey, a narrow southeast-trending mesa about 3 km (1.8 mi) long and 0.4 km (0.25 mi) wide. The mesa surface slopes gently, from an altitude of about 2,100 m (6,900 ft) near its western margin to about 2,000 m (6,600 ft) near its eastern end. It is bounded on the north by an unnamed canyon and Canada del Buey, and on the south by Pajarito Canyon. The canyon floors range from 15 to 30 m (50 to 100 ft) below the surface of the mesa. The edges of the mesa are vertical or near-vertical cliffs with steep slopes at their bases.

The Laboratory TAs are generally located in the area bounded by State Roads 4, 501, and 502. The location of TA-54, Area G within the Laboratory site boundary and in its location with respect to other TAs at the Laboratory is depicted in Figure 1-2. Area G is about 8 km (5 mi) southeast of the Los Alamos town site and, at its closest point, about 1,600 m (5,200 ft) west of White Rock. As shown in Figure 1-3, the northern boundary of TA-54, Area G and the Laboratory site boundary coincide. Land immediately beyond this location belongs to the San Ildefonso Pueblo. The Laboratory facility closest to Area G is Area L to the west.

TA-54, Area G covers a relatively large area and consists of multiple facilities. Thus, the closest site boundary distance widely varies depending on the specific Area G facility. For consequence analysis, an evaluation boundary is defined where the Evaluation Guideline (EG) is applied. The term evaluation boundary is considered equivalent to the term “directionally dependent, maximally exposed offsite individual (MEOI)” defined in Erickson 2002. The evaluation boundary accounts for roads crossing the Laboratory that are routinely traveled by the public. This evaluation boundary is more restrictive than the official site boundary. Evaluation boundary distances have been determined for 16 azimuthal sectors for buildings and sites at Area G. For each azimuthal sector, the minimum distance between the building or site center and the evaluation boundary within that sector is determined and used as the evaluation boundary distance for that entire sector. A wedge of land belonging to San Ildefonso Pueblo, located north of TA-54, defines the site and evaluation boundary closest to TA-54. These distances have been evaluated and the results are presented in Table 1-1.
Figure 1-1    Location Map of Los Alamos in Northern New Mexico
Figure 1-2  Location Map of Technical Areas at Los Alamos National Laboratory
Figure 1-3  TA-54, Area G, Site Facilities Location
Table 1-1  Distances to Evaluation Boundary from TA-54 Buildings and Sites

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1.3.1.2  Local and Regional Transportation Routes

The major transportation routes to LANL are the highways and the Los Alamos Airport. The highways that pass through or border LANL boundaries include State Roads 4, 501, and 502. The only local access road to Area G is Pajarito Road, south of the Area G facilities.

The Los Alamos Airport, located about 5.8 km (3.6 mi) north of Area G, has a single runway running from east to west that handles a low number of small commercial and private flights. Because of local conditions and air space restrictions over the LANL site, most air traffic enters from and exits to the east. The west end of the runway is typically used for run-ups or taxiing.
1.3.1.3 Exclusion Areas

DOE-STD-3009-94, CN 3 [DOE 2006] requires information on the public exclusion area, access control areas, and the point where the EG is applied. Although the public exclusion area and the point where the EG is applied are the same at some sites (often referred to as the site boundary), they are not common at LANL, which uses an evaluation boundary as discussed above. This concept is explained in an NNSA policy memorandum [Erickson 2002] on the location of the MEOI, which is equivalent to the location where the EG is applied.

As shown in Figure 1-2, State Roads 4, 501, and 502 traverse the LANL site. The public is also allowed to routinely access East Jemez Road. Access control checkpoints at both ends of Pajarito Road limit public access to the TAs located along this road. The closest public access to Area G is the access control checkpoint at the southwest end of Pajarito Road. State and federal government agencies and local Indian tribes control the land surrounding Los Alamos County. Of these, three federal agencies (the Bureau of Indian Affairs, the U.S. Forest Service, and the Bureau of Land Management) control the majority of the land in the area.

East Jemez Road runs through the laboratory in a generally east-west direction. Sites south of East Jemez Road use East Jemez Road and the Royal Crest Mobile Home Park, which is along East Jemez Road and adjacent to the Laboratory, as part of the northern evaluation boundary when determining distances from a facility to the boundary for consequence analysis. This evaluation boundary is closer to these sites than the actual northern boundary of the Laboratory. Similarly, the SE boundary is taken as State Road 4, and, in some places near the NW boundary, as State Road 501 rather than the actual, more distant site boundaries.

The Santa Fe National Forest comprises 634,486 hectares (1,567,181 acres) of land in several counties. The Española District of the Santa Fe National Forest includes 142,521 hectares (352,170 acres) that border Laboratory land to the northwest and southeast. The Bandelier National Monument borders the southwest portion of the Laboratory complex and is managed by the National Park Service. The monument includes 12,950 hectares (32,000 acres) of land, 9,308 hectares (23,000 acres) of which are designated as wilderness. Access routes to the Monument pass through or along the Laboratory property.

Thirteen Native American Pueblos are located within 80 km (50 mi) of the Laboratory. Each is governed by its own tribal government, with technical and administrative assistance from the Bureau of Indian Affairs. The San Ildefonso Pueblo owns a triangular piece of land that directly borders TA-54, Area G within Cañada del Buey to the north of the facility. The total area owned by the Pueblo is 10,600 hectares (26,192 acres).

Although the public is normally allowed access to several roads that traverse LANL property, DOE controls the area within LANL boundaries and can completely restrict access. The Laboratory maintains a dedicated emergency response organization and a protective force capable of controlling public access to roads that cross or border the LANL site. In accordance with DOE-STD-3009-94 CN 3 [DOE 2006], such roads are considered within the site boundary for establishing an exclusion area. Thus the public exclusion area corresponds to the area within the LANL site boundary (the yellow highlighted area shown in Figure 1-2).
According to NNSA/OLASO (Office of Los Alamos Site Operations) Policy on Site Boundary for Dose Evaluation of the Directionally Dependent Maximally Exposed Off-site Individual [Erickson 2002], the policy for the site boundary points out that emergency evacuation from civilian residences at the Royal Crest Trailer Park and the County landfill office (manned by civilian personnel), both located on East Jemez Road, would require public travel on East Jemez Road. Thus, although East Jemez Road is within the public exclusion area because DOE can control access during an emergency, public access could be required.

1.3.1.4 Archeological Sites

Laboratory-controlled land, including TA-54, Area G, is of archeological interest because of the presence of ruins of prehistoric Indian dwellings built before the Spanish occupation. Laboratory lands contain about 2,000 known archaeological and historical sites. The Laboratory’s Ecology Group oversees the management and protection of cultural resources. Before ground is broken for a new building, facility, or pit, an archeological dig is performed to determine if there are cultural resources in the area in accordance with Section 106 of the National Historic Preservation Act. If any cultural resources are found, the area is fenced off to prevent personnel from entering. There are a number of such areas at TA-54, Area G.

1.3.1.5 Drinking Water Supplies

The Laboratory and the communities of Los Alamos and White Rock are supplied by water pumped from 16 deep aquifer wells in the Otowi and Guaje Canyons and on the Pajarito Plateau. Production from these wells is from the main aquifer of the Los Alamos area. The main aquifer is the only aquifer in the area capable of municipal and industrial water supply, as it provides water to Los Alamos, LANL, and Bandelier National Monument. A further discussion of the hydrology of the Laboratory area is provided in Section 1.4.2.

1.3.2 DEMOGRAPHY

Los Alamos County had an estimated year-2000 population of 18,343. The Los Alamos town site, including the original area of development and the residential areas known as Eastern Area, Western Area, North Community, Barranca Mesa, and North Mesa, had an estimated population of 11,900. The White Rock area (including the residential areas of White Rock, La Senda, and Pajarito Acres) had about 6,100 residents. Population estimates for 2000 placed about 264,000 persons within an 80 km (50 mi) radius of Los Alamos. Santa Fe is the largest city within that radius, with an approximate population of 62,200 based on the 2000 U.S. census figures. Albuquerque, about 97 km (60 mi) south of LANL, has an estimated population of 490,000 based on the 2004 Mid-Region Council of Government population estimates.

About 40% of the estimated 10,000 people in the LANL workforce commute from other counties. This number is based on a recent report and is subject to change. The bulk of the facilities in the town-site business district are of the commercial, service, or light industrial type.

1.4 ENVIRONMENTAL DESCRIPTION

This section provides applicable information on the areas of meteorology, hydrology, and geology necessary to define the regional natural phenomena of concern for facility operation and accident assessment modeling.
1.4.1 METEOROLOGY

Los Alamos County has a semiarid, temperate, mountain climate. A detailed discussion of the climate of the county, including frequency analyses of extreme events, is found in the \textit{Environmental Surveillance at Los Alamos during 2002} [LANL 2004].

1.4.1.1 Observation Network

The Laboratory Air Quality Group maintains a meteorological tower and monitoring network. The six monitoring towers are located at TA-6, TA-41, TA-49, TA-53, TA-54, Area G, and on top of Pajarito Mountain. The measured meteorological variables include horizontal wind speed and direction, vertical wind speed, temperature, relative humidity, and precipitation.

The six tower heights range from 20 to 90 m (70 to 300 ft). Precipitation is measured at only three of the six sites. The TA-54, Area G monitoring station is at the tip of the mesa, between the current outer boundary of Area G and White Rock.

1.4.1.2 Temperature

Summer afternoon temperatures in Los Alamos County typically range from 20° C to 25° C (68° F to 77° F), infrequently reaching temperatures greater than 32° C (90° F), and nighttime temperatures typically range from 10° C to 15° C (50° F to 59° F). Typical winter temperatures are between –1°C and 10°C (30°F and 50°F) in the daytime, and between –10°C and –3°C (14°F and 27°F) at night, occasionally dropping to –17°C (1°F) or below. A record high temperature of 35° C (95° F) was set in June of 1981.

1.4.1.3 Precipitation

Average annual precipitation in the Los Alamos area is about 48 cm (19 in.), with about 37% of the precipitation occurring as brief, intense thunderstorms during July and August. Snowfall is greatest from December through March, with infrequent heavy snowfall in other months. Annual snowfall averages are about 150 cm (59 in.), and seasonal snowfall extremes range from 23.6 cm (9.3 in.) to 389.1 cm (153.2 in.). Variations in precipitation from year to year can be quite large: annual precipitation extremes in Los Alamos range from 17 cm (7 in.) to 77 cm (30 in.). Daily rainfall extremes of 2.54 cm (1 in.) or greater occur in most years, and the estimated 100-year daily rainfall extreme is about 6.4 cm (2.5 in.). Precipitation generally increases westward, with elevation, toward the Jemez Mountains.

1.4.1.4 Wind Speed and Direction

Wind speed and direction are measured at six locations around LANL. The monitoring stations collect data at a height of 11 m (36 ft) and 92 m (302 ft) Above Ground Level (AGL). Four of the towers are located on mesa tops of the Pajarito Plateau (TA-6, TA-49, TA-53, and TA-54). The remaining two towers are located in a canyon (TA-41) and on top of Pajarito Mountain. Winds vary dramatically with the time of day, location, and height AGL. Figures 1-4 and 1-5 present the average wind roses for daytime and nighttime conditions, respectively, as observed in the year 2004 from five of the monitoring towers [LANL 2005]. Both figures show predominant south-southwesterly winds blowing up the Rio Grande Valley. However, westerly, down-slope winds from the Jemez Mountains are commonly observed at night. Even though the frequency of wind directions varies with the season of the year, a high frequency of south-southwesterly winds is evident during all four seasons. In winter, north-northeasterly winds occur at about the same frequency as south-southwesterly winds. Winds atop Pajarito Mountain are most representative of the upper-level flows [LANL 2005].
Figure 1-4   Daytime Wind Roses at Los Alamos
Figure 1-5  Nighttime Wind Roses at Los Alamos
1.4.1.5 Atmospheric Stability

The irregular terrain at Los Alamos affects atmospheric turbulence and dispersion, both favorably and unfavorably. Increased dispersion promotes greater dilution of contaminants released into the atmosphere. The complex terrain and forests create an aerodynamically rough surface, forcing increased horizontal and vertical turbulence and dispersion. However, dispersion is greatly restricted within the canyons of Los Alamos. In addition, the dispersion generally decreases at lower elevations, where the terrain becomes smoother and less vegetated. The frequent clear skies and light winds cause good vertical daytime dispersion, especially during the warm season. The strong daytime heating during the summer can force strong vertical mixing of up to 900 to 1,900 m (3,000 to 6,000 ft) AGL. The generally light winds are limited in diluting contaminants horizontally. The same clear skies and light winds have a negative effect on dispersion at night, causing strong, shallow surface inversions to form. These inversions can severely restrict near-surface vertical and horizontal dispersion. The inversions are especially strong during the winter. Shallow drainage winds can fill lower areas with cold air, thereby creating deeper inversions. A deeper inversion is common toward the Rio Grande Valley on clear nights with light winds. Canyons can also limit dispersion by channeling airflow. A large-scale inversion during the winter can limit vertical mixing to under 3,000 m (10,000 ft).

Overall dispersion is generally the greatest during the spring when winds are strongest. However, deep vertical mixing is the greatest during the summer when the atmosphere is unstable up to 1,500 m (5,000 ft) AGL or more. Low-level dispersion is generally the least during summer and autumn when winds are quite light.

Even though low-level winter dispersion is generally greater, intense surface inversions can cause the low-level dispersive conditions during the night and early morning. The Laboratory’s location, on top of the mesas, provides good atmospheric dispersion characteristics. Two key factors are the surrounding terrain’s roughness scale and the atmospheric stability.

Bowen [LANL 1990] determined a surface roughness of 38 cm for the Laboratory. This was done using data from the TA-50 meteorological tower. This tower was later moved. TA-50, which is located in the central part of the Laboratory, is representative of the Laboratory as a whole. It is on a mesa top where ponderosa pine forests thin and transition to pinon-juniper woodlands. A fit to turbulence intensity data as a function of height for neutrally stable atmospheric conditions was used to determine the 38-cm value for the roughness factor.

Atmospheric stability is measured on a six-part Pascal scale, A–F, with A being the most unstable and F the least. During the winter, the frequencies of atmospheric stability categories are 52% unstable (A-C), 21% neutral (D), and 27% stable (E-F), as measured at TA-49. During the summer, the frequencies are 44% (A-C), 22% (D), and 34% (E-F). The stability categories are based on the vertical change in thermal conditions. The combined meteorological data (stability classes, wind speeds, wind directions, and their associated frequencies) for the LANL site have been compiled and evaluated using a straight-line Gaussian dispersion model.
1.4.2 HYDROLOGY

1.4.2.1 Surface Hydrology

Stream flow in the Los Alamos area is intermittent. Surface water runoff occurs during snowmelt and, occasionally, during summer thunderstorms. The Laboratory currently does not use any surface water resources, and no potable water storage reservoirs are near TA-54, Area G facilities.

The only hydrological characteristic applicable to operations conducted at Area G is surface runoff in small drainages off the mesa for brief periods during spring snowmelt and intense summer thunderstorms. Such runoff is controlled at Area G by surface grading and other stormwater controls.

1.4.2.2 Subsurface Hydrology

Groundwater in the LANL region occurs in two separate systems: (1) an upper-perched groundwater body in the alluvium of Mortandad Canyon and (2) a deep aquifer about 400 m (1,300 ft) below the site, in the Tesuque and Puye Formations. The primary recharge for the main aquifer is thought to be from small streams on the western flank of the Sierra de Los Valles and the western part of the Pajarito Plateau [Conover 1964 and Cushman 1965]. Additional recharge from alluvial aquifers is also possible. In contrast, recharge to the main aquifer from infiltration from the mesa tops is unlikely because of the great thickness of unsaturated tuff underlying the mesas.

When LANL facilities opened in 1943, water was derived solely from surface water sources. Water wells, using ground water sources, were installed because of later site expansions. LANL and the communities of Los Alamos and White Rock are currently supplied by water pumped from 16 deep aquifer wells in Otowi and Guaje canyons and on the Pajarito Plateau. Production from these wells is from the main aquifer in the Los Alamos area. This aquifer is the only one in the area capable of supporting municipal and industrial water supply requirements. Two additional small reservoirs are also present in the Los Alamos area.

1.4.3 GEOLOGY

This section provides the geological information necessary to define regional phenomena of any concern with respect to facility hazards. Basic geological data presented in this section are derived primarily from the LANL Site-Wide Environmental Impact Statement (SWEIS) [DOE 1999] and Environmental Surveillance of Los Alamos During 2002 [LANL 2004].

1.4.3.1 Geologic Setting

The Laboratory site is situated on the Pajarito Plateau, sloping from about 2,438 m (8,000 ft) at the Sierra de Los Valles on the west to about 2,128 m (7,000 ft) towards the Rio Grande on the east. Finger-like mesas that are separated by numerous narrow and steep-sided canyons characterize the Pajarito Plateau. The majority of LANL is underlain by the Tshirege Member of the Bandelier Tuff. The tuff is derived from welded volcanic detritus. The tuff is composed of layers dipping slightly to the southeast. The Bandelier Tuff is more than 300 m (1,000 ft) thick in the western part of Pajarito Plateau and about 80 m (260 ft) thick toward the east along the west side of the Rio Grande. Along the western edge of the plateau, the tuff overlaps the older volcanic soils that form the Jemez Mountains.
The volcanic eruptions that produced the Bandelier Tuff took place about 1.6 and 1.2 million years ago. The 1.2-million-year-old Valles Caldera was formed when a great volume of magma was ejected along ring fractures that now define the caldera structure. Another primary geologic feature in the region is the Rio Grande Rift that extends from northern Mexico to central Colorado (the valley of the Rio Grande River). The north-trending Pajarito Fault system is part of the Rio Grande Rift and consists of a group of interconnecting faults that are nearly parallel to each other.

1.4.3.2 Stratigraphy

The Bandelier Tuff forms the surface rocks of the Pajarito Plateau. The Bandelier Tuff is rhyolitic in composition, with phenocrysts of quartz and sanidine crystals, crystal fragments, and a few small rock fragments of dacite and rhyolite in an ashy matrix. A volcanic pumice layer is also present; the pumice is cellular in structure and the matrix is gray ash. The tuff and pumice range in porosity from 30% to about 60% by volume, with densities ranging from less than 1 g/cm³ (60 lb/ft³) for pumice to as much as 1.8 g/cm³ (115 lb/ft³) for moderately welded tuff.

The Tshirege Member of the Bandelier Tuff is composed of several distinct layers. Layers 3 and 4 are important as contributors to the mesa-top soils. Layer 3 is a (comparatively) strongly welded rock that resists erosion sufficiently to form the mesa topography. Layers 2 and 3, as well as the non-welded bed between them, are exposed along the canyons.

1.4.3.3 Soils

Soils on the mesas can vary widely in thickness and are typically thinnest near the edges of the mesas, where bedrock is often exposed. The walls of the canyons often consist of steep outcrops and patches of shallow, undeveloped colluvial soils (e.g., the clay, silt, sand, and gravel deposited at the base of a slope). The south-facing canyon walls are steep and usually have little or no soil material or vegetation, while the north-facing walls or slopes generally have areas of very shallow, dark-colored soils that are more heavily vegetated.

1.4.3.4 Subsurface Geology Investigation

The subsurface geology beneath LANL was investigated through a program of core hole drilling, downhole velocity measurements, and dynamic laboratory testing of core-hole samples. Based on these LANL-specific data and the seismic source characterization, deterministic and probabilistic ground motions, in terms of peak accelerations and response spectra, were estimated. The deterministic ground motions were evaluated through empirical and stochastic approaches.

The youngest localized volcanic episode within the Pajarito Plateau occurred during the late Pliocene (2.6–2.4 million years ago). Samples of temporally and chemically correlative flows were encountered in several water and test wells distributed in the central part of the Pajarito Plateau. Most of these subsurface flows are exposed along both sides of the White Rock Canyon. They represent the northern part of the widespread and voluminous eruptions of the Cerros del Rio volcanic field east of the Pajarito Plateau.

1.4.3.5 Geologic Faults in the Laboratory Area

The Rio Grande Rift represents a series of connected, en echelon structural basins flanked on both sides by a series of uplifted, tilted, and faulted north-south-trending blocks. The major faults within the basins express a predominantly northward trend and, although discontinuous, develop en echelon zones of closely spaced parallel faults.
On the east side of the Jemez Mountains, the Pajarito fault system has pre- as well as post-Bandelier Tuff ages (1.2 million years). Most of the pronounced en echelon fault displacement occurs within pre-Tshirege Member rocks. The presence of older and younger en echelon fault members is evidence of a long history of recurrent fault movement on both sides of the caldera. The Upper Bandelier Tuff has been vertically offset more than 150 m (500 ft) by the Pajarito fault system along the west side of the Pajarito Plateau. This information suggests that this major fault system is geologically active.

The three potentially active fault zones in the Pajarito Plateau are shown in Table 1-2. These faults are accompanied by numerous smaller secondary faults. The larger faults are clearly expressed by surface offsets at some locations and inferred from geologic evidence at others. The faults, including the young faulting that is significant in determining the seismic hazard at LANL, have been recently mapped. However, recent detailed mapping in the vicinity of TA-55 showed no southern extensions of the young faults.

Table 1-2  Major Faults at Los Alamos National Laboratory

<table>
<thead>
<tr>
<th>Name</th>
<th>Approximate Length (km)</th>
<th>Type*</th>
<th>Most Recent Movement</th>
<th>Maximum Earthquake (Mw)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pajarito</td>
<td>26</td>
<td>Normal, East Side Down</td>
<td>100,000 to 200,000 years ago</td>
<td>6.9</td>
</tr>
<tr>
<td>Rendija Canyon</td>
<td>9</td>
<td>Normal, West Side Down</td>
<td>8,000 to 9,000 years ago</td>
<td>6.5</td>
</tr>
<tr>
<td>Guaje Mountain</td>
<td>8</td>
<td>Normal, West Side Down</td>
<td>4,000 to 6,000 years ago</td>
<td>6.5</td>
</tr>
</tbody>
</table>

* “Normal Fault” describes a steep to moderately steep fault for which the movement is downward for the rocks above the fault zone.

** “Mw” denotes the moment magnitude scale, which is physically based and calibrated to the Richter local magnitude scale at the lower values.

The Pajarito fault is considered the currently active western boundary fault of the Española Basin. The fault forms the western boundary of the Pajarito Plateau and is easily visible above West Jemez Road as an east-facing escarpment about 91 m (300 ft) high.

The Rendija Canyon and Guaje Mountain faults are shorter than the Pajarito fault. These three faults influence the estimates of seismic hazard at TA-54, Area G because of their lengths, trends, proximity, and evidence of geologically young movement. All three faults are geologically young and are capable of producing future earthquakes. The fault locations are shown in Figure 1-6.
Figure 1-6    The Pajarito Fault System and the Rendija Canyon and Guaje Mountain Faults
1.5 NATURAL EVENT ACCIDENT INITIATORS

This section describes natural phenomena and environmental threats that may contribute significantly to the risks that TA-54, Area G poses. The discussion focuses on consequences that result from natural phenomena events, including releases of radiological and hazardous materials.

Effects on the building and equipment from accidents that are caused by credible natural phenomena, including the beyond design basis event, are considered and evaluated in Chapter 3. Tornadoes, hurricanes, and flooding are eliminated from evaluation based on the criteria found in DOE-STD-1020-2002 [DOE 2002a].

Five Performance Categories (PCs) for NPH resistance are specified in DOE-STD-1020-2002. These categories range from PC-0 for structures, systems, and components (SSCs) that require no hazard evaluation, to PC-4, a desired performance level comparable to commercial nuclear power plants.

1.5.1 SEISMOLOGY

As stated before, the Laboratory site is situated between the Pajarito fault system and the Rio Grande along the western part of the Española Basin of the Rio Grande Rift. This region has been shaped by tectonic and volcanic processes since its inception about 32 million years ago. Instrumental and historical records about faulting and earthquakes in the Pajarito Plateau and the adjacent Jemez Mountains are sparse because available documents extend back only about 100 years.

An evaluation of the seismicity recorded by the LANL network from 1973 to 1992 can be found in Seismic Hazards Evaluation of the Los Alamos National Laboratory [Wong 1995]. Only one well-located earthquake has occurred near the Laboratory or the three local faults. Although active on the microearthquake level, the Laboratory region has experienced only six earthquakes of estimated Richter magnitude or moment magnitude (M<sub>r</sub>) 5.0 or greater. The most significant event was the May 18, 1918, Cerrillos earthquake of an estimated M<sub>r</sub> 5.5, Intensity VIII, that occurred about 50 km (30 mi) southeast of Los Alamos. An earthquake of M<sub>r</sub> 4.0 to the southwest of the Laboratory in 1952 caused a reported modified Mercalli Intensity of V in Los Alamos.

The three major faults listed in Table 1-2 were examined to estimate the risk of seismic hazard in the region. Earthquakes in the region, however, are not always well correlated with faults that are expressed in the surface geology. Evidence suggests that there may be a stronger correlation between earthquakes and stress from magmatic activity. Only a few of the epicenters for reported earthquakes near LANL from 1873 through 1992 were near the Pajarito and Rendija Canyon faults (within the uncertainties of the epicenter determinations). The important conclusion that can be drawn from both the geologic and seismic evidence is that faulting in the region is an ongoing process.

This section describes natural phenomena and environmental threats that may contribute significantly to the risks that TA-54, Area G poses. The discussion focuses on negative consequences that result from natural phenomena events, including releases of radiological and hazardous materials.

Effects on the building and equipment from accidents that are caused by credible natural phenomena, including the beyond design basis event, are considered and evaluated in Chapter 3. Tornadoes, hurricanes, and flooding are eliminated from evaluation based on the criteria found in DOE-STD-1020-2002 [DOE 2002a].

Five PCs for NPH resistance are specified in DOE-STD-1020-2002. These categories range from PC-0 for SSCs that require no hazard evaluation, to PC-4, a desired performance level comparable to commercial nuclear power plants.
1.5.2 EARTHQUAKES

*Seismic Hazards Evaluation of the Los Alamos National Laboratory* [Wong 1995] details the regional and local tectonic setting for the LANL site. Site-specific ground motions have been estimated, both probabilistically and deterministically, for eight facility sites close to TA-54, Area G (i.e., TA-2, TA-3, TA-16, TA-18, TA-21, TA-41, TA-46, and TA-55). The objective of the evaluation was to determine and characterize the seismic tectonics of the area and the seismic design criteria for LANL. Within the LANL region defined in the study, 26 faults and five seismic source zones were identified as potential seismic sources significant to LANL in terms of ground shaking. In particular, the three most significant and closest faults to LANL were the focus of the study: the Pajarito, Guaje Mountain, and Rendija Canyon faults.

As is commonly observed throughout the Basin and Range Province, and reinforced by seismicity data recorded at the LANL network from 1973 to 1992, seismicity is generally not associated with mapped faults or structures. However, some microearthquakes that occurred in the region appear to correlate with some of the faults located in the region, including Puye, La Bajada-Rosario, and La Canada del Amagre-Clara Peak fault zones. Only one well-located earthquake has occurred near LANL or the three local faults. The Valles Caldera also appears to be seismically quiescent. Maximum magnitudes for the random earthquakes within these provinces range from Mw 6 to 6.5. Recurrence for these source zones was computed in the Woodward-Clyde study [Wong 1995] based on an evaluation of the historical and contemporary seismicity. The study identified a hypothesized simultaneous rupture of the Pajarito Fault, Guaje Mountain Fault, and Rendija Canyon Fault as the maximum credible event associated with these fault zones.

Seismic hazard curves were developed for each LANL site for peak horizontal (PH) accelerations and response spectral accelerations at periods of 0.2 and 2.0 seconds. These curves were based upon a probabilistic seismic hazard analysis using logic trees. This approach allows the incorporation of the full range of possible sources, paths, and site parameters and their uncertainties.

DOE-STD-1020-2002 [DOE 2002a] specifies the seismic design requirements for each PC to be used as design criteria for structures at the Laboratory. The seismic PCs and seismic hazard exceedance levels from DOE-STD-1020-2002 are presented for each PC in Table 1-3.
Table 1-3 Seismic Performance Categories and Seismic Hazard Exceedance Levels

<table>
<thead>
<tr>
<th>Performance Category</th>
<th>Mean Seismic Hazard Exceedance Levels, $P_H$</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Requirements</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Follow International Building Code (IBC) 2000 in its Entirety*</td>
<td>Use IBC 2000 Seismic Use Group I Criteria-2/3 Maximum Considered Earthquake (MCE) Ground Motion</td>
</tr>
<tr>
<td>2</td>
<td>Follow IBC 2000 in its Entirety*</td>
<td>Use IBC 2000 Seismic Use Group III Criteria 2/3 MCE Ground Motion with Importance Factor of 1.5</td>
</tr>
<tr>
<td>3</td>
<td>$4 \times 10^{-4}$</td>
<td>$P_H$ ground acceleration not calculated for this $P_H$**</td>
</tr>
<tr>
<td>4</td>
<td>$1 \times 10^{-4}$</td>
<td>0.56 g $P_H$ acceleration [Wong 1995]</td>
</tr>
</tbody>
</table>

* Based on MCE Ground Motion—generally 2% Exceedance Probability in 50 years from the seismic hazard maps, modified to account for site effects. $P_H = 4 \times 10^{-4}$.

** The Woodward-Clyde study [Wong 1995] determined that the $P_H$ ground acceleration for an earthquake with a mean exceedance level of $5 \times 10^{-4}$ per year at LANL sites near TA-50 is 0.30 g. This exceedance level was that specified for PC-3 in previous versions of DOE-STD-1020-2002 [DOE 2002a]. The new Probabilistic Seismic Hazards analysis shows that the horizontal surface Peak Ground Acceleration values are about 0.5 g at a frequency of $4 \times 10^{-4}$ per year.

In 2007, a new *Probabilistic Seismic Hazards* Analysis was prepared for Los Alamos [URS 2007]. The new characterization of the Pajarito Fault System in this analysis is significantly revised based on new mapping, displacement measurements, and paleoseismic data for the Pajarito Fault System. The new data shows that the Pajarito Fault System exhibits complex rupture patterns and shows evidence for at least two, probably three surface-faulting earthquakes in the last 11,000 years. This recent clustering is in contrast to evidence for the occurrence of only six to nine events in the last 110,000 years, although this longer record was judged to be possibly incomplete. In the Probabilistic Seismic Hazards Analysis, a suite of topographic amplification factors was developed for LANL on the basis of recent LANL modeling results, other modeling results and observations in the literature, and recommendations of international seismic codes. The modeling shows that the Pajarito Fault System primarily controls the Peak Ground Acceleration (PGA). The Pajarito Fault System also controls the LANL seismic hazard for longer-period ground motions such as 1.0-second spectral acceleration. Background seismicity in the Rio Grande Rift, which contributed to the hazard at LANL in the 1995 study, is not a significant contributor in this new analysis. This is probably due to the increased activity rate in the Pajarito Faults System in the Holocene (clustering).

The new Probabilistic Seismic Hazards Analysis shows that the horizontal surface PGA values are about 0.5 g at a return period of 2,500 years. The vertical PGA values at the same return period are about 0.3 g. The 1995 horizontal PGA values for a return period of 2,500 years are about 0.33 g. The estimated hazard increased significantly from the 1995 study due to the increased ground motions from the site-specific stochastic attenuation relationships and increased activity in the Pajarito Fault System. The site response effects, as modeled in this study with the newer site geotechnical data, appear to amplify ground motions more than the 1995 analysis. Other factors could be the increased epistemic uncertainty incorporated into the empirical attenuation relationships and the characterization of the Pajarito Fault System.
The site-wide PGAs as a function of Return Period are described in Table 1-4.

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Horizontal PGA</th>
<th>Vertical PGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 year</td>
<td>0.27</td>
<td>0.32</td>
</tr>
<tr>
<td>2,500 year</td>
<td>0.52</td>
<td>0.60</td>
</tr>
<tr>
<td>10,000 year</td>
<td>1.03</td>
<td>1.21</td>
</tr>
</tbody>
</table>

Based on the increased seismic hazard at LANL, a site-wide Justification for Continued Operation (JCO) was prepared and submitted to Los Alamos Site Office for approval. The JCO was approved for all LANL nuclear facilities, including TA-54, Area G. The JCO required facility-specific seismic analysis of all PC-2 and PC-3 SSCs for all nuclear facilities, and has since been closed.

Because TA-54, Area G is considered a limited-life nuclear facility, structures are not credited for withstanding seismic events. The accident analysis does consider NPH design basis accidents, though controls are limited to reducing consequences of the event versus evaluating PC requirements for dome structures (no impact on the structure DR=0). Non-dome structures, such as Building TA-54-412, and the compactor facility, have limited material-at-risk, so consequences for the unlikely seismic event are low. Below-ground storage has adequate overburden to prevent any release during a seismic event. During retrieval operations, the exposed face of the below-ground waste being retrieved is at risk from a seismic event and is analyzed in Chapter 3.

1.5.3 VOLCANISM

The El Cajete pumice fallout, which forms the youngest volcanic eruption within the Valles Caldera, erupted about 50,000 to 60,000 years ago after a long period of quiescence of about 460,000 years. Vestiges of volcanism continue today, as evidenced by gas venting and hot spring activity within the caldera moat, notably at Sulfur Springs, more than 32 km (20 mi) west of TA-54, Area G, and southwest of the caldera at several localities in San Diego Canyon along the present course of the Jemez River.

Wolff and Gardner [Wolf 1995] demonstrated that the products of the El Cajete and related eruptions were from newly generated magma batches that are unrelated to other caldera magmas. This, together with the age of the eruptions (50,000 to 60,000 years ago) following a 450,000-year period of volcanic quiescence, led them to conclude that instead of representing the waning stages of caldera volcanism, the youngest eruptions in the caldera represent the onset of a new volcanic cycle. Steck et al. [Steck 1998] showed that magma exists beneath the caldera through the use of seismic velocities. Thus, the possibility of renewed volcanism, likely in the form of small eruptions, is real, albeit unquantified. DOE has not established standards for resistance to a volcanic event, and in consideration that the TA-54, Area G is a limited-lifetime nuclear facility (shut down as a waste facility by 2015), the volcanic event is considered a beyond design basis accident and not addressed any further.

1.5.4 FLOODS

Large-scale surface flooding is not common in New Mexico. Flooding is possible in the spring from snowmelt, although snowmelt flooding is usually confined to areas in which the larger rivers in the State of New Mexico are located. Snowmelt can cause muddy conditions in the Los Alamos area, along with minor flooding of streams in the Jemez Mountains.
Although large-scale surface flooding is less common in New Mexico, flash floods from heavy thunderstorms are possible in susceptible areas such as arroyos and canyons. Flooding from a heavy thunderstorm could occur in Los Alamos in canyons or facility low spots. Drainages from the watersheds above Los Alamos that were burned by the Cerro Grande Fire of May 2000 and the Las Conchas Fire of June 2011 are at extreme risk of flash flooding under even normal rainfall patterns.

Because of the Cerro Grande Fire flooding, evaluations have been performed to account for the reduced ground absorption capacity from the loss of vegetation. Based on the analysis results, the TA-18 area and the town of White Rock were of major concern. Because of this concern, a flood retention dam was constructed to the west of TA-18. TA-54, Area G is located to the northeast of TA-18 and is downstream of the retention dam. Additionally, Area G is located on a mesa top about 100 ft above the flood path. Flooding evaluations because of the Cerro Grande Fire did not identify Area G as a flood concern because of its location on a mesa top.

1.5.5 SEVERE WEATHER

This subsection describes the severe weather conditions in Los Alamos that can affect the design and operation of LANL facilities. The following discussions are taken from LA-11735-MS, Los Alamos Climatology [LANL 1990].

1.5.6 COLD WEATHER CONDITIONS

Frigid weather occasionally occurs in Los Alamos when polar or Arctic air masses settle over the region. Normally, the temperature drops to -17° C (1° F) or below only once or twice a year. Los Alamos cold waves can be defined as times when the temperature drops to -23° C (-9° F) or lower, or when the temperature drops to -17° C (1° F) or below for at least two consecutive days. The most severe cold wave probably occurred during the week beginning January 3, 1971. Temperatures plunged after a snowstorm dropped 25 cm (10 in.) of snow on Los Alamos. From January 3 to 7, 1971, Los Alamos’s morning low temperatures were -22° C (-9° F), -25° C (-13° F), -27° C (-17° F), -26° C (-15° F), and -22° C (-8° F), respectively. The record low temperature is -28° C (-18° F), which was set in January 1963. Between January 4 and 7, 1971, high temperatures recorded in the Los Alamos area only reached -16° C (3° F), -13° C (9° F), -13° C (9° F), and -13° C (9° F). The TA-54, Area G structures were designed for expected extremes in temperature. The effect of such conditions was considered in the hazard analysis.

1.5.7 SNOW OR RAIN

Winter storms with snowfalls of 10 cm (4 in.) or more are common in Los Alamos. Winter storms with winds above 24 km/h (15 mph) may be associated with cold temperatures, resulting in dangerous wind chills, considerable drifting, and low visibility. Occasionally, snowstorms cause heavy snowfall in the mountains, while little snow falls in Los Alamos. The combination of heavy snowfall and restricted visibility may create hazardous driving conditions.

The accumulation of snow on trees, followed by strong winds, may result in downed trees and utility lines. Such conditions are often created after wet snows, which are common in the late fall and spring. The record snowfall in Los Alamos occurred in January 1987. Snow from a single storm accumulated 122 cm (4 ft) at TA-59 and 152 to 183 cm (5 to 6 ft) in North Community. Another 122 cm (4 ft) of snow fell at TA-59 during February 1987. The snow’s weight damaged or collapsed several residential roofs in Los Alamos. The water equivalent from the 1987 monthly snowfall totaled 8.71 cm (3.43 in.) in January and 8.74 cm (3.44 in.) in February. Snow loads were considered in the hazard analysis.

A precipitation event is not expected to occur that could challenge the dome structures. Rain, hail, and ice are not expected to challenge the structures. The dome’s roofs are slanted, which will allow rain, hail, and
ice to flow off the structures. Snow typically slides off the dome structures due to the slope of the domes; however, some accumulation could be postulated.

1.5.8 LIGHTNING STRIKES

Lightning in Los Alamos can be frequent and intense during some thunderstorms. Lightning strike data, based on an informal communication with LANL’s Environment, Safety, and Health (ESH-17) personnel and information obtained from the National Oceanic and Atmospheric Administration website (www.nws.noaa.gov), indicate a local lightning strike density/frequency of about six strikes/km²/yr. Lightning strikes were considered in the hazard analysis.

1.5.9 TORNADOES AND STRONG WINDS

Historically, tornadoes have not been reported in Los Alamos County. However, a funnel cloud was reported near White Rock on August 23, 1983. In addition, numerous funnel clouds were reported near Santa Fe on August 24 and 25, 1987. A tornado touched down in Albuquerque on September 20, 1985 and caused some damage to a small area. Most recently, a tornado was sighted near Budaghers, north of Albuquerque, on June 9, 2007.

Dust devils are more likely to cause locally damaging winds in Los Alamos. It has been determined that dust devils theoretically could develop uppermost winds of 179 km/h (112 mph). Strong dust devils commonly produce 120 km/h (75 mph) winds. Several dust devils have caused damage in Los Alamos. A strong dust devil on April 24, 1973, at TA-53, knocked a trailer off its supports and rolled it one complete revolution.

High-speed, short-duration gusts can be generated locally by outflow (microbursts) from summertime thunderstorms. Sustained, high-speed winds, on the other hand, occur with cold frontal passages and when Los Alamos lies in a sharp pressure gradient field between high and low pressure systems. A high-pressure gradient field was responsible for the sustained high winds that occurred during the Cerro Grande Fire of May 2000.

Los Alamos is considered a light wind site, with surface winds at the Laboratory averaging 7 mph. Wind gusts exceeding 50 mph are common during the spring. The highest recorded wind gust in recent history was 77 mph on Nov. 15, 1998. DOE-STD-1020-2002 [DOE 2002a] recommends that the peak gust wind speeds listed in Table 1-5 be used as design-basis criteria for a PC-2 structure at the Laboratory.

<table>
<thead>
<tr>
<th>Performance Category</th>
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</tr>
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<tbody>
<tr>
<td>Annual exceedance probabilities</td>
<td>1E-2</td>
</tr>
<tr>
<td>Return period (yr)</td>
<td>100</td>
</tr>
<tr>
<td>Peak gust wind speed (mph)*</td>
<td>90*</td>
</tr>
</tbody>
</table>

* A 90 mph three-second gust wind speed as required by both IBC-2003 and American Society of Civil Engineers (ASCE) 7. ASCE 7, which provides the technical basis for the wind speed used in the building codes, changed from fastest-mile to three-second-gust wind speed in 1995. ASCE 7 supersedes American National Standards Institute A58.1. All buildings are currently designed to three-second-gust wind speeds.

Because TA-54, Area G is considered a limited life nuclear facility, structures are not credited for withstanding wind events. The accident analysis does consider a PC-3 wind event, though controls are
limited to reducing consequences of the event versus evaluating PC requirements for dome structures (because dome structures have a damage ratio equal to zero). Non-dome structures, such as Building TA-54-412, have limited material-at-risk so that consequences for the unlikely wind event are low.

1.6 MAN-MADE EXTERNAL ACCIDENT INITIATORS

1.6.1 WILDLAND FIRE

The semiarid climate, particularly during a dry season, makes the region susceptible to human-caused forest fires and those started by lightning. Five forest fires in the area, American Springs (June 1954), La Mesa (June 1977), Dome (spring 1996), and Cerro Grande (May 2000), and Las Conchas (June 2011) have approached or threatened the Laboratory. The Cerro Grande damaged some facilities but did not result in releases of nuclear materials. Wildland fire exposure has been evaluated in the Fire Hazard Analysis for TA-54, Area G [LANL 2013]. The Fire Hazard Analysis concludes that wildland fires result in a high hazard rating to Area G dome structures. Wildland fires are considered credible scenarios and are addressed as a potential accident initiator in the Chapter 3 hazard analysis.

Firebreaks and cleared areas around buildings have been provided to reduce the threat of direct propagation of a wildland fire, but airborne transport of burning embers from fires remains a credible threat to LANL facilities. Burning embers from large wildfires such as the Las Conchas fire can be transported up to several miles, with the potential to ignite spot fires at significant distances from the main fire [LANL 2013a].

The Los Alamos Fire Department is trained and experienced in forest-fire fighting. Adjacent forested lands to the south and west of LANL boundaries are owned by the U.S. Park Service and the U.S. Forest Service, respectively. These services have fire-fighting teams available on call to fight fires in these areas.

The Cerro Grande Fire threatened TA-54, Area G; however, due to past vegetation/tree thinning and firefighting efforts, the fire never came closer than within about 3.3 km (2 mi) of the facility. The facility had taken actions before the fire to minimize vegetation near the domes, and performed cutbacks of trees near the facility boundaries to mitigate the effects of a wildfire if it came close to the facility. In June 2011, the Las Conchas Fire occurred. No essential buildings at LANL were threatened by this fire. Only a one-acre spot fire burned on Laboratory property before firefighters extinguished it.

1.6.2 DESIGN BASIS OR EVALUATION BASIS EXPLOSIONS FROM NATURAL GAS LINES

Natural gas is not piped into TA-54, Area G.

1.6.3 AIRCRAFT CRASH HAZARD

An aircraft crash at TA-54, Area G is considered a credible event due to the proximity of an airport and the associated flight traffic. Because an aircraft crash is a credible event, it is addressed in Chapter 3.

1.6.4 TRANSPORTATION ACTIVITIES

Vehicle accidents from public roadways are not considered possible given the location of TA-54, Area G away from Pajarito Road. Operational vehicle accidents at Area G are considered credible events based upon the frequency of vehicular travel within Area G. Various types of vehicles are allowed inside the security fence and may include heavy construction and earth-moving equipment, waste transport trucks, forklifts, large cranes, personnel transport vehicles, and service and utility vehicles. Flammable and explosive fuel types inside the fence may include diesel, gasoline, cleaning solvents, and propane. High
explosives are not allowed within Area G; however, high explosives may be transported on Pajarito Road, located about 200 m (656 ft) to the south and 33 m (108 ft) below Area G.

1.7 NEARBY FACILITIES

No industrial facilities, except for those within the Laboratory TAs, are in the vicinity of TA-54, Area G. The closest collocated facilities to Area G (distances are approximate from the nearest Area G waste storage/disposal location to the named area) are as follows:

- TA-54, Area L: chemical and mixed waste storage; office trailers (560 m [1,850 ft])
- TA-54, Area J: solid nonradiological, non-hazardous waste landfill, and temporary storage of hazardous waste (1,925 m [6,315 ft])
- TA-54, Area H: classified waste burial site (inactive) (2,335 m [7,660 ft])
- TA-54 West: Radioassay and Nondestructive Testing Facility (2,280 m [7,480 ft])
- TA-54-1009, AirNet Analytical Laboratory (3,300 m [10,800 ft])
- TA-18 Facilities (1,960 m [6,430 ft])
- TA-36 Facilities (945 m [3,100 ft])

As shown in Figure 1-2, the closest TAs to TA-54, Area G, include TA-18, and TA-36. TA-18, situated across Pajarito Road, is currently in the process of decommissioning. TA-36, also located across Pajarito Road along the western boundaries of Area G, is the Kappa Site. Various explosives phenomena are investigated at TA-36. The type of activities conducted and the separation distances ensure that these nearby sites will not affect the safety of operations conducted at Area G.

TA-54, Area G’s impact on nearby facilities is mainly limited to activities that are required during some waste transfers. In the event of an accident at Area G, Pajarito Road may need to be closed off to non-emergency public and Laboratory traffic. This may limit access to nearby facilities. Other than limiting vehicle access, no other significant impact was postulated. It is important to note that public access to Pajarito Road is prohibited.

Accidents at other facilities could result in restricted access to TA-54, Area G. In this event, Area G would not be greatly affected, as there are no systems which would require continuous operation, nor are there systems or operations that cannot be suspended for prolonged periods of time. The waste containers would remain in storage as they were left before the accident. Road closures are also required by other facilities for movement of materials or training exercises. As stated above, these have little impact on TA-54, Area G.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

The information contained in Section 1.3 of this chapter confirms that the location of Area G at TA-54 is adequate to meet its program objectives. The geographic and demographic settings combine to make TA-54, Area G an area that is remote and secure, with minimal environmental impact, and subject to few severe natural phenomena. The Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory [DOE 1999] was issued in 1999. Assumptions in the SWEIS relating to demographics, land use, local economy, and transportation have been updated.
1.9 REFERENCES


LANL 2013 REPORT-WFM-017, Rev. 5, Fire Hazard Analysis for Technical Area 54, Area G, Los Alamos National Laboratory, Los Alamos, NM, March 2013.

LANL 2013a LA-UR-13-24529, Revision 1, Airborne Projection of Burning Embers Planning and Controls for Los Alamos National Laboratory Facilities, July 2013
URS 2007  

Conover 1964  

Cushman 1965  

Erickson 2002  

Wolf 1995  

Wong 1995  

Steck 1998  
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<tbody>
<tr>
<td>ALARA</td>
<td>As Low As Reasonably Achievable</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>BG</td>
<td>Bolas Grande</td>
</tr>
<tr>
<td>BIO</td>
<td>Basis for Interim Operation</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CMP</td>
<td>Corrugated Metal Pipe</td>
</tr>
<tr>
<td>CWDR</td>
<td>Chemical Waste Disposal Requests</td>
</tr>
<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
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<tr>
<td>DOT</td>
<td>U.S. Department of Transportation</td>
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<tr>
<td>DVS</td>
<td>Drum Venting System</td>
</tr>
<tr>
<td>FOD</td>
<td>Facility Operations Director</td>
</tr>
<tr>
<td>FRP</td>
<td>Fiberglass-Reinforced Plywood</td>
</tr>
<tr>
<td>GC</td>
<td>Gas Chromatography</td>
</tr>
<tr>
<td>HalfPACT</td>
<td>Half-Transuranic Package Transporter</td>
</tr>
<tr>
<td>HAZMAT</td>
<td>Hazardous Material</td>
</tr>
<tr>
<td>HDPE</td>
<td>High-Density Polyethylene</td>
</tr>
<tr>
<td>HENC</td>
<td>High-Efficiency Neutron Counter</td>
</tr>
<tr>
<td>HEPA</td>
<td>High-Efficiency Particulate Air</td>
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<tr>
<td>HERCULES</td>
<td>High-Efficiency Radiation Counters for Ultimate Low Emission Sensitivity</td>
</tr>
<tr>
<td>HE-RTR</td>
<td>High Energy Real-Time Radiography</td>
</tr>
<tr>
<td>HPG</td>
<td>High-Purity Germanium</td>
</tr>
<tr>
<td>HTO</td>
<td>tritiated water/vapor</td>
</tr>
<tr>
<td>HW</td>
<td>Hazardous Waste</td>
</tr>
<tr>
<td>ISOCS</td>
<td>In-Situ Object Counting System</td>
</tr>
<tr>
<td>LAFD</td>
<td>Los Alamos Fire Department</td>
</tr>
<tr>
<td>LANL</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>LLW</td>
<td>Low-Level Waste</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>MAR</td>
<td>Material-at-Risk</td>
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<tr>
<td>MLLW</td>
<td>Mixed Low-Level Waste</td>
</tr>
<tr>
<td>MS</td>
<td>Mass Spectrometry</td>
</tr>
<tr>
<td>NDA</td>
<td>Nondestructive Assay</td>
</tr>
<tr>
<td>NDE</td>
<td>Nondestructive Evaluation</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>NMED</td>
<td>New Mexico Environmental Department</td>
</tr>
<tr>
<td>OM</td>
<td>Operations Manager</td>
</tr>
<tr>
<td>ORPS</td>
<td>Occurrence Reporting and Processing System</td>
</tr>
<tr>
<td>OSRP</td>
<td>Offsite Source Recovery Program</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated Biphenyl</td>
</tr>
<tr>
<td>PE-Ci</td>
<td>Plutonium Equivalent Curies</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>Pu</td>
<td>Plutonium</td>
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<tr>
<td>RANT</td>
<td>Radioassay and Nondestructive Testing Facility</td>
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<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<td>Radiation Protection Program</td>
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<td>RTR</td>
<td>Real-Time Radiography</td>
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<tr>
<td>SSC</td>
<td>Structures, Systems, and Components</td>
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<tr>
<td>SSSR</td>
<td>Sort, Segregate, Size Reduction, and Repackaging</td>
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<td>SWB</td>
<td>Standard Waste Box</td>
</tr>
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<td>TA</td>
<td>Technical Area</td>
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<td>TDOP</td>
<td>Ten-Drum Overpack</td>
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<td>TEU</td>
<td>Temperature Equilibration Unit</td>
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<td>TRU</td>
<td>Transuranic</td>
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<td>TRUPACT</td>
<td>TRU Package Transporter</td>
</tr>
<tr>
<td>TSD</td>
<td>Transportation Safety Document</td>
</tr>
<tr>
<td>TSDF</td>
<td>Treatment, Storage, and Disposal Facility</td>
</tr>
<tr>
<td>VAC</td>
<td>Volts Alternating Current</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Chemical or Compound</td>
</tr>
<tr>
<td>WAC</td>
<td>Waste Acceptance Criteria</td>
</tr>
<tr>
<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
</tr>
</tbody>
</table>
FACILITY DESCRIPTION

2.1 INTRODUCTION

The objective of this chapter is to provide facility and process descriptions and relationships of structures, systems, and components (SSCs) to support assumptions used in the hazard and accident analyses. A graded approach was established for this chapter by providing a model of the facilities that would allow an independent reader to develop an understanding of facility operations and appreciation of facility structure without extensive consultation of controlled references. The level of detail required in the facility description is based on the significance of preventive and mitigative features identified and the degree of facility complexity necessary to understand the analyses. These descriptions are intended as a general reference for the user of the Area G Basis for Interim Operation (BIO). Configuration and performance criteria are contained in Chapter 4 of this BIO.

The mission of Technical Area-54 (TA-54), Area G is to provide receipt, storage, processing, retrieval, disposal, or shipment of radiological, hazardous, and mixed waste. Activities at Area G are conducted such that the health and safety of the facility worker, the collocated worker, the offsite general public, and the environment are protected.

Area G activities occur concurrently to allow for flexibility and optimizing operations. The activities include the following:

- Low-Level Waste (LLW), Mixed Low-Level Waste (MLLW), Hazardous Waste (HW), tritium waste, tritium-contaminated waste, and transuranic (TRU) waste receipt, disposal and/or storage
- Drum venting
- Sort, Segregate, Size Reduction, and Repackaging (SSSR)
- Head-space gas analysis and thermal equilibration
- Shipping, including Type B container loading operations using mobile equipment
- Non-destructive evaluation and analysis
- Retrieval of waste containers from underground storage

This chapter also provides an overview of the Area G site, including its mission and history, and descriptions of the following as required by DOE-STD-3009-94, CN 3 [DOE 2006]:

- Area G site facilities
- Activities within a defined areas
- Confinement systems
- Safety support systems
- Site utilities
- Auxiliary systems and support systems

2.2 REQUIREMENTS

The following essential regulatory documents, including federal laws and U.S. Department of Energy (DOE) orders and standards, contain the requirements for establishing the facility’s safety basis:
2.3 FACILITY OVERVIEW

Area G is the primary site for the disposal of LLW and tritium-contaminated waste, and the storage of MLLW, HW, tritium waste, higher activity tritium-contaminated waste, and TRU waste. The Area G facilities shown in Chapter 1, Figure 1-3, are situated in the middle of TA-54 on Mesita del Buey. The LLW to be disposed of includes radiologically contaminated asbestos, bio-organics, beryllium, and small amounts of polychlorinated biphenyls (PCBs). The HW and MLLW are stored in arrays that are easily inspected in a Resource Conservation and Recovery Act (RCRA)-permitted storage area. Small amounts of tritium waste, higher activity tritium-contaminated LLW and MLLW are also stored in specific, commercially constructed steel chemical storage units on a RCRA-permitted pad. The TRU waste destined for the Carlsbad, NM Waste Isolation Pilot Plant (WIPP) is also stored in easily inspected arrays that allow for container integrity as well as RCRA inspections. Radiological wastes with significantly high dose rates that pose an unacceptably high exposure hazard to workers are placed in shafts for storage and/or disposal to meet as low as reasonably achievable (ALARA) requirements.

Operations associated with waste management at Area G and subject to this BIO include radiological waste receipt, handling, repackaging, storage, container inspection, decontamination, waste characterization and verification (both intrusive and non-intrusive), venting and purging, size and volume reduction, disposal, retrieval of legacy waste, environmental monitoring, and other operations to disposition the waste. The transport of TRU waste by Area G personnel between TA-54, Area G and the TA-54 Radioassay and Nondestructive Testing Facility (RANT) occurs along Mesita del Buey Road. This road is not part of the TA-54, Area G boundaries; however, the transport of TRU waste inventory between RANT and Area G by Area G personnel is covered under the Area G BIO. Chapter 5 of the Area G BIO provides information on the interface between the Area G BIO and the RANT documented safety analysis. The transport of TRU waste over public roads within the Laboratory site is governed by the Laboratory Transportation Safety Document (TSD). The interface between the Area G BIO and the LANL TSD requirements is described in Chapter 5 of the Area G BIO.

The LLW, MLLW, HW, tritium waste, tritium-contaminated waste, and TRU waste are managed according to applicable regulations. In accordance with RCRA, all mixed waste received is stored within RCRA permitted storage areas. Retrievably stored TRU wastes at Area G, if acceptable under the WIPP Waste Acceptance Criteria (WAC), will be prepared for eventual shipment to WIPP. TRU waste not meeting the WIPP WAC, and MLLW with no treatment path, will be held in storage at Los Alamos National Laboratory (LANL) until process activities are developed to treat and/or prepare this waste for acceptance at WIPP or another Treatment, Storage, and Disposal Facility (TSDF).

Radiological wastes (TRU, LLW, MLLW, tritium waste, and higher activity tritium-contaminated waste) are stored in designated storage areas. These areas can be either indoors or outside, and are designed to control liquid run-on and runoff. The storage areas may also house radiation-monitoring equipment (e.g.
continuous air monitors), assay equipment and emergency response, and spill clean-up equipment. Stored waste within these areas is separated by inspection aisles per RCRA requirements. Whether above or below ground, waste containers are generally stacked in three-dimensional storage arrays. As waste containers are retrieved from storage areas for processing in preparation for transport to WIPP, they may be staged within the storage area, or any other defined area within Area G, awaiting processing or transport. These defined areas can be within domes or buildings or in the open, such as locations adjacent to pits or trenches as needed to support retrieval operations. Similarly, processing may be done at any defined process area, either in buildings or under temporary contamination control structures. The accident analysis is done using bounding values for dispersion factors ($\chi/Q$) so that results are bounding for any Area G location. For tritiated water and water vapor (HTO), the dose consequences associated with skin absorption are determined. These are often estimated as 50% of the inhalation dose from any HTO.

Area G still serves as a processing and storage area for newly generated radiological waste at LANL. Thus, some new waste is periodically received at Area G. Radiological waste is also generated as a result of waste handling activities in Area G. Most of the activities at Area G currently deal with retrieving and processing older waste in preparation for transport to WIPP as part of the plan for terminating the role of Area G as a TRU waste facility. Therefore, the net radiological inventory (Material-at-Risk [MAR]) at Area G is decreasing with time. The MAR used for accident analysis is determined by a statistical approach defined in DOE-STD-5506 [DOE 2007]. With this approach, MAR values are largely defined by legacy high-activity containers. Bounding MAR values for accident analysis are likely to decrease over time as these high-activity containers are processed.

2.4 FACILITY STRUCTURES

This section provides an overview of the major facility buildings and structures significant to the hazard and accident analyses. Area G is comprised of both administrative facilities and facilities where waste operations occur. The administrative facilities are not subject to the requirements of this BIO and include, for example, Buildings 54-11, 54-20, 54-156, 54-252, 54-276, 54-295, 54-306, 54-324, 54-325, and 54-371.

Area G structures provide weather protection for above-ground stored waste, process operations, and process equipment. Some of these structures provide a confinement function, though this capability is not credited as a safety-class or safety-significant function. Buildings are not credited with mitigating any accident scenarios.

The structures and facilities that are subject to the requirements of this BIO are where all radiological, hazardous, and mixed waste operations occur, and include the following:

- Waste Assay Facility, Building 54-2
- Drum Preparation Facility, Building 54-33
- Pads 1 through 10
- Rigid Storage/Processing Structures 54-486, and 54-491
- Tritium waste, tritium-contaminated waste, and MLLW Storage Areas
- Waste Holding Shed, Building 54-8
- Building 54-412
• Radiological Confinement Structures
• LLW Disposal Pits
• Underground Shafts for Retrievable Storage and Disposal
• Underground Pits and Trenches for Retrievable TRU Waste
• Nondestructive Evaluation (NDE)/Nondestructive Assay (NDA) Structures
• Temperature Equilibration Units (TEUs), Buildings 54-545 and 546
• Auxiliary systems and support structures are described later in this chapter in Section 2.9.

2.4.1 WASTE ASSAY FACILITY, BUILDING 54-2

The Waste Assay Facility (Building 54-2) is a single-story, steel-frame building set on a concrete slab foundation with steel siding and roof deck. The total gross floor area of this building is about 139.35 m² (1,500 ft²). The building is partitioned into two equally sized main rooms by gypsum-board on wood-stud construction.

Space is provided for offices and storage of equipment, tools, and supplies related to characterization operations. Building 54-2 also houses analytical equipment to characterize waste containers. For example, high-efficiency radiation counters, a long-range alpha detector, and High-Purity Germanium (HPG) gamma detectors are currently used in this facility. As instrumentation technologies change, waste characterization systems are updated to meet current mission requirements. Building 54-2 also includes a shop area for general maintenance and equipment storage.

2.4.2 DRUM PREPARATION FACILITY, BUILDING 54-33

Building 54-33 is a single-story, aluminum arch-frame-supported, membrane-covered dome with an attached cement-block-constructed annex. The construction of the building annex is concrete block on a concrete slab with a flat, built-up roof on a steel deck. Building 54-33 has a gross floor area of about 465.52 m² (5,000 ft²) which is divided into two areas, one of which is 348.38 m² (3,750 ft²) covered by the aluminum arch-frame building and the second is 116.13 m² (1,250 ft²) covered by the annex building. The dome is separated from the building annex by motorized roll-up doors set in concrete-block construction. The perimeter of the dome is provided with a concrete curb except at the dome access doorways, which are ramped.

The dome portion of the building has no partitions. Access into the dome is provided through large clamshell-type doors, one at the west end and one at the southeast end. Access into the annex is through two smaller roll-up doors. There are personnel access doors to both the annex and the dome. The annex building is partitioned by two tee-configured concrete-block walls. The north-south wall separates two bays. The ceiling of the annex is constructed of painted gypsum board. In addition to the waste containers, drum handling and radiological monitoring equipment is located within the facility.

The Drum Venting System (DVS) unit has historically been located in Building 54-33. However, this equipment may be relocated if the need arises.

2.4.3 PADS 1 THROUGH 10

Pads 1 through 10 and Building 54-33 are where the RCRA-permitted waste storage or processing (i.e., characterization, drum venting, repackaging) activities occur. The activities may occur inside a dome or building structure that is anchored to the pad, or directly on the pad, such as outside storage of waste.
containers. All of the pads are of asphalt construction. The pads were originally dimensioned to accommodate dome or building structures as well as to provide sufficient space for outside storage of waste containers. Therefore, the dimensions of the pads vary. To fulfill RCRA permit requirements, slopes and berms are constructed around each of the pads so that rain water (and thus any other fluids) from outside a pad area will not flow into the pad area. Facility procedures extend the RCRA requirements for berms, slopes, and/or impediments at TRU waste defined areas where there are non-RCRA TRU waste storage areas.

With the evolution of the LANL RCRA Permit with the New Mexico Environmental Department (NMED), the original pad 1-10 identifiers have been revised and consolidated [NMED 2009]. Currently, in alignment with the information in the LANL RCRA Permit, buildings and structures on each pad are listed below. A description of each cited building or structure on the pads is provided in other sections of this document.

- Pad No. 1 – Location of Building 54-412.
- Pad No. 3 – Location of dome structure 54-48.
- Consolidated Pad No. 5 – Formerly pads 5, 7, and 8. Location of the tritium shed 54-1027, hazardous waste storage sheds 54-1028, 54-1041, and 54-1030; tritium monitoring shed 54-273; dome structures 54-224 and 54-49; miscellaneous storage sheds 54-144, 54-145, 54-146, and 54-147.
- Pad No. 6 – Location of dome structures 54-283 and 54-153.
- Pad No. 9 – Location of dome structures 54-229, 54-230, 54-231, and 54-232.
- Consolidated Pad No. 10 – Formerly pads 2 and 4. Location of various characterization and TEUs).

The miscellaneous storage sheds are commercially-available, small portable steel buildings designed for chemical storage with no electrical or plumbing systems. The floor is grated with secondary containment. Passive ventilation is provided through vents at the bottom and the top of the sheds. The sheds are about 5 ft by 6 ft by 8 ft high. They are used to temporarily store chemicals that are in the process of being disposed of. RCRA inspections of these locations are performed weekly.

The hazardous waste sheds are larger than the miscellaneous storage sheds, about 9 ft by 23 ft by 8 ft high. These storage sheds have electrical power for lighting, ventilation, and fire alarms. Fire suppression is provided via a dry chemical system. While passive ventilation is provided by gratings at the top and bottom of the shed, forced ventilation is also provided. An exhaust fan with intake at the bottom and top of the building is operated by a manual switch on the outside of the shed. Vapor sampling can be set up in these sheds. The sheds are placarded to allow for segregation of hazardous materials.

The tritium storage shed is similar to the hazardous waste sheds, except that a tritium monitor is installed in the shed. When the tritium monitor is functional, it provides a signal to tritium monitoring shed 54-273, which has alarm indicators on the outside of the building.

Mixed low-level waste was observed in one of the miscellaneous storage sheds, but otherwise they were empty during the walk-down. No waste was identified in the hazardous waste sheds. Tritium-contaminated waste was present in drums in the tritium storage shed. However, Dome 54-224 held non-regulated poisons, acids, caustics, and lab-packs containing fluorescent light bulbs, in addition to low-level mixed waste. Secondary containment and segregation is used in Dome 54-224.
In addition to the waste containers, various equipment such as durable plastic clamshells with secondary containment, pallets for drum storage, drum handling equipment, drum processing equipment, and radiation monitoring equipment can be found on these pads. The Area G roadways run adjacent to the pad locations.

2.4.4 DOMES

Currently at Area G, there are 9 dome structures used for waste storage: 54-33, 54-48, 54-49, 54-153, 54-224, 54-229, 54-230, 54-232, and 54-283, and 2 domes that house Perma-Cons used for SSSR activities: 54-231 and 54-375. Each structure is a single-story dome with no internal partitioning. Representative arch (sprung) and truss dome structures are presented in Figure 2-1 and Figure 2-2, respectively. Each structure is set and anchored on an asphalt pad. These asphalt pads and structures are located over inactive waste disposal pits, except for dome structure 54-33. Although these structures vary in size, their configuration, interior/exterior finish, and construction are similar to the domed portion of Building 54-33 with several exceptions. The west end of 54-283, and both ends of 54-375, are rectangular (flat-walled) rather than arched semicircular. Structures 54-48, 54-49, 54-153, 54-224, 54-229, 54-230, and 54-283 are supported with an aluminum arch-frame design, and structures 54-231, 54-232, and 54-375 are supported with an aluminum A-frame truss design. Characteristics of the dome structure fabric were evaluated in Structural Effects of Fabric Integrity on TA-54 Dome Structures [LANL 2006a]. The evaluation segmented the dome structures into two groups: (1) Group A - domes for which the fabric does not provide structural support to the steel and aluminum members: 54-224, 54-229, 54-230, 54-231, 54-232, and 54-375, and (2) Group B - domes for which the fabric currently provides structural support to the steel and aluminum members: Domes 54-33 (Section 2.4.2), 54-48, 54-49, 54-153, and 54-283.

Access into 54-33, 54-48, 54-49, 54-153, and 54-283 is provided by large clamshell doors; access into 54-224, 54-229, 54-230, 54-231, 54-232, and 54-375 is provided by large roll-up doors. Additional personnel access is provided in the perimeter of the domes through industrial personnel doors.

Buildings 54-224 and 54-230 are equipped with a high-density polyethylene (HDPE) floor liner for secondary containment. The floor liners for these buildings are located under their asphalt pads. Buildings 54-33, 54-229, and 54-230 have sumps at the east ends to collect water, 54-375 has a sump on the east end, and 54-224 has a sump located in the middle of the dome. Lighting inside the domes is provided by ambient light. Additional lighting is installed to support process operations on an as-needed basis. In general, airflow movement in the domes is by natural convection; on occasion, local zone fans are used to circulate air. When specific operations require controlled ventilation, portable duct-fan units with high-efficiency particulate air (HEPA) filters are installed. Domes are equipped with fire extinguishers and radiation monitoring equipment, as necessary. All domes have lightning protection. Electrical power is supplied to domes as necessary. In order to fulfill the requirements of RCRA, pads and storage areas have certain design requirements such as slopes and/or berms. Facility procedures extend the RCRA requirements for berms, slopes, and/or impediments at TRU waste defined areas where there is non-RCRA storage. When domes are de-inventoried, they are dismantled and removed to support Area G closure.

A summary of the domes’ characteristics is provided in Table 2-1.
Table 2-1 Characteristics of Storage Domes at Area G

<table>
<thead>
<tr>
<th>Dome</th>
<th>Frame Design</th>
<th>Height (ft)</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Door Type</th>
<th>Floor</th>
<th>Other Features</th>
<th>Manufacturer</th>
</tr>
</thead>
</table>
| 54-33 | Arch         | 23.58       | 156         | 50         | Clamshell (2) | concrete | • Dry-pipe sprinkler system (active)  
• Grated trench drain  
• 2 bays in annex  
• Drainage sump | Sprung |
| 54-48 | Arch         | 23.17       | 287         | 46         | Clamshell | asphalt | | Sprung |
| 54-49 | Arch         | 26.0        | 436.5       | 60         | Clamshell | asphalt | | Sprung |
| 54-153| Arch         | 25.58       | 325         | 60         | Clamshell (2) | asphalt | | Sprung |
| 54-224| Arch         | 26.08       | 107.17      | 60         | Roll-Up   | asphalt | • HDPE floor liner  
• Drainage sump | Canvas Specialty |
| 54-229| Arch         | 35.83       | 246.08      | 88.58      | Roll-Up   | asphalt | • Dry-pipe sprinkler system (inactive)  
• Drainage sump | Canvas Specialty |
| 54-230| Arch         | 35.83       | 246.08      | 88.58      | Roll-Up   | asphalt | • Pre-action fire suppression system (inactive)  
• HDPE floor liner  
• Drainage sump | Canvas Specialty |
| 54-231| A-truss      | 30.82       | 242.08      | 88.58      | Roll-Up   | asphalt | • Drain to 54-229 sump  
• Pre-action fire suppression system for permacon installed in this dome. | Rubb |
| 54-232| A-truss      | 30.82       | 242.08      | 88.58      | Roll-Up   | asphalt | • Drain to 54-229 sump | Rubb |
Table 2-1  Characteristics of Storage Domes at Area G

<table>
<thead>
<tr>
<th>Dome</th>
<th>Frame Design</th>
<th>Height (ft)</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Door Type</th>
<th>Floor</th>
<th>Other Features</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-283</td>
<td>Arch</td>
<td>25.67</td>
<td>248</td>
<td>60</td>
<td>Clamshell</td>
<td>asphalt</td>
<td></td>
<td>Sprung</td>
</tr>
</tbody>
</table>
| 54-375| A-truss      | 37.67       | 300         | 100        | Roll-Up (2) | asphalt| • Drainage sump  
  • Pre-action fire suppression system for the permacon and 4 ancillary connexes installed in this dome. | Rubb         |

1 Storage domes are categorized as light construction as described in Section 4.4.5, DOE-STD-5506-2007 [DOE 2007].

2 The Rubb manufacturer used galvanized steel structural members. Sprung and Canvas Specialty used aluminum structural members.
Buildings 54-486 and 54-491 are of metal exterior and steel frame construction. Building 54-486 is 16 ft wide by 20 ft long. Building 54-491 is 16 ft wide by 40 ft long. The structures have no internal portioning walls. The structures have limited power capability to support various analytical equipment and heaters. Building 54-486 houses a Gas Chromatography/Mass Spectroscopy (GC/MS) system. Building 54-491 is a heated structure that is used to provide a working space to sample the containers for head-space gas analysis. Access to Building 54-486 is through personnel doors on the west and north side. Access into Building 54-491 is through personnel doors on the northwest and northeast sides of the structure. Building 54-486 also contains ancillary equipment for the GC/MS sampling activities, (e.g., sample needles, syringes, calibration gases). Building 54-491 is equipped with a localized ventilation unit.
(MAC 21) which provides radiological protection during sampling activities according to Radiation Protection Program (RPP) requirements. Building 54-491 is also equipped with a dry chemical fire suppression system. Drum handling equipment such as drum dollies and small hand trucks, in addition to radiation monitoring equipment, can be found in these facilities.

2.4.6 WASTE COMPACTOR FACILITY, BUILDING 54-281

The waste compactor facility, Building 54-281, has been demolished.

2.4.7 TRITIUM-CONTAMINATED WASTE AND MIXED LOW-LEVEL WASTE STORAGE AREAS

Located at Pad 7 are dome structure 54-224, commercially constructed steel tritium storage sheds 54-1027, 54-1028, 54-1030, and 54-1041, and a tritium monitoring structure, 54-273. Dome structure 54-224 is described in Section 2.4.4. The tritium storage sheds are near the southeast side of Building 54-49. Each of the tritium storage sheds are unanchored, free-standing metal structures. Each shed has a floor area of about 16.35 m² (176 ft²). The tritium monitoring structure, Building 54-273, is a wood shed structure with a floor area of about 22.3 m² (240 ft²).

In addition to structures, stored tritium-contaminated waste and MLLW containers, and drum-handling and radiological monitoring equipment can be found in the vicinity of the storage areas. Storage sheds are equipped with a dry chemical fire suppression system that is capable of suppressing fires. The storage sheds are also equipped with sumps built into the floor to provide secondary containment of leaks or spills. The floor of each shed consists of a metal grating that covers the sump area. Access into the sheds is provided through double-leaf doors. The entrances are wide enough to allow the tines of a forklift to reach into the sheds for the purpose of placing or retrieving waste drums. Electrical conduits run from the tritium monitoring structure to the tritium storage sheds. The tritium monitoring structure houses equipment used to monitor the air inside the tritium storage sheds. If not used to store tritium-contaminated waste, the sheds may contain stored equipment, material, or RCRA-permitted waste.

2.4.8 WASTE HOLDING SHED, BUILDING 54-8

The Waste Holding Shed (Building 54-8) is a single-story, steel-frame building set on a concrete slab foundation with steel siding and roof decks. The interior finish is composed of vapor-barrier-covered insulation material bound to the steel siding and roof. The total gross floor area is about 59.46 m² (640 ft²). Access to the building is through a roll-up door. The building contains no internal partitioning. In addition to temporarily stored waste containers, drum handling and radiological monitoring equipment are located within the facility.

2.4.9 BUILDING 54-412

Building 54-433 facility consists of a free-standing structure housed within Building 54-412 that provides secondary confinement. The inside primary-confinement structure (Building 54-433) provides the primary confinement and contamination control for process operations. Building 54-412 is equipped with a supply ventilation system, an exhaust ventilation system, a fire suppression system, and a diesel backup generator. Building 54-412 is a steel-framed structure, with steel siding and roof decks. Building 54-433 is constructed of gypsum board on metal studs. Building 54-412 is about 1,114.84 m² (12,000 ft²) and contains the staging/receiving area, the shear baler, and support equipment for the inner confinement building (Building 54-433). Building 54-433 is about 232.26 m² (2,500 ft²) and is divided into five freestanding cells that are used to perform processing activities.
Building 54-433 was originally planned as housing and a support structure for the shear baler. Future use of the shear baler is not anticipated; therefore, Building 54-433 is being considered for other operations, particularly SSSR. The five free-standing cells were originally planned for processing fiberglass-reinforced plywood (FRP) boxes. These include a cell for receiving/unsheathing/package removal/preparation, a cell for segregation/decontamination, a cell for special decontamination activities, a cell for waste packaging/size reduction, and a cell as an input station for the shear baler. This inner structure is equipped with two airlocks and has its own ventilation system to maintain a negative pressure relative to Building 412 with HEPA-filtered exhaust. Building 54-433 has continuous air monitors to alert personnel if airborne radiation levels exceed acceptable limits.

A large roll-up door provides access to the host building (Building 54-412). Building 54-412 includes an airlock for moving equipment and waste containers in and out of the building while maintaining confinement and negative pressure. Roll-up doors are located at each end of the airlock. Standard industrial doors are located along the sides and ends of the building to provide personnel access.

2.4.10 RADIOLOGICAL CONFINEMENT STRUCTURES

Metal-constructed Perma-Con structures, other similar tent-like radiological confinement control enclosures, or glove bags are used within or outside of Area G dome structures or Building 54-412. The confinement structures may be as small as a single 55-gal drum or as large as an FRP waste container that holds a discarded glovebox. The confinement structures may be equipped with HEPA filtration according to RPP requirements.

2.4.11 LOW-LEVEL WASTE DISPOSAL PITS

LLW pits are constructed on an as-needed basis within Area G. The number of pits in use and their dimensions may vary based on operational requirements. Ramps may be provided on one end of a pit (Figure 2-3) to provide access for waste transport vehicles and heavy equipment. The requirements for the construction and closure of the pits are derived from the *Performance Assessment and Composite Analysis for LANL TA-54, Area G* [LANL 2008].
2.4.12 UNDERGROUND SHAFTS FOR DISPOSAL AND RETRIEVABLE STORAGE

2.4.12.1 Low-Level Waste Disposal Shafts

There are about 260 LLW disposal shafts in Area G, grouped into five general locations. One group is located between Pit 39 and Pit 15. Two groups are near Building 54-412, with one group just west and another just south. The fourth and largest group is located south of Pit 15 and the equipment yard. The fifth and smallest group is just northeast of Building 54-281. The LLW disposal shafts are located away from the edge of the mesa rim. Shafts vary in diameter from 0.3 m (1 ft) to 4.87 (16 ft) and are up to 20.12 m (66 ft) in depth.

Most LLW disposal shafts are unlined, but some have metal liners to facilitate disposal activities. A shaft cover limits entry of water run-off into active shafts and helps protect the integrity of the top of the shaft. Closed shafts have been sealed (capped) with concrete or crushed tuff. The requirements for the construction and closure of the LLW disposal shafts are derived from the Performance Assessment and Composite Analysis for LANL TA-54, Area G [LANL 2008].

2.4.12.2 TRU Shafts

Shafts used for TRU waste storage are fairly shallow (about 4.87 m [16 ft] in depth). Figure 2-4 provides an example of a shaft location. The shafts are typically identified with numbers ranging from 200 to #306 (i.e., #200, #201, #202, etc.) and contain below-grade retrievable TRU waste, except for the unlined shafts (#33, #72 through #76). The TRU shaft configuration consists of the following:

- **Lined Shafts (#200 through #232)**
  The 33 lined shafts, numbered 200 through 232, were constructed in Shaft Field B. The shafts were augered into the volcanic tuff and are approximately 2 ft in diameter and 18 ft deep. A 13-ft-long by 8.5 in.-diameter, ¼-in.-thick carbon steel pipe liner was placed into the shaft. The steel pipe liner has a steel plate welded to the bottom and a steel cap attached to the top. Crushed tuff, cobbles, and sand were backfilled into the void between the pipe liner and the initial boring. A concrete cap was then placed over the top.

- **Hot Cell Liner Shafts (#302 through #306)**
  Five lined shafts, 302 through 306, contain hot cell liners, which are decommissioned gloveboxes encased in steel boxes as containers. The shafts have a ¼-in.-thick carbon steel liner on the sides, with a crushed tuff, cobbles, and sand bottom, and a ¼-in.-thick carbon steel plate welded to the shaft liner on the top. The shafts exceed 10 ft in depth (to accommodate the outer steel boxes), and measure 9 ft 4 in. by 9 ft 4 in. in cross section. The bottoms of the shaft liners are open.

- **Canister Shafts (#236 through #243, and #246 through #253)**
  These 16 shafts are 3 ft in diameter and 16 ft deep, and are currently empty.

- **Unlined Shafts (#33, #72 through #76)**
  Radiological waste was placed into these shafts in the early 1970s. During that time, TRU waste at LANL was not segregated for these shaft disposals. As a result, a small number of TRU waste packages were disposed of with the LLW.

- **Tritium Torpedo Shafts (#262 through #266)**
Five shafts were constructed to contain torpedo-shaped waste containers. Four of the torpedoes are large enough to contain three 55-gallon drums each; the fifth torpedo contains a 20-ft long tank with tritium-contaminated waste. This waste was generated from a decommissioning project at TA-55 and was emplaced in the shafts between 1995 and 1997.

Figure 2-4  Shaft Disposal Units
2.4.13 UNDERGROUND PITS AND TRENCHES FOR RETRIEVABLE TRU WASTE

2.4.13.1 Pit 9 Underground Burial Area

Pit 9 was constructed with an asphalt pad upon which TRU waste drums and FRPs were placed in a dense pack array. The waste containers were positioned in cells within the pit; successive layers in each cell were separated by sheets of plywood. After each cell was filled, it was covered with plywood sheets, heavy vinyl sheeting, and approximately 1 m (3 ft) of soil. Pit 9 contains approximately 200 FRPs and 4,000 waste drums (see Figure 2-5).

![Figure 2-5 Historical Pit 9 Underground Burial Area]

2.4.13.2 Corrugated Metal Pipe Underground Burial Area

A burial area in Area G was constructed for the placement of 158 corrugated metal pipes (CMPs) filled with cemented TRU waste. This burial area is directly above Pit 29. There is approximately 6 ft of soil separating the CMP burial area and Pit 29. The CMPs have dimensions of 86.3 cm (34 in.) outside diameter, 76.2 cm (30 in.) inner diameter, and are 6.1 m (20 ft) long. Both ends of a CMP are sealed with a 0.3-m (11.8-in.) concrete plug. After the area was filled with CMPs, they were covered with plywood, tarps, and soil. Figures 2-6 through 2-8 are archival photos showing a single CMP, placement of the CMPs within the pit, and stacks of the CMPs before they are covered with plywood, tarps, and soil.
Figure 2-6  Single-filled Corrugated Metal Pipe placed at Area G

Figure 2-7  Operators placing Corrugated Metal Pipes at TA-54, Area G
2.4.13.3 Underground Trenches A through D for Retrievable TRU Waste

Trenches A through D are four trenches covering an area of roughly 1,700 ft by 200 ft. The trenches contain 363 reinforced pipe concrete casks. The buried casks have dimensions of approximately 81.28 cm (32 in.) outside diameter and 60.96 cm (24 in.) inside diameter and are about 1.82 m (~ 6 ft) long. The exterior surface is coated with coal-tar epoxy; some casks are also coated with asphalt roofing-type compound. The concrete casks were placed single-file in the four trenches in groups of 10, with about 3-ft separation between each group of ten (Figure 2-9). Each concrete cask contains one or two 30-gallon drums. The concrete cask lids are sealed to the cask with asphalt roofing-type compound. Closed casks are covered with sheets of corrugated, galvanized metal decking, followed by about 1.82 m (~ 6 ft) of soil. Figures 2-10 and 2-11 are photos showing a concrete-lined cask with a 30-gal drum, the placement of the 30-gal drums within a cask, and the storage array with several of the concrete casks sealed.
Figure 2-9  Trenches A through D, Typical Elevation for Cask Array

Figure 2-10  Historical Photograph Showing a 30-Gallon Drum inside a Concrete Cask
Figure 2-11  Historical Photograph showing a Cask Array

(Photo also shows black liquid concrete seal and casks with concrete cap, and the corrugated metal planks that were placed on top of the sealed casks before covering the trench area with soil overburden)

2.4.14 NDE/NDA STRUCTURES

The mobile characterization structures are trailer-mounted units (axles and hitch), which are moved from site to site as needed by the National TRU Program. They are constructed with metal exteriors. The structures have typical dimensions of, for example, 2.44 m (8 ft) wide, 6.1-12.19 m (20-40 ft) long, and 2.44 m (8 ft) high. The trailers are powered with 220 or 480 volt, available at the site. The interior of the trailer typically has a control room/office and an analysis chamber. Access to the trailer is through a personnel door, which leads into the control room. Personnel doors inside the control room allow access to the analysis chamber. Inside the analysis chamber, various pieces of characterization equipment may be installed. Characterization equipment includes, for example, x-ray, gamma spectroscopy, and neutron detection systems. Ancillary equipment, such as computers or other detection equipment, may be used to analyze and/or video record analysis results.

The High-Energy Real-Time Radiography (HE-RTR) is housed in a shielded vault with a nearby control trailer. The vault contains a high-energy accelerator, which is used to analyze contents of large containers. Access for personnel and waste drum is through a door that is interlocked with the accelerator. The door must be closed for the accelerator to activate.

2.4.15 TEMPERATURE EQUILIBRATION UNITS

The TEUs are converted metal SeaLand containers. The interiors of the SeaLand containers are insulated so that heat is retained. The typical outside dimensions of a TEU are approximately 12.19 m (40 ft) long and 2.44 m (8 ft) wide, with an inside height of approximately 2.44 m (8 ft). The floors are of metal-plated wood. Access is through metal-hinged doors on one end, and a roll-up door on the other end.
2.5 PROCESS DESCRIPTIONS

Area G provides permanent disposal and temporary storage for various types of radiological, hazardous, and mixed waste generated and received at LANL. Process activities include receipt and handling of waste containers, waste container storage and associated support activities, waste repackaging, TRU waste container venting, characterization, underground retrieval of TRU waste, and shipping. All process activities at Area G occur in defined areas. Defined areas are facility-identified and demarcated physical locations that meet applicable safety basis requirements to safely carry out the process activity intended for that defined area. A defined area may or may not align with physical structures. The boundaries of these defined areas are established before commencement of activities. These same waste handling or processing activities may be conducted concurrently in multiple Area G locations, utilizing portable or mobile equipment along with minimum fixed or permanent facility structures. Other support activities include inspection and maintenance of stored waste containers or equipment, and maintenance and surveillance of below-ground burial areas.

2.5.1 ACCESS CONTROL / RECEIPT AND HANDLING OF WASTE CONTAINERS

2.5.1.1 Access Control

Waste transportation vehicles travel down Mesita del Buey Road to reach Area G. Vehicle and personnel access to the site is controlled at the Operations Center. Drivers stop their vehicles and enter the Operations Center for authorization to proceed into Area G. Personnel are required to receive authorization before entry. Vehicles that access Area G may include micro-vans, all-terrain vehicles, full-sized to 1-ton capacity pick-ups, Type B container transportation vehicles, LANL Packaging and Transportation vehicles, heavy equipment (i.e., front-end loader, water truck, bulldozer, road graders, and water wagons), and refueling vehicles.

2.5.1.2 Receipt of Waste Containers

Documentation to support waste disposal and/or storage is completed by waste generators and approved by LANL personnel before the actual shipments of waste to Area G. Radiological waste (i.e., LLW, MLLW, HW, tritium waste, tritium-contaminated waste or TRU waste) is transported to Area G from LANL waste generators in accordance with applicable Hazardous Material Regulations or the LANL TSD. Waste is received utilizing a waste acceptance process that includes Waste Profiles, Chemical Waste Disposal Requests (CWDR), WAC, and a Waste Verification Program. The Waste Profile provides the information necessary to classify the waste, including physical form, chemical characteristics, the waste-generating process, etc. The CWDR or TRU Waste Storage Record describes the transportation-specific information related to the waste, including the amount of waste, type of container, radiological constituents, dose rates, etc. The WAC identifies the material forms, content, packaging, and radioactive quantities allowed to be accepted at Area G. The Waste Verification Program ensures that waste received at Area G has been characterized and packaged in accordance with an approved Waste Profile consistent with the waste characterization data provided by the waste generator, and that it meets the LANL WAC. Waste containers received at Area G are accompanied with documentation completed by the waste generator that identifies the contents (including isotopic constituents), hazards, and dose rates of each container. Visual inspections are performed on waste shipments upon receipt at Area G. This includes verification that incoming pallets are compliant with fire protection requirements and facility procedures (i.e., they are of metal or non-flammable construction). Any nonconformance associated with waste packaging, characterization, or documentation is documented and addressed in accordance with approved procedures. In the event that a nonconformance is identified, the waste generator is responsible for correcting the problem, either at TA-54, or, if necessary, after the waste is returned to the generating facility.
2.5.1.3 Transport / Handling Waste Containers

Once waste containers are received at Area G, depending on the waste type, the waste containers are transported to a defined area. Transport of waste containers includes moving waste containers between different defined areas. Handling occurs within a defined area and includes removing or inserting waste containers from a dome storage area and/or storage process areas. Transport or handling equipment may include large or small trucks, forklifts, or hand dollies.

2.5.1.4 Transport Between RANT / Area G

Waste transports between RANT and Area G down Mesita del Buey Road may be performed by Area G personnel. RANT is located about one mile from the entrance gate to Area G. Both RANT and Area G are within the TA-54 perimeter, as is Mesita del Buey Road between these two sites. The material transfer takes place using the same vehicles, personnel, and controls used for transport within Area G. The accident analysis uses bounding dispersion values so that results are bounding for all of Area G and RANT. Thus, this transport activity is covered by this BIO with escort requirements specified in the TSR.

2.5.2 WASTE STORAGE OR DISPOSAL

2.5.2.1 TRU Waste

The TRU wastes are normally shipped to Area G in 55- and 85-gal compliant drums or standard waste boxes (SWBs). Large pieces of TRU-contaminated waste, such as gloveboxes, are packaged in custom metal boxes. Other large pieces, e.g., a discarded caustic liquid waste treatment tank with residual amounts of TRU contamination, that are too large to fit into a metal-type box, are wrapped tightly in plastic for contamination control. Past practices included the receipt of oversized TRU items in FRP waste containers. The FRP waste containers are no longer accepted as newly generated TRU waste packaging.

Contact-handled waste containers are surveyed for external contamination and dose rates before acceptance at Area G and before placement into a defined area. Contact-handled TRU waste containers are placed in a storage area inside a structure, such as a dome, or on an outdoor pad. Drums are placed on metal or non-flammable pallets (Figure 2-12). Remote-handled TRU waste containers are stored in shafts. Retrieval of remote-handled TRU waste containers is not in the scope for this BIO. The FRPs are also placed into a storage area (Figure 2-13). Containers are stored in rows separated by aisles, consistent with applicable permits and codes. Drums banded with straps of various materials (i.e., metal or other sturdy material) and SWBs may be stacked three layers high (Figure 2-12). The containers may be grouped by type within a defined area.

The actual TRU waste is typically packaged directly into a TRU waste container (drum, SWB, etc.). In some cases, the waste contents are inserted into smaller containers of various sizes, such as screw-top metal containers, Volrath cans, or miscellaneous metal containers with a taped lid. Alternatively, a smaller nested drum may be placed in the TRU waste container, with waste items within the smaller drum. The various-sized containers can be as large as 30 gal, and as small as a 30-ml vial.

In general, a variety of waste matrices may be found in the TRU waste container. Carbuoy-sized containers (~ 5 gal) with residual liquids have been found inside the TRU waste container. The types of liquids encountered include cleaning solutions (sometimes in their original packaging [i.e., a Fantastik® bottle]), and organic solvents such as ethanol and acetone. Other organic liquids such as pump oil (which could be within a discarded pump), paint, etc., may also be within the TRU waste container. A TRU waste container may be entirely filled with unpunctured aerosol cans with some residual contents. In
addition, flammable gases may be present within a TRU waste container. Other waste matrices include, e.g., combustible debris (i.e., paper, rags, plastic, rubber, wood, and other plastic-based and cellulose-based waste); metal debris (i.e., glovebox parts, small tools, cans, motors, and pumps); inorganic and organic sludge; and other inorganic debris (i.e., glass, ceramics, and pyrochemical salts). The waste may contain RCRA-regulated constituents, lead shielding, and free liquids (both organic and aqueous). These waste matrices may be remediated either through SSSR activities or at the Waste Characterization, Reduction, and Repackaging Facility at TA-50-69, depending on the MAR content.

The outer, parent TRU waste containers are typically vented. Inner containers within the parent TRU waste container may be sealed or unsealed. Based on the LANL WAC and container characterization studies, Class 1 oxidizers (pyrophoric) such as nitrates, and reactive flammables such as lithium metal or hydrides, are not expected in the waste matrices; however, they are considered in the hazards analysis as possibly being present in the TRU waste containers.

![Transuranic Waste Storage (Typical of All Domes)](image.png)
2.5.2.2 Low-Level Waste

The LLW delivered to Area G for storage or disposal at Area G complies with the LANL WAC. The LLW may be received in a wide variety of containers. Typical containers used to transport LLW to Area G for storage and disposal include metal or fiber drums (55- and 85-gal), 96 ft³ metal boxes (B-25 boxes), wood boxes, fiber (cardboard) boxes, fiber bags (super sacks), and roll-off bins. LLW comes from the same activities, processes, and generators as TRU waste, but has an activity less than 100 nCi/g per the LANL WAC. Thus the same waste matrices described for TRU waste apply to LLW as well.

Much of the LLW received in Area G is directed to a pit or shaft for immediate disposal. LLW containing asbestos may also be disposed of at TA-54 in pits or shafts. Any LLW containing tritium greater than 490 Ci/m³, animal tissue, beryllium, classified items, radiation sources, or having surface dose rates greater than or equal to 1 R/hr, may be disposed of in a shaft. LLW prohibited from disposal at TA-54 is specifically defined in the WAC (i.e., explosives, RCRA-regulated waste, pathogens, pyrophorics.)

The LLW destined for pit disposal is generally directed to and placed in the appropriate pit upon completion of receipt inspection at TA-54. The transport vehicle may enter the pit as needed. Heavy containers may be unloaded with a forklift or crane. Bulk waste is delivered in roll-off bins. The contents of these bins are emptied directly into the pit. Light containers, such as cardboard boxes, may be unloaded by hand. Containers are placed to maximize pit efficiency. The LLW in pits is covered to maintain exposed MAR below specified limits as required, and when required to stabilize waste within the pit. The LLW pits are filled to the level allowed by the Performance Assessment and Composite Analysis for LANL TA-54, Area G [LANL 2008].

The LLW destined for shaft disposal is generally directed to and placed in the appropriate shaft following completion of receipt inspection at TA-54. The placement of waste in a shaft may involve the use of large mobile cranes and slings for heavy containers. Lighter containers may be placed manually or using chutes. Waste is placed in a manner that maximizes the use of a shaft’s volume capacity. The LLW shafts are filled to the level allowed by the Performance Assessment and Composite Analysis for LANL TA-54, Area G [LANL 2008].
Some LLW is stored at Area G to allow further processing, characterization, and verification of the material, and to address waste nonconformance with WAC requirements. Storage of LLW at Area G may also be performed as part of the process to ship LLW to offsite facilities for final disposition. Offsite disposal of waste may be considered an appropriate strategy for handling waste that does not comply with the LANL WAC, and as a means of preserving the limited available LLW disposal capacity within Area G pits or shafts.

### 2.5.2.3 Mixed Low-Level Waste

MLLW is LLW that contains a RCRA-listed HW. Per the LANL WAC, MLLW received at Area G cannot contain explosives or certain classes of highly reactive substances. Solid and liquid MLLW are not combined in one container. A complete and specific characterization of the chemical and radiological content of the waste must be provided by the generator. Containers for MLLW must meet U.S. Department of Transportation (DOT) requirements for shipment.

Most of the MLLW shipped to Area G is stored in Dome 224 or Consolidated Pad 5 for temporary storage awaiting final deposition. On occasion, MLLW may require storage in a dome where TRU waste is stored. In this situation, the MLLW is segregated from the TRU storage locations within the dome. All MLLW is shipped off-site for final disposition. RCRA permitting allows MLLW to be stored at Area G for one calendar year.

MLLW containers are surveyed for external contamination and dose rates before placement into the storage areas. Drums are placed on metal or non-flammable pallets and placed into a storage area. Containers are stored in rows separated by aisles in accordance with applicable permits and codes. The MLLW drums may be stacked three layers high. The container/waste types are grouped/segregated in designated locations.

Occasionally TRU waste containers are characterized and reclassified as MLLW. The documentation associated with the containers is updated. These containers may be transferred to a MLLW storage area while awaiting the verification of the assay analysis. When the verification process is completed, the drum is relabeled to indicate that the contents meet MLLW criteria and is handled as MLLW thereafter.

### 2.5.2.4 Tritium Waste

Tritium waste and tritium-contaminated waste is received at Area G for disposal in pits or shafts, or for storage pending transportation for offsite disposal. Packaged tritium-contaminated waste with less than 20 Ci/m³ may be placed in waste pits or trenches. This is typically equipment with residual tritium contamination. Tritium-contaminated waste with tritium concentrations greater than 20 Ci/m³ and tritium waste is subject to additional packaging requirements as defined in the LANL WAC. These requirements are progressively more stringent as the concentration of tritium increases up to 100,000 Ci/package. Tritium waste packages typically contain tritiated water absorbed on a molecular sieve or equivalent zeolite materials. Tritium waste packages with greater than or equal to 500 Ci/pkg and less than 100,000 Ci/pkg are stored in welded stainless-steel containers or stainless steel containers with machined metal flanges and metal gaskets. A HDPE or stainless steel overpack is then used over the inner container. These packages may be stored in the tritium sheds, pending disposition.

### 2.5.3 UNDERGROUND RETRIEVAL

A requirement of the New Mexico Consent Order for the removal of TRU waste from Area G by 2015 is the removal of TRU waste stored underground. Work is being planned for the removal of buried CMPs; FRPs and drums from Pit 9; and unvented 30-gal drums from Trenches A through D. Retrieval of remote-
handled TRU waste containers is not in the scope of this BIO. Details on the processes involved in the underground waste retrieval work follows.

2.5.3.1 Corrugated Metal Pipes Retrieval Activities

Previous wastewater treatment operations (May 1968 to June 1978) at TA-21 generated an effluent that was solidified in a pug mill using Portland cement. The homogeneous wet cement product was then pumped into 6.1-m-long (20-ft-long) CMPs. 158 CMPs were generated in this process. The weight of each CMP ranges from 10,000 lbs (4535.92 kg) to 14,000 lbs (6,350.3 kg). Each CMP contains anywhere from 10 to 191 Plutonium (Pu)-239 plutonium equivalent curies (PE-Ci). The CMPs were placed in a pit near the southeastern end of Building 54-153 and covered with plywood, tarps, and soil. Because the CMPs lie directly under an active road, the road will be relocated before initiation of CMP retrieval operations.

The CMP retrieval program entails overburden removal with equipment such as backhoes or other heavy equipment. The CMPs are to be retrieved with equipment such as, a backhoe or a crane, depending on the integrity of the CMP. Following retrieval, the CMPs are cleaned of any loose debris, screened for radiological contamination, and stored at Area G until their further disposition. CMPs that are stored at Area G may require wrapping in plastic, according to RPP requirements for contamination control or NMED requirements for their storage. The CMPs are transported to storage locations with equipment such as flatbed trucks or a forklift. An alternative to storing the CMPs is to cut the CMP into smaller lengths for insertion into a container such as an SWB, which will be stored within the Area G storage areas. Before cutting the CMPs, a confinement structure can be erected directly over the CMP location, if required by RPP requirements, so that the CMPs can be cut as they are unearthed.

Before storage, the CMP may be sampled, such as with a coring tool, to characterize the cemented waste for hazardous constituents. Samples may be shipped for analysis to either a LANL analytical laboratory or an offsite laboratory. When all CMPs are removed, the pit will be monitored for residual contamination and decontaminated if required.

2.5.3.2 Trench A-D Retrieval Operations

Trenches A–D contains approximately 721 unvented 30-gal drums placed within 363 lined concrete casks. Each cask holds up to two 30-gal drums. The drums contain myriad waste matrices, predominantly contaminated with heat-source Pu oxide, $^{239}\text{PuO}_2$. Each of the 30-gal drums contains from about 2 to 620 PE-Ci. Following the placement of cask lids, corrugated decking was placed over the casks.

Following removal of overburden, equipment such as a crane or forklift with suitable strapping and/or slings will be used to retrieve each drum. Immediately after retrieval, the drums can be inspected for their integrity and surveyed for contamination. If contamination is detected, it may be addressed by using one of many methods, e.g., decontamination, treatment with a fixative, or wrapping in plastic to contain the contamination. Drums may also be vented following their retrieval. Alternatively, a lid-restraining device can be applied to the drum lid, or the drum can be overpacked for transport to an Area G storage location. After drums are removed from cask locations, the trench area is monitored for contamination and decontaminated if necessary.

2.5.3.3 Pit 9 Retrieval Operations

Pit 9 contains an estimated 6,000 PE-Ci in approximately 4,000 drums and 200 FRPs or similar boxes. The waste packages were buried in Pit 9 during the late 1970s and early 1980s. The pit was divided into 3
or 4 cells, and each cell was filled with waste containers. Historical data indicate that the drums were stacked up to 6 high in the pit. FRPs were also stacked around and on top of some of the drums.

Pit overburden will be removed with heavy equipment such as backhoes or front-end loaders. Equipment such as cranes or forklifts will be used to remove waste containers. Waste containers are removed from Pit 9 so that a stair-step configuration is achieved. This is accomplished, for example, by the removal of soil and plywood covers so that a number of waste container lids are exposed. A crane will remove the first layer of waste containers from a starting row, then remove additional containers from secondary rows that are situated on either side of the starting row (if the starting row is within the middle of the exposed containers). Then the crane will return to the starting row and remove a second layer of drums. The crane will then go to the rows that are next to the secondary rows, and two rows away from the starting row – these rows are depicted as the third row of drums. The crane removes the first layer from the third row of drums, a second layer from the secondary rows, and a third layer from the starting row. This process continues until the stair-step configuration is achieved, and the soil can be removed so that a forklift can be situated at the bottom of the pit to access the front bottom layer of waste container rows. The process experience gained from the TWISP activities indicates that removal of the drums using this stair-step approach is the most stable configuration for retrieval.

Drums may be washed, vented, or overpacked at Pit 9 or at another Area G process location. FRPs are transported to a defined storage area until they are remediated. Alternatively, significantly damaged FRPs can be remediated at Pit 9. After retrieval of waste containers, the pit will be monitored for residual contamination and decontaminated if required.

2.5.4 DRUM VENTING

Container venting and sampling activities are performed to prevent accumulation of flammable gas in the container headspace of drums. Venting includes penetrating the confinement barrier of a container and providing a drum vent mechanism.

The drum is provided with a blast-mitigation device (e.g. doublepack or lid restraint) prior to puncturing the container. Workers are located at a safe standoff distance from the drum while venting occurs. The tools or processes used for drum venting are chosen to minimize mechanically-induced sparking. Equipment/tools used to minimize mechanically-induced sparking may be constructed of non-sparking material, and/or the process may be conducted in such a manner that the potential for sparks is minimized (e.g., low-speed cold drilling).

Various methods may be used to perform the drum venting. For example, venting may be performed using portable equipment that installs lightweight dart filters. The venting unit is self-securing to the drum lid and facilitates puncturing using an installed, remotely activated pneumatic device. The dart filter sample port penetrates the container lid with an aluminum bronze housing, which prevents sparking during penetration of the container. The dart filter has a sharpened tip for ease of penetration, and a wide flanged filter head that seats against the drum lid and protects against the dart filter penetrating completely through the drum lid. Other techniques may be used to perform drum venting. These include the use of brass drum penetration tools or cold/speed drilling processes that are non-sparking. One such example of a system which uses the cold/speed drilling process is the commercially available DVS. The DVS has a chamber which supports the blast mitigation function by minimizing the physical hazards to the personnel in the immediate vicinity. However, a safe standoff distance would still be required for the worker should the DVS be used.

Contamination will be controlled in accordance with Radiation Protection Program requirements for a contamination-controlled environment. After the unvented drum is vented, access to the drum and the
necessity for personnel protective equipment are determined by the results of radiological monitoring, also performed according to Radiological Protection Program requirements.

For transport, drum handling controls include the use of lid restraints (or other blast mitigation devices), and blast shields/engineered barriers or a safe standoff distance for worker protection.

Unvented drums awaiting venting are stored in a single planar array in an isolation area where nonessential personnel and activities are not allowed. The areas are designated as operation-free locations, and barriers or posting are placed around them.

Following penetration/venting, and the installation of WIPP-approved filters and a sampling port, the drum is placed back into isolated storage to allow for flammable gas equalization. After the drum completes its equalization time, the drum is returned to the containment structure and a headspace gas sample is collected. Equalization time depends upon the initial hydrogen concentration. Guidance on equalization times is available from the filter manufacturer. Historically, hydrogen concentrations have dissipated to acceptable levels during the filter manufacturer’s prescribed equalization time. In a few cases, drums with methane production have required much longer equalization times.

If it is found that the headspace gas analysis is unacceptable, the drum is treated as an unvented drum. The unvented drum is stored in isolation until further headspace gas analysis indicates that flammable gas concentrations are at acceptable levels and the drum is considered a vented drum. Purging will not be done. This means that equalization times will be longer, but also eliminates potential problems with flammable gas rebound.

2.5.5 WASTE VOLUME / SIZE REDUCTION, SEGREGATION, REPACKAGING, AND DECONTAMINATION

LLW, MLLW, and TRU waste volume/size reduction, segregation, repackaging, and decontamination may be performed throughout Area G in defined areas. The following activities may occur: waste segregation, waste transferred from one container to another, prohibited item removal, waste consolidation, lid replacement, decontamination, inspection, and other open-container activities necessary to make waste containers compliant for offsite shipment or disposal. Details on specific waste volume reduction, repackaging, and decontamination activities are provided below.

2.5.5.1 Low-Level Waste Compaction

Compaction of LLW was previously performed in Building 54-281. Waste compaction is no longer performed at Area G, and the waste compactor facility has been demolished.

2.5.5.2 Low-Level Waste Repackaging

LLW may require repackaging before final disposition. Repackaging may occur in a confinement structure that may be equipped with a HEPA ventilation system. Repackaging is necessary to minimize the disposition of drums that are not filled to meet the LANL WAC. The LLW is repackaged and segregated according to its composition, characteristics, compatibility, reactivity, and off-site facility approval. Inner containers are not opened during repackaging. Therefore, blending or neutralization of LLW contents does not occur.
### 2.5.5.3 Chemical and Mixed Low-Level Waste Repackaging

The MLLW may require repackaging before its final disposition. MLLW repackaging may also occur in a confinement structure that may be equipped with a HEPA ventilation system. Repackaging is necessary to minimize the disposition of drums that are not filled. Repackaging of MLLW occurs according to LANL WAC requirements. The MLLW is repackaged and segregated according to its composition, characteristics, compatibility, reactivity, and offsite facility approval. Inner containers are not opened during repackaging. Therefore, blending or neutralization of MLLW contents does not occur.

Empty outer containers that previously contained MLLW are considered as potentially contaminated material and disposed of as LLW. These containers may also be monitored by a radiological control technician (RCT) to determine the possibility for their reuse according to LANL requirements.

### 2.5.5.4 TRU Sort, Segregate, Size Reduction, and Repackaging Activities

A large percentage of the waste containers at Area G require repackaging. In the repackaging process, waste items may be characterized, decontaminated, or undergo SSSR. The SSSR process may also include the removal or absorption of liquids from TRU waste containers. The concept of equivalent combustible PE-Ci is developed further in the hazard analysis.

SSSR activities may be performed in a number of different locations. The accident analysis assumes a location nearest the site evaluation boundary. SSSR activities occur in a confinement structure located within a defined area. Confinement may be provided in the form of huts/tents, a glove bag, or other appropriate radiological confinement. For some TRU waste container remediation, a confinement structure may be built directly over containers that are difficult to transport and require size reduction and repackaging (e.g., FRP TRU waste containers).

Repackaging involves opening a vented TRU waste container, separating the waste items, remediating noncompliant waste, and placing compliant waste into one or more compliant containers. To protect workers from significant injury due to a possible deflagration, sealed inner TRU waste packages are not opened during SSSR activities except for inner containers with bolted lids/flanges as described in Section 2.5.5.5. Repackaging of larger-sized packages, such as FRPs, may include size reduction of large pieces of equipment, including decommissioned gloveboxes. If size reduction is required, it is performed using manual and electric hand tools, for example, nibblers, saws, etc. The size-reduced waste is repackaged and disposed or shipped offsite.

### 2.5.5.5 Opening Sealed Containers With Bolted Lids/Flanges During SSSR Activities

During SSSR Processing, sealed containers may be encountered inside of fiberglass-reinforced plywood (FRP) boxes or other appropriate outer container. The sealed containers are internally contaminated and may contain accumulated flammable gases including hydrogen above the lower flammability limit (LFL).

Under this activity, sealed inner containers are removed from the outer container in an SSSR Area. These sealed containers are opened in a controlled manner within the SSSR Area to allow for the safe dispersion of flammable gases that may have accumulated within the containers. Only those sealed inner containers that have bolted lids or flanges are opened. After the container has been opened, it undergoes SSSR processing in accordance with established procedures. Other types of sealed containers that may be encountered are removed from the SSSR Area.
2.5.6 WASTE CHARACTERIZATION AND VERIFICATION ACTIVITIES

Several waste characterization and verification operations are conducted within Area G. Many of these activities are used to meet the qualitative and quantitative analysis requirements for various Laboratory and offsite TSDFs.

2.5.6.1 Nondestructive Radioassay and Testing Systems

2.5.6.1.1 Neutron and Gamma Counting Systems

The High-Efficiency Radiation Counters for Ultimate Low Emission Sensitivity (HERCULES) and ZEUS systems assay low-density material to verify the absence of radioactivity in waste items. The HPG detector systems (Figure 2-14) are used in Building 54-2, at other locations within TA-54, and at LANL generator sites. The detectors utilize up to 5,000 volts supplied through shielded high-voltage cables. The systems assay both LLW and TRU waste contaminated with gamma-producing radionuclides (or their daughter products). They consist of liquid-nitrogen-cooled germanium detectors, associated electronics, portable lead shielding, and carts. The HPG liquid nitrogen Dewar typically contains either 2.5 L (0.66 gal) or 6.81 L (1.8 gal). They are filled from either a transfer Dewar within the building or one of the two 159.0 L (42 gal) storage Dewars outside the building. The outside storage Dewars have a transfer hose that can be used outside or routed into the building. The building has active oxygen monitors.

![Portable High-Purity Germanium Detector System](image)

Figure 2-14 Portable High-Purity Germanium Detector System

2.5.6.1.2 Real-Time Radiography Systems

Mobile Real-Time Radiography

Mobile Real-Time Radiography (RTR) systems are employed at various work locations at TA-54, Area G, to support waste operations. The RTR system utilizes three separate analysis systems to perform nondestructive examinations of the contents of TRU waste drums. Each system utilizes an X-ray beam directed at the revolving TRU waste container. These systems are powered by facility power. The
attenuated beam that emerges from the container is recorded and analyzed using analog or digital methods. The operator uses the RTR system to look for liquids, particulates, and pressurized containers; to verify the waste matrix code; and to determine waste material parameter weights. Dose rates outside the units during radiography are at background levels.

The RTR-1 trailer is situated on a modified commercial tractor-trailer. The trailer is divided into two separate rooms: a control room and an examination area. A forklift is used to raise and lower waste containers (one at a time using a drum clamp) to the unit. The RTR testing systems and control room are located in the central part of the trailer and separated by a lead wall.

The RTR-2 trailer is situated on a modified commercial tractor-trailer. The trailer is divided into four separate rooms: a control room, an examination area, a utility area, and a storage area. A forklift is used to raise and lower waste containers (one at a time using a drum clamp) to the unit. The sled is electrically actuated and conveys up to three drums into the trailer simultaneously. The RTR testing systems and control room are located in the central part of the trailer and separated by a lead wall.

The RTR-3 is a floor-mounted shielded examination chamber. A forklift is used to place waste containers into the unit.

The X-ray produced in RTR-1 and -2 is 450 keV, RTR-3 is 320 keV. The RTR safety features include shielding, surveillance camera, in-operation indication warning light (amber and red x-ray on), emergency shutdown switch, and vault door safety interlocks.

High Energy Real-Time Radiography (HE-RTR)

A High-Energy Real-Time Radiography (HE-RTR) unit is located in a permanent structure near Dome-48 for NDE of large or dense packages. The main structure associated with the HE-RTR is a shielded vault, TA 54-577. The process is controlled remotely from an adjacent control room located in a trailer designated as TA 54-578.

The HE-RTR unit consists of the following components:

- Linear Accelerator
- Digital Detector
- Manipulators used to raise and lower the Linear Accelerator and the Digital Detector
- Enclosure for radiation protection
- Waste container handling system
- Vault door system
- Car and rail system
- Audio/video recording system

The HE-RTR unit is a dual energy, 3 MeV and 6 MeV radiation generating device (RGD), a linear accelerator known as the Linatron. The RGD is controlled from a separate, re-locatable, pre-fabricated Control Room adjacent to the vault structure. The HE-RTR vault and the trailer housing the Control Room are situated on concrete pads and supplied by normal facility power.

The control trailer contains a control room and an equipment room. The control room provides for operator comfort and houses the controls for the entire system. The equipment room is used for storage.
and contains the main electrical cabinet. The control trailer is a standard commercial structure measuring approximately 8 feet wide by 30 feet long.

The vault of the unit is an exempt shielded installation in accordance with ANSI-N43.3-2008 [ANSI 2008], which requires a maximum external surface dose rate during full x-ray power of 0.5 mrem/hour. The exempt class provides the highest degree of inherent safety because protection does not depend on compliance with any operating limitations. This type of installation also eliminates the necessity for restrictions on occupancy outside the enclosure since inherent shielding is sufficient to meet the maximum permissible dose equivalent requirements for uncontrolled areas.

For radiation protection, the vault is constructed as a labyrinth (See Figure 2-15) with walls filled with sand/gravel and an overburden above the ceiling slab. Walls and the ceiling of the vault room are approximately 8-in. thick prefabricated concrete panels. The height of the vault (from floor to ceiling) is approximately 11 ft. Fill at the front of the building (in front of the energy beam pointing) is approximately 56-in. thick, while the fill at the back-side (away from the energy beam) of the building is approximately 32-in. thick. The fill will consist of both sand and pea gravel.

The shielded x-ray vault includes three separate sections: a waste container loading area, a cart and rail system, and the x-ray generation area. The waste container loading area provides the only access point to the vault through a sliding lead-shielded door that must be in the closed position for activation of the Linatron.

The cart and rail system is used to deliver the waste container to the x-ray generation area. A turntable is mounted on the cart. The cart, directed from the Control Room, travels on rails to a position in front of the RGD. The x-ray generation section of the vault contains the linear accelerator, detector, manipulators for the linear accelerator and detector, and a hoist that travels down the length of the section for installation and maintenance of the linear accelerator.

![Figure 2-15 HE-RTR Vault](image-url)
In addition to shielding, a suite of interlocks, e-stops, audible/visible enunciators, signs and postings, and procedural controls will be in place to prevent inadvertent exposure and to ensure compliance with ANSI-N43.3-2008 [ANSI 2008] as required by DOE G 441.1-1C.

- The single personnel/waste container access door is fitted with two independent safety interlocks. Interlock 1 prevents the Linatron from producing x-rays prior to closing the door. Interlock 2 is linked to a gamma monitor within the enclosure and, if the door is opened while the gamma monitor is seeing a dose rate greater than 100 mR/hr, the Linatron will shut down. When the HE-RTR Operator actuates the “X-RAY ON” control, there is an appropriate delay (on the order of 20 seconds) with a corresponding horn and strobe warning prior to x-rays being generated.
- During radiography a warning beacon attached to the vault exterior will remain illuminated, and if a beacon bulb fails, the Linatron will automatically shut down.
- Within the vault enclosure, there is an emergency pull rope mounted around the perimeter of the vault tied into E-stop circuitry.
- There are seven E-stops associated with the HE-RTR: a push button at the Operator Control Console, a push button inside the vault and adjacent to the vault door, and five pull cords positioned throughout the vault.
- The waste handling operator will have control over the shield door via local controls to preclude inadvertent remote door closure.

Industrial safety controls are present as well, e.g., pressure sensitive switches on the shield door that will prevent closure if any interference is sensed, and disablement of the waste container conveyance when the shield door is open to prevent injury to the waste handling operator.

### 2.5.6.1.3 High-Efficiency Neutron Counter Systems

The high-efficiency neutron counter (HENC) is a large rectangular-shaped neutron counter that is specifically designed to assay the container in a $4\pi$ counting geometry. Two HENC systems and one Super HENC system are employed at Pad 10 at TA-54, Area G, to support waste assay operations. The systems primarily consist of a conveyor/drawbridge, barrel rotator, $4\pi$ counting shield, add-a-source mechanism, and control system. The HENC systems utilize passive and add-a-source neutron analysis methods to assay the nuclide mass contained in 55-gal drums of TRU waste. The $^{252}\text{Cf}$ add-a-source is used to monitor detector performance and to correct assays for moderation in the waste.

Waste drums to be assayed are placed on a conveyor that feeds drums into the HENC system. A forklift is used to raise and lower waste containers (one at a time, using a drum clamp) to and from the conveyor. The conveyor system has guard rails as a barrier to waste containers falling during conveyor operations. Numerous sensors or safety switches are located throughout the system to control drum movement.

The HENC systems will accommodate up to 110 gal waste drums, and the Super HENC system is sized to accommodate SWBs.

To accommodate the assay of larger containers or containers that need to be evaluated in place, the mobile In-Situ Object Counting System (ISOCS) large container counter is available. The ISOCS can provide nuclide-specific assay results for field measurement of objects or surfaces. This mobile system uses the same technology as the Super HENC, but does not have a conveyor system or a chamber with rotators.
2.5.6.2 Other Assay Activities

2.5.6.2.1 Headspace Gas Sampling

Flammable gas analysis is used to establish the concentration of flammable gas/VOCs, hydrogen, and methane in a waste container intended for shipment in Type B containers (e.g., TRUPACT-II Half PACT or remote-handled TRU 72-B). An aliquot of headspace gas is sampled from a waste container and analyzed using GC/MS and a thermal conductivity detector. The sample introduced to the GC is split; part goes to MS, and the other part goes to the thermal conductivity detector. The MS analyzes for VOCs, and the thermal conductivity detector analyzes for hydrogen and methane.

The most common flammable gas present is hydrogen. Other flammable gases, such as VOCs, are also present. To satisfy WIPP WAC requirements, filters are required on waste containers to ensure that flammable gases do not accumulate and drums do not over-pressurize. Flammable gases generated are dependent on the waste stream.

2.5.6.2.2 Discrete Waste Sampling

Wastes received at Area G may require further sampling for RCRA metals or other regulated constituents. The selected containers may need to be opened in a controlled environment, such as in a confinement structure or under local ventilation (i.e., with the use of a down-draft table) to ensure worker safety during visual inspection of contents and collection of samples for further analysis.

2.5.7 TRU WASTE SHIPMENTS – TYPE B LOADING OPERATIONS

To support the removal of TRU waste from Area G by 2015, a payload assembly area will be established for the loading of compliant waste containers (55-gal drums, 85-gal drums, Ten-Drum Overpacks [TDOPs], and SWBs) into a Type B TRUPACT-II or HalfPACT shipping container or directly onto a transportation trailer. The TRUPACT-II/HalfPACT containers are government furnished equipment. The TRUPACT-II or HalfPACT payload will consist of compliant waste containers in a payload assembly built according to transportation requirements.

Payload assemblies can be built within defined storage areas or within the defined payload assembly area, whichever allows the most operational flexibility. A diesel-powered trailer jockey (mule) or other transport vehicle is used to move the TRUPACT-II/HalfPACT trailer into position in the payload assembly area. The tractor is unhitched from the TRUPACT-II/HalfPACT trailer, and then moved out of the payload assembly area until the entire loading operation is completed. The TRUPACT-II and HalfPACT shipping containers remain on the trailer. Once the payload is built and positioned near the trailer, a mobile crane lifts the payload and places it into the Type B container. A forklift may also be used to lift payload assemblies directly onto the transportation trailer.

Upon completion of operations, the truck/tractor re-enters the payload assembly area, hitches to the trailer, and exits the area. A diesel-powered trailer jockey (mule) can be used in place of a truck to move the TRUPACT-II/HalfPACT trailer out of the payload assembly area.

TRU waste shipments and mobile loading operations involving the use of other types of approved Type B containers (e.g., Model 10-160B) are also performed at Area G.
2.5.8 DEFINED AREA DEACTIVATION

For a defined area, once the proposed activity is completed and the material removed, any specific applicable controls are no longer required; facility operations can declare this area as no longer managed as a defined area. At that point, the area is treated like any other non-storage or non-process area at Area G until it is re-designated as a defined area for processing or storage of nuclear material.

Final, formal Decontamination and Decommissioning for any location at Area G will require separate documentation with step-out criteria for approval by DOE.

2.5.9 STORED WASTE INVENTORY

The total Area G above-ground radiological inventory of TRU waste is less than 57,000 PE-Ci. The underground inventory of buried TRU waste is approximately 110,000 PE-Ci. As buried TRU waste is retrieved, the above-ground inventory will be maintained to less than 57,000 PE-Ci. Tritium-contaminated waste above-ground storage contains approximately 100,000 tritium Ci. The below-ground inventory of disposed tritium is around $3 \times 10^6$ tritium Ci.

An evaluation was performed of the chemical information obtained from 2,890 drums of MLLW and hazardous chemicals stored in TA-54, Area G [LANL 2007]. The evaluation confirmed the presence of toxic (i.e., mercury metal and compounds, beryllium, selenium and lead compounds, carbon tetrachloride), reactive (i.e., sodium, lithium, uranium, potassium and barium metals; lithium hydride); corrosive (i.e., sodium, lithium, and potassium metals; lithium hydride), and ignitable (i.e., tritium, semi-volatile organic compound) materials. Storage of hazardous chemicals complies with Laboratory requirements.

2.5.10 OTHER ACTIVITIES

Other routine operations conducted at Area G include decontamination of vehicles, equipment, and waste containers; sanding and painting of drums; audit and inspection of waste disposal and storage operations; RCRA inspections; excavation and closure of pits and shafts; and general facility maintenance, environmental assessment, and environmental monitoring activities.

2.5.10.1 Decontamination of Vehicles, Equipment, and Waste Containers

Decontamination of vehicles, equipment, and waste containers is routinely performed. These activities may need to be performed in a controlled environment as deemed appropriate by RCTs. Standard decontamination methods may be used.

2.5.10.2 Sanding and Painting

Drums may be sanded and painted. Sanding may be performed by using sandpaper to remove tarnish and light corrosion from drums that are believed to be of sound integrity. Drums may contain waste during this activity. Floors and other surfaces can also be painted to seal contamination as directed by the RCTs.

2.5.10.3 General Facility Maintenance and Support Activities

Area G facilities and site personnel are responsible for performing support, corrective, and preventive maintenance functions. The activities may include excavation, backfilling pits and shafts, capping and sealing shafts, surveying, heavy equipment and machinery operations, small spill cleanup, vegetation
control, facility repair, material / supply delivery, and latrine service. The facilities (e.g., domes, other structures, closed pits and shafts, and roadways) are routinely inspected for normal deterioration.

2.5.10.4 Vehicle Refueling and Recharging Service

Because of the remoteness of Area G, a gasoline or diesel refueling service truck visits the site on a routine schedule; refueling occurs at designated refueling locations inside Area G. In addition to diesel or gasoline, liquefied petroleum gas (LPG) is delivered by truck into Area G for LPG-powered forklifts. The empty LPG tank is removed from the forklift and exchanged for a pre-filled tank that is then installed on the forklift. Gasoline-powered vehicles are refueled either on-site or off-site. Small utility vehicles and passenger vehicles are refueled on-site. All other maintenance activities related to truck, passenger, or heavy equipment are in general, performed in a central service area outside TA-54. On some occasions, some maintenance activities are performed in Area G when it is not feasible to remove the equipment.

A small number of vehicles/equipment operated at Area G are electric and require recharging. Vehicle/equipment recharging occurs in designated areas.

2.5.10.5 Drum Washing Equipment

Before being placed under earth-covered retrievable storage, TRU waste drums were covered with a corrosion inhibitor. This corrosion inhibitor needs to be removed from the drums before they are placed into inspectable storage. Typically, an automatic industrial washer is used to remove the corrosion inhibitor. This type of machine uses high-pressure (approximately 150 psig) high-temperature (approximately 150°F) water to remove the corrosion inhibitor. The water is supplied through nozzles that atomize the water. Atomization of the water keeps the jets from damaging the drums. During the closed-loop washing operations, water collected in a sump at the base of the drum washer is pumped out through filters into the spray nozzles. The wash water drains back into the sump. The system has a vault door interlock, which ensures that the drum washing machine can operate only when the containment vault door is closed.

To reduce the spread of contamination and control the buildup of fissile material, waste containers are visually inspected, and limited radiation surveys are performed before placing the drums in the washer. When the drums are removed from the washer, they are dried and surveyed for contamination. Water collected in the sump is also sampled on a regular basis, and, if contamination is detected (in the water or on the drying rags), the water is removed and transferred for radiological treatment and disposal.

2.5.10.6 Vehicle Traffic Control

Vehicle traffic volume is moderate at the site because of its layout. The roads with vehicle traffic are not designated as a specific defined area because of the transient nature of vehicle movements between defined areas. Vehicles vary in size from very small utility trucks to large earth-moving equipment. Roadways are kept in good condition, and the area has a posted speed limit. During waste receipt and offloading activities, additional traffic restrictions are sometimes employed as a safety precaution. Vehicle barriers are strategically located throughout Area G to protect stored waste.

2.5.10.7 Environmental Monitoring

Environmental monitoring is conducted at Area G under the Laboratory’s environment surveillance program, in support of the Performance Assessment and Composite Analysis for LANL TA-54, Area G [LANL 2008], and by LANL Environmental Restoration Program groups. Air, surface water, soil, sediments, and biota sampled media are analyzed for both radiological and chemical constituents. Routine
moisture monitoring is conducted in pipes, in and under disposal pits, and in monitoring boreholes throughout the area. Characterization of the density and rooting characteristics of plants that may inhabit a closed disposal site may also occur. The LANL Environmental Restoration Program also conducts quarterly subsurface pore-gas monitoring for VOCs. These activities are conducted at various monitoring boreholes throughout Area G.

Numerous methods are used for the analysis and collection of sample media. As a result, varieties of activities are involved, dependent on the type of media and the depth of the media below the ground surface. Sampling of biota, water, soil vapor, and air media is required to determine the nature and extent of contamination. Biota sampling can include collection of vegetation samples, tree core samples, and live species samples. Samples may be collected using small hand tools, such as scoops, spades, shears, borers, or traps, and then placed in appropriate sample containers. Water sampling can include collection of water samples from flowing surface/storm water, impounded surface/storm water, groundwater, or precipitation. Sampling methods depend on the location of the water to be sampled. Vapor sampling can be used to assess subsurface characteristics associated with vapor-phase contaminants, such as tritium and volatile organic compounds. Vapor sampling can be conducted at the ground surface or at depth in boreholes. At ground surface, vapor sampling may involve placing monitoring tubes, canisters, or probes into the surface material to collect samples. For deep sampling, vapor samples are collected from vapor monitoring systems that have been installed in boreholes. Air sampling can be used to monitor potential airborne contaminants, such as radionuclides, dust, or chemicals. Air samples are generally collected real-time for health and safety purposes during environmental sampling activities. However, some air sampling can be conducted to provide site characterization data. Air samples can be collected using either fixed or portable equipment.

Subsurface sampling typically involves boring/drilling into the ground to collect cores. Monitoring wells are sometimes installed in the resulting boreholes to collect vapor or water samples. Drilling methods may involve the use of a hollow-stem auger drill rig or an air-rotary rig; both methods continually deliver both core and cuttings to the surface. After drilling, boreholes may be used for monitoring purposes. Groundwater monitoring wells can be constructed or vapor monitoring systems can be installed. Core or cuttings material are monitored for radiological and/or hazardous constituents. Boreholes not needed for monitoring purposes may be optionally backfilled/ stabilized or capped.

Surface and near-surface sampling and can be accomplished using manually operated equipment. Samples are collected from surface and near-surface materials using small hand-held scoops or spades, or manual or power hand-operated augers. Samples of soil and sediment materials can be homogenized in a bowl; or samples of soil, tuff, or sediment materials can be collected directly from core barrels. Collected material is monitored for radiological and hazardous constituents before collecting samples. Sample locations may be optionally backfilled with excess material, grout, or other stabilizing material.

2.5.11 RESPONSE TO ABNORMAL EVENTS

In the event of an abnormal occurrence, workers are trained to leave the vicinity of the hazard, notify the Area G operations center of the event, warn other workers, and prevent anyone else from approaching the hazard. The Area G operations center in turn notifies and coordinates with the appropriate emergency response organizations to deal with the abnormal occurrence.

The laboratory Emergency Response Division includes the laboratory’s organizations geared toward responding to emergencies. This includes the Hazardous Materials (HAZMAT) Response and Hazardous Devices teams. Los Alamos County runs the fire department, which is under contract to respond to fires and emergencies at laboratory facilities. Firefighters are trained and equipped to respond to incidents at nuclear facilities. The Facility Operations Director (FOD) and Operations Manager (OM) are responsible
for securing the scene of the event to ensure that all safety and operation concerns are addressed. The event is then categorized against the DOE reporting criteria and formal notifications are made.

A critique process is used to gather facts as soon as practical after the event and to determine follow-on lines of inquiry. The goal of the critique process is to capture the available facts related to the occurrence, evaluate them for proper immediate and corrective actions, and develop lessons learned from the occurrence that can be incorporated into facilities’ programs to prevent recurrence. Additionally, the critique process frequently uncovers areas that need improvement that were not directly involved with the incident itself. LANL uses a graded approach to critiques that depends on the severity of the event. The critique process is used to supply information for Event Notification and the Occurrence Reporting and Processing System (ORPS) Notification reports.

A follow-up investigation will take place for more serious incidents. The LANL occurrence investigation team provides trained investigators in apparent and root cause methodologies. The occurrence investigation team provides the FOD or OM their formal, unbiased investigatory finding for approval. Once approved, the FOD/OM provides corrective actions that address the casual factors associated with the final report. For restart after serious events, senior laboratory management approval is required. For less-serious events, the FOD or OM approves restart.

2.6 CONFINEMENT SYSTEMS

The following systems provide confinement at Area G. The radiological waste stored at Area G is contained within individual metal waste drums, FRP boxes, metal boxes (i.e., SWBs), or other containers. A waste container is considered compliant or non-compliant depending on whether it meets WIPP WAC inspection criteria for a container of sound integrity, as described in Section 4.4.1 of DOE-STD-5506-2007 [DOE 2007]. The WIPP WAC acknowledges that most TRU containers are legacy, and, therefore, has established the container integrity checklist to document that legacy drums qualify against new drum requirements based on DOT 7A criteria. Compliant containers are those metal containers that meet the criteria for container integrity. In the Area G BIO, the criterion for container integrity is extended to two types of non-drum waste containers – corrugated metal boxes and Bolas Grande (BG) spheres. This is discussed below. Non-compliant containers are non-metal containers that do not meet the criteria for container integrity. For the most part, these containers are robust, though their robustness cannot be confirmed through any technical documentation.

2.6.1 COMPLIANT WASTE CONTAINERS

2.6.1.1 Drums, Standard Waste Boxes, and Ten Drum Overpacks

Specifications for drums, SWB, and TDOP containers for waste generators are prescribed by the LANL WAC. Drums include standard steel-fabricated 30-, 55-, 85- and 110-gal drums. Metal drums containing TRU waste that are observed to be of suspect integrity are overpacked into a larger drum or an SWB. Drums, SWBs, and TDOPs used for TRU waste storage or shipping operations at Area G are considered compliant waste containers, and fulfill the WIPP WAC container inspection criteria.

2.6.1.2 Corrugated Metal Boxes

These TRU waste containers were generated in the mid-1980s. These containers are considered the predecessor design of the current SWBs and are also considered the first approved WIPP containers. The containers are, for the most part, filled with metal waste from the size reduction of large metal plate waste items, such as gloveboxes. The sides of the boxes are of welded construction. After the waste was

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loaded into the containers, the lid was welded to the box. Comparable to the current design of the SWBs, these containers are structurally sound.

### 2.6.1.3 Bolas Grande Spheres

There are test BG spheres in inspectable storage at Area G. The BG spheres were generated as a result of explosives and Pu experiments performed by the weapons program in the 1970s and 1980s. The containment spheres were designed, fabricated, and certified to withstand the impulse pressure of controlled, sub-critical experiments. High-strength steels were formed and welded into spherical shapes with numerous ports and flanges to allow monitoring of the experiment. Before being shipped to TA-54, Area G, the spheres were opened and a large portion of the radiological debris material remaining from the experiments was removed. After the cleanout process, all openings associated with the spheres were rescaled. The radiological material remaining in the spheres ranges from 0.1 to 7.7 PE-Ci. There are several spheres of approximately 3 ft in diameter with gross weights of 2,400 lbs each. Several other spheres are 6 ft in diameter, with gross weights over 17,500 lbs each.

### 2.6.1.4 Sealed Sources

Two types of sealed sources are relevant to the Area G operations: (1) sealed sources used as radionuclide standards to verify assay instrument performance, and (2) excess sealed sources dispositioned as part of the Offsite Source Recovery Program (OSRP).

Sealed sources used as radionuclide standards to verify assay instrument performance at Area G conform to the requirements of American National Standards Institute (ANSI) N43.6, Sealed Radioactive Source Classifications [ANSI 1997] or meet the Special Form requirements of 49 CFR 173.469. Area G personnel maintain other verification standards, but they may not conform to the requirements of ANSI N43.6. When these sources are not in use, they are kept in appropriate containers.

The OSRP is responsible for retrieving, storing, and disposing of radiological sealed sources. Both certified and non-certified sealed sources are stored pending shipment to WIPP. These sources primarily contain $^{239}\text{Pu}$, $^{238}\text{Pu}$, or $^{241}\text{Am}$ and may be combined with light elements, such as beryllium. These sources are designed to meet DOT requirements for special-form material. All sources are leak-tested before packaging. Sealed sources are overpacked in standard, S100, or S200 pipe overpack components inside 55-gal drums before transfer to Area G for storage. In some instances, pipe overpacks are used to contain TRU waste or sources recovered in the OSRP.

### 2.6.1.5 Pipe Overpack Containers

Pipe overpacks are robust engineered containers. The capability of the pipe components to maintain structural integrity during postulated accident conditions is attributable to the design and material construction of the pipe overpack. Testing has demonstrated the ability of the pipe overpack to provide two significant control functions: (1) confinement of fine particulate waste material during normal conditions of transport and hypothetical accident conditions, and (2) shielding [DOE 2009].

### 2.6.2 NON-COMPLIANT WASTE CONTAINERS

Other (non-drum) TRU waste containers at Area G are those that do not have the design pedigree of the compliant container. These non-compliant containers provide contamination control either by their design or because of their outer layer. The majority of the non-compliant containers represent a legacy issue because they cannot be shipped to WIPP without size reduction and repackaging. Generally, the LANL WAC does not allow further receipt of non-compliant containers as the outermost container at Area G. In
special cases, such as large waste containers, allowance for their receipt at Area G may be negotiated. The non-compliant containers at Area G are described below:

2.6.2.1 Fiberglass-Reinforced Plywood Boxes

Plywood-constructed boxes containing large pieces of equipment, such as discarded gloveboxes, were coated with a fiberglass material to minimize the potential for fires or to reinforce the construction of the plywood box. Over time, if the FRP box shows signs of degradation, the FRP box may be plastic-wrapped and taped, or resealed with new FRP material where damage has occurred or is suspected. In addition, FRP boxes suspected of containing free liquids are stored on pans or tarps to collect any leaked fluids. Over time, if the FRP has been exposed to the elements such as rain or snow, the outer layer of the FRP may degrade. In such cases, the FRP is wrapped in heavy plastic to contain any contamination or to protect the FRP from further exposure to the elements. The FRPs in storage now typically contain large pieces of decommissioned equipment or gloveboxes and are not air-tight. The FRP boxes are no longer accepted at the Area G site, according to the LANL WAC.

2.6.2.2 Transportainers

Transportainers, such as SeaLand Transportainers, are of an all-metal outer construction. A transportainer typically has the following features: A door may be located at both ends, and the inside floors may be covered with wood and/or metal to facilitate equipment movement. Any gasket material in the doorframe helps reduce the potential for moisture to accumulate inside (i.e., from rain). With or without door gaskets, the transportainers are not considered to be air-tight, although they are tight enough to contain the large waste items.

Transportainers received at Area G will typically have one or more individual waste packages that are bar-coded separately. During waste inspection activities, the transportainers will have to be opened so that the individual waste items can be inspected. Empty transportainers at Area G are available for the storage of bulky waste items, such as equipment generated from the size reduction of gloveboxes. These items may be stored in the transportainers until a final disposition pathway is determined. The RPP requirements will dictate the necessity to control contamination on the waste item, such as wrapping the waste item in plastic for storage in the transportainers.

2.6.2.3 Metal Boxes

Since 1996, generators have been prohibited from sending oversized TRU waste in wooden boxes. As a result, metal boxes slightly larger than the waste item have been used. These various-sized metal boxes are typically constructed with a single door at the top, side, or bottom. The door is secured with a series of bolts along the edge. The gasket material in the frame helps to reduce the potential for moisture to accumulate inside. The metal boxes are not considered to be air-tight, but are tight enough to contain contamination. The contents of these containers are largely metal components, which may be wrapped in plastic. Legacy wood box crates that are of the same construction as FRP boxes, but do not have fiberglass covering the plywood, are also stored in TA-54, Area G. These wood boxes are either placed in large metal containers such as transportainers, or clad with minimum 18-gauge-thick sheet metal with overlapping edges to protect them from ignition and fire sources.

2.6.2.4 Plastic-Wrapped Waste

Some waste forms at Area G, such as large pieces of decommissioned equipment (e.g., a caustic waste tank), do not fit within available rigid, metal-type containers. Such equipment may be wrapped in several layers of heavy plastic to further contain the spread of contamination.
2.6.2.5 Corrugated Metal Pipes

These containers are CMPs filled with contaminated waste from TA-21 legacy operations that were then encased in cement; each end is filled with a cement plug. A description of these containers is in Section 2.5.3.1. RPP or other regulatory requirements will specify the storage configuration of the CMPs, such as being wrapped in plastic.

2.6.3 CONFINEMENT ENCLOSURES

Modular confinement enclosures are used to house several operations at Area G, including the SSSR operations. Typically the confinement structure provides a controlled environment for activities involving waste that is remediated or characterized. The confinement structure may require specific ventilation air flow rates, filtered environment, or exhaust ducting according to RPP requirements. The confinement structure may be erected directly over waste containers (i.e., FRPs) that may need to be decontaminated, volume-reduced, and repackaged, but are problematic to move. A confinement structure may be constructed of modular steel panels or a tent-like structure.

2.7 SAFETY SUPPORT SYSTEMS

Safety support systems at Area G include radiation monitoring, fire protection, lightning protection, communications, personal protective equipment (PPE), and other miscellaneous safety equipment. Each of these support systems is described below.

2.7.1 RADIATION MONITORING

Radiation monitoring devices, which are located throughout Area G, consist of continuous air monitors; fixed-head air monitors; portable alpha, beta/gamma, and neutron detectors; tritium monitors; and personnel monitors. These systems serve to monitor and alert personnel to the presence of airborne contamination, elevated direct radiation, or contamination.

2.7.2 FIRE PROTECTION

Most buildings and domes at Area G are equipped with portable fire extinguishers, manual alarm pull stations, and notification appliances. Domes 54-153, 54-230, and 54-231 have fire recognition systems based on ultraviolet/infrared flame detectors. The contamination control enclosures (e.g., Perma-Cons) installed inside Domes 54-231 and 54-375, and 4 connexes for the Dome 54-375 Perma-Con are equipped with pre-action fire suppression systems. Domes 54-33, 54-230, and Building 54-412 have fire suppression systems. The fire suppression systems in Domes 54-33, 54-230, and Building 54-412 are capable of being operated in automatic mode, while systems in the other domes are manually activated. Fire hydrants are located throughout Area G to ensure that at least two hydrants are within 91.44 m (300 ft) of waste storage locations. Fire alarm signals are transmitted to the Los Alamos Fire Department (LAFD) via two automatic-dialing phone lines. No fire-fighting brigade or support vehicles are resident at Area G. Response to fire emergencies is provided by LAFD. Building 54-419 is equipped with a dry-chemical fire suppression system.

Automatic fire extinguishing systems are not provided in waste storage and processing domes 54-48, 54-49, 54-153, 54-224, 54-229, 54-231, 54-232, 54-283, and 54-375. These dome structures within Area G comprise a Hazard Category 2 nuclear facility. The domes are considered “significant” facilities generally warranting remotely monitored automatic fire extinguishing systems per DOE O 420.1B Chapter II ¶ 3.c(4). LANL has submitted an Exemption Request to DOE O 420.1B Chapter II ¶ 3.c(4) for the lack of automatic fire suppression for all appropriate waste storage domes [LANL 2013]. The Exemption Request
has not been approved by DOE/NNSA. Alternative controls selected for the prevention or mitigation of a fire are identified in the accident analysis in Chapter 3, with the derivation and evaluation of those controls documented in Chapters 4 and 5.

The tritium storage sheds, Buildings 54-1027, 54-1028, 54-1030, and 54-1041, each have an internal, factory-installed, automatic dry-chemical fire suppression system. The tritium monitoring shed, Building 54-273, is provided with a smoke detector, thermal detector, and horn/probe unit.

Welding, cutting, and similar spark-producing work is not permitted in areas where there are flammable liquids without an appropriate work permit authorization and associated controls.

A few of the Area G structures have sumps for fire-fighting water containment that are adequate. The remaining structures lack sufficient retention/collection provisions. Following a fire, the LAFD may initiate some control of runoff, provided the threat of fire is no longer of concern. Assistance can be provided from on-site LANL personnel and the LANL HAZMAT team.

### 2.7.3 LIGHTNING PROTECTION

Lightning protection at TA-54 Area G, is provided by a power-pole grid distribution system. The lightning protection coverage includes all of the important facilities in Area G. Those facilities that are not equipped with a power-pole grid system have air terminals, down leads, and either a counterpoise system or grounding rods. Domes 54-33, 54-153, 54-224, 54-229, 54-230, 54-231, 54-232, 54-283, and 54-375 are protected using air terminals connected through the fabric to the frame. Building 54-412 is protected using air terminals connected to the frame. A catenary lightning protection system is used to protect Domes 54-48, and 54-49,. The catenary lightning protection system consists of connected wires suspended by telephone poles connected to down conductors. Both the air terminals and the catenary lightning protection system are connected by the frame or down leads to either a counterpoise system or grounding rods.

### 2.7.4 COMMUNICATIONS

The communication and emergency notification system at Area G consists of multiple independent systems to ensure prompt personnel notification in the event of a site emergency. This system includes telephones, radios, wireless network, personnel emergency pagers, a public address system, and fire and evacuation alarms. Both building and pole-mounted telephones are available at Area G with a listing of emergency response numbers. The public address system consists of a transmitting station and pole-mounted speakers, which are located throughout Area G. When personnel are located where audible alarms and annunciations cannot be heard, the Person-in-Charge is required to check out a two-way radio with the TA-54 Operations Center to ensure that communications are established for prompt notifications in case of emergencies. The public address system and evacuation alarms are tested periodically (e.g., weekly) in accordance with RCRA requirements. Site evaluation drills are conducted on an unannounced schedule to ensure the effectiveness of the notification systems. Wind socks are provided throughout the area to inform personnel of wind flow patterns, and to aid in route selection for emergency escape and retreat during airborne release of radiological or hazardous materials.

### 2.7.5 MISCELLANEOUS

Area G is surrounded by an industrial exclusion fence topped with razor wire. Traffic and personnel entry to the site is through a monitored access control gate and a badge-activated personnel gate at the west end of the complex.
Two additional, normally-closed gates allow access to the outside of the Area G fence line to permit clearing of brush and vegetation within the defensible space to limit combustible loading. One gate is on the fence line west of 54-49, and the second gate is on the fence line northwest of 54-33.

Emergency showers, eyewash stations, and PPE are available on-site.

Emergency muster stations are strategically located within Area G to provide personnel accountability and controlled communications in emergencies. An emergency crash gate is located at each of the stations along the south fence line. The muster station crash gates lead to a marked trail to a designated pickup area on Pajarito Road.

2.8 UTILITY DISTRIBUTION SYSTEMS

Area G is served by electrical and water systems. The distribution systems are briefly described in the following sections.

2.8.1 ELECTRICAL SERVICE

Primary electrical service to Area G is from a 13.2 k volts alternating current (VAC) overhead power distribution line that closely follows the site boundary fence line on the north side. Numerous pole-mounted transformers are supplied to provide 480/277 VAC to the facilities. The pole-mounted transformer may contain up to 75 gal of transformer oil. The transformer fluid in the pole-mounted transformers is ten centipoise (10 cP) mineral oil, which has a high flashpoint and would require significant preheating before it would burn. If a pole-mounted transformer fell toward a defined area during an earthquake, it would not spill flammable fluid into an area that contained MAR. There are three pad-mounted transformers near Buildings 54-33 and 54-412 and on Pad 10 supplying 120/208 VAC to several adjacent facilities. These pad-mounted transformers contain up to 278 gal of transformer oil. Within Building 54-412 is a separate 480 volt to 120/208 VAC dry type transformer and electrical panel serving the temporary containment structure within the building. Power to this portable transformer is supplied from the building’s 480 volt power panel. The power distribution system is designed for selective tripping of breakers to isolate faults with minimum impact on supplied loads (i.e., breakers trip from load to source). Electrical inspections are performed to ensure that electrical hazards are not present.

An oil-filled transformer with a nominal transformer oil capacity of 169 gal is located outside and well to the north of Building 54-2. This transformer is located so that it does not present a fire hazard to Building 54-2 or other structures. A back-up power diesel generator is located on an integral diesel fuel storage tank about 2.4 m (8 ft) west of the Building 54-412 structure northwest corner. The engine has a capacity of about 20 quarts of standard engine oil (30 weight), and the diesel fuel tank has a nominal capacity of 500 gal. The diesel fuel tank is double-walled. An oil-filled transformer is located outside and to the northwest of Building 54-412 and has a nominal capacity of 278 gal of transformer oil. A pad-mounted, oil-filled transformer is located outside and east of Building 54-048 on Pad 10. This transformer has a capacity to hold approximately 260 gal of transformer oil.

2.8.2 WATER SERVICE

Domestic, industrial, and fire-fighting water services are drawn from a 40.6-cm (16-in.) cast-iron water main that extends along the Mesita del Buey roadway. This main serves all of TA-54 except TA-54 West. This main is supplied from a 1.5 million-gal air-gapped tank (TA-54-1006) and booster station (Pajarito #2, TA-54-1008) at the intersection of Rex Drive, Mesita del Buey Road, and Pajarito Road. This water main is looped to the water main that runs parallel to Pajarito Road below the mesa.
2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

This section discusses Auxiliary Lighting, Heating Systems, Compressed Air, and TEUs.

2.9.1 AUXILIARY LIGHTING

Auxiliary lighting systems are installed near the exits of Building 54-2. The systems include standard dual battery-powered units with self-contained trickle chargers. These lights are activated by loss of line voltage and are reset upon resumption of line voltage.

2.9.2 HEATING SYSTEMS

All facility heating is electrical (heating coil space heaters and infrared reflectors). The hot-water supply used in the local washrooms or for drum cleaning is also electrically heated. Fixed electrical heaters are installed in Buildings 54-33 and 54-2, and may also be used in the forced air systems for contamination enclosures such as in the Perma-Con structures in Domes 54-231 and 54-375. Portable fuel-fired heaters are not allowed for use in Area G as part of the Fire Protection Plan [LANL 2006b].

2.9.3 COMPRESSED AIR

Compressed-air systems are located in Buildings 54-33, 54-229, 54-230, and 54-412. The systems in Buildings 54-229 and 54-230 were installed initially to support the dry-pipe fire suppression systems installed in these domes. However, due to fire suppression system related changes, the compressed air systems in Buildings 54-229 and 54-230 are not required and have been abandoned in place. The fire suppression systems in Buildings 54-33 and 54-412 are fully active and supported by their respective compressed-air systems.

2.9.4 TEMPERATURE EQUILIBRATION UNITS

As part of waste characterization/remediation activities, it is necessary to ensure that any liquid in a waste container is not frozen. The issue of frozen liquid is only a concern during the winter months. Two TEUs (Buildings 54-545 and 54-546) have been installed on Pad 10 to perform this function. The TEUs are SeaLand type transportainers mounted on a concrete base, constructed of all-metal components, and use fused/overload protected electrical heaters with enclosed wiring to provide heating for container warming. To access the TEUs, a rollup door is installed at one end for container handling, and the original swing doors at the other end. To minimize the potential of frozen liquids, up to 40 waste containers are placed in a TEU that warms the containers to above freezing temperatures. The waste containers remain in the TEU for the necessary time to ensure that there is no frozen liquid. The TEUs are not sealed units and, therefore, do not allow accumulation of concentrate flammable or VOC gasses above LFL. These gases could be generated during the temperature equilibration process. While warmed waste containers are being removed for waste characterization/remediation activities from one TEU, the second TEU is also providing the warming operation. After the waste containers have completed their resident time, waste characterization/remediation activities can proceed.

2.9.5 OTHER

The south end of Area G contains a storage area for equipment awaiting reuse or disposition. The equipment has not been surveyed for free release. No waste is stored in this location.
2.10 REFERENCES


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HAZARD AND ACCIDENT ANALYSIS
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Acronyms and Abbreviations

AA  Accident Analysis
AC  Administrative Control
ANSI American National Standards Institute
ARF Airborne Release Fraction
BDBA Beyond Design Basis Accident
BEU Beyond Extremely Unlikely
BIO Basis for Interim Operation
BLEVE boiling liquid expanding-vapor explosion
CFR Code of Federal Regulations
CHA Consolidated Hazard Analysis
CMP Corrugated Metal Pipe
DBA Design Basis Accident
DCF Dose Conversion Factor
DF Design Feature
DID Defense-in-Depth
DOE U.S. Department of Energy
DOT U.S. Department of Transportation
DR Damage Ratio
DSF Dose Scaling Factor
DST Dose-to-Source Term
EG Evaluation Guideline
EPP Emergency Preparedness Program
EU Extremely Unlikely
FGE fissile gram equivalent
FHA Fire Hazards Analysis
FPE fire protection engineer
FRP Fiberglass-Reinforced Plywood
GFE Government-furnished equipment
gpm gallons per minute
HA Hazard Analysis
HalfPACT half-TRUPACT
HC Hazard Category
HE Hazard Evaluation
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tr>
<td>HEPA</td>
<td>High-Efficiency Particulate Air</td>
</tr>
<tr>
<td>HE-RTR</td>
<td>High Energy Real-Time Radiography</td>
</tr>
<tr>
<td>HW</td>
<td>Hazardous Waste</td>
</tr>
<tr>
<td>IC</td>
<td>initial condition</td>
</tr>
<tr>
<td>ID</td>
<td>Identification</td>
</tr>
<tr>
<td>INL</td>
<td>Idaho National Lab</td>
</tr>
<tr>
<td>ISI</td>
<td>in-service inspection</td>
</tr>
<tr>
<td>LAA</td>
<td>low-activity area</td>
</tr>
<tr>
<td>LANL</td>
<td>Los Alamos National Laboratory</td>
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<tr>
<td>LLW</td>
<td>Low-Level Waste</td>
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<tr>
<td>LPF</td>
<td>Leak Path Factor</td>
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<tr>
<td>LPG</td>
<td>Liquefied Propane Gas</td>
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<tr>
<td>LPS</td>
<td>lightning protection system</td>
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<tr>
<td>MAQ</td>
<td>maximum allowable quantity</td>
</tr>
<tr>
<td>MAR</td>
<td>Material-at-Risk</td>
</tr>
<tr>
<td>MEOI</td>
<td>Maximally Exposed Offsite Individual</td>
</tr>
<tr>
<td>MLLW</td>
<td>Mixed Low-Level Waste</td>
</tr>
<tr>
<td>NDA</td>
<td>Nondestructive Assay</td>
</tr>
<tr>
<td>NDE</td>
<td>Nondestructive Examination</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NPH</td>
<td>Natural Phenomena Hazard</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PAN</td>
<td>Passive-Active Neutron (NDA System)</td>
</tr>
<tr>
<td>PC</td>
<td>Performance Category</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated Biphenyl</td>
</tr>
<tr>
<td>PE-Ci</td>
<td>Plutonium-Equivalent Curies</td>
</tr>
<tr>
<td>POC</td>
<td>Pipe Overpack Container</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>RANT</td>
<td>Radioassay and Nondestructive Testing</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
<tr>
<td>RF</td>
<td>Respirable Fraction</td>
</tr>
<tr>
<td>RPP</td>
<td>Radiation Protection Program</td>
</tr>
<tr>
<td>RTR</td>
<td>Real-Time Radiography</td>
</tr>
<tr>
<td>SAC</td>
<td>Specific Administrative Control</td>
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<tr>
<td>SIH</td>
<td>Standard Industrial Hazard</td>
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SMP  Safety Management Program
SSC  Structures, Systems, and Components
SSSR  Sort, Segregate, Size Reduction, and Repackaging
ST  Source Term
STD  Standard
SWB  Standard Waste Box
TA  Technical Area
TDOP  Ten-Drum Overpack
TED  Total Effective Dose
TRU  Transuranic
TRUPACT  transuranic package transporter
TSR  Technical Safety Requirement
TWISP  Transuranic Waste Inspection Project
UCL  upper confidence limit
USQD  Unreviewed Safety Question Determination
UTL  upper tolerance limit
VCE  vapor cloud explosion
VOC  Volatile Organic Compounds
WAC  Waste Acceptance Criteria
WIPP  Waste Isolation Pilot Plant
CHAPTER 3  HAZARD AND ACCIDENT ANALYSIS

3.1  INTRODUCTION

This chapter provides an assessment of the hazards associated with the operation of Technical Area (TA)-54, Area G. This chapter analyzes the hazards that exist and the event scenarios that were postulated to occur during TA-54, Area G operations, considering both normal and abnormal conditions, external events, and natural phenomena. TA-54, Area G is the primary site for the receipt, processing, storage, shipping, and disposal of low-level waste (LLW), mixed low-level waste (MLLW), hazardous waste (HW), tritium-contaminated waste, and transuranic (TRU) nuclear waste generated at Los Alamos National Laboratory (LANL). TA-54, Area G operations also include the retrieval and preparation of legacy waste items for shipment to offsite treatment, storage, and disposal facilities. The analyses in the Consolidated Hazard Analysis (CHA) (Appendix 3H) have been performed after considering the consequences from the material-at-risk (MAR) limits associated with TA-54, Area G operations. This examination results in a bounding analysis for all TA-54, Area G operations.

The results of the CHA include potential event scenarios and the associated safety controls (preventive and mitigative); potential safety-class or safety-significant structures, systems, and components (SSCs); and a spectrum of scenarios to be evaluated quantitatively in the Accident Analysis (AA). The methodology used to identify and evaluate hazards is documented in the TA-54, Area G CHA, Appendix 3H, and in Section 3.3.1 of this chapter.


Based on the results of the CHA in Section 3.3.2, and the comparison of the TA-54, Area G inventory to the Threshold Quantities (TQs) from DOE-STD-1027-92 [DOE 1997], TA-54, Area G is categorized as a Hazard Category (HC)-2 non-reactor nuclear facility. According to DOE-STD-3009-94 [DOE 2006a], an AA is required for HC-2 facilities or activities because there is a potential for exceeding the DOE Evaluation Guideline (EG) of 25 rem Total Effective Dose (TED) to the Maximally Exposed Offsite Individual (MEOI), herein referred to as the public. The public is postulated to be located at the nearest site (Laboratory) boundary adjacent to TA-54, Area G.

3.2  REQUIREMENTS

The CHA and AA presented in this chapter were developed using 10 CFR 830 [CFR 2011a], Subpart B, Safety Basis Requirements.

Other sources of requirements include the following documents:

- DOE O 420.1B, Facility Safety [DOE 2005]
3.3 HAZARD ANALYSIS

The HA provides a comprehensive assessment of facility hazards and event scenarios that could produce undesirable consequences for the public, collocated workers, and workers associated with the TA-54, Area G waste container handling and storage operations.

3.3.1 HAZARD ANALYSIS METHODOLOGY

This section describes the HA methodology used to present a comprehensive evaluation of process-related, natural phenomena, and external hazards in TA-54, Area G that can affect the public, collocated workers, and workers. The HA and AA methodology is based on a graded approach, as described in DOE-STD-3009-94 [DOE 2006a] and DOE-STD-1027-92 [DOE 1997], which dictates that complex, high-hazard facilities be assessed more rigorously and documented more thoroughly than that of simple,
low-hazard facilities (the more significant the consequences, the more detailed the analysis). DOE-STD-5506-2007 [DOE 2007] provides guidance on the identification (ID) of hazards expected during various types of TRU waste operations, as well as listing a minimum set of event types that are applicable, based on these hazards. DOE-STD-5506-2007 guidance is used in the development of the Hazard ID Checklist and is shown in Appendix 3H, Section 9.1. The Hazard Evaluation (HE) Tables are also shown in Appendix 3H.

### 3.3.1.1 Hazard Identification

Hazard ID involves identifying all facility and process hazards and energy sources. Hazard ID is a comprehensive, systematic process by which all known facility hazards (hazardous materials and energy) are identified, recorded, and screened. The Hazard ID considered (1) division of the facility into areas, (2) facility walk-downs, and (3) screening for Standard Industrial Hazards (SIHs). The Hazard ID Checklist used to identify facility hazards is documented in Appendix 3H, Section 9.1.

**Division of the Facility** – TA-54, Area G is divided into major operations and sub-areas (defined areas), based on process activities intended to be performed in them, to facilitate Hazard ID and evaluation. Major operations at TA-54, Area G are as follows:

- Above-ground TRU operations (HA Identifier: AGTRU)
- LLW/MLLW/tritium-contaminated waste activities (HA Identifier: LLW, H3)
- Below-ground TRU operations (HA Identifier: BGTRUCMP, BGTRUCSK, BGTRUPIT)
- Building 54-412 operations (HA Identifier: BLDG412)
- Movement of TRU waste between TA-54, Area G and the Radioassay and Nondestructive Testing (RANT) facility (HA Identifier: RANTTOG)

Defined areas within Area G are as follows:

- Sort, Segregate, Size Reduction, and Repackaging (SSSR) Area
- Low-Activity Area (LAA)
- Specified areas within Building 54-412
- Process Area (i.e., drum venting, mobile loading, non-destructive assay (NDA), etc.)
- Retrieval Area
- Tritium Area
- TRU Compliant (metal) Container Storage Area
- TRU Non-Compliant (non-metal or unvented) Container Storage Area
- TA-54, Area G

**Facility Walk-Downs** – Facility walk-downs include physical walk-downs, reviews of current design, and direct interactions with individuals who are knowledgeable and responsible for the specific storage and process activities in the facility (existing safety documentation, design/system drawings, procedures etc.). This information is used in the ID of hazardous materials and energy sources associated with each storage area or process activity, producing a list of expected radiological and chemical hazards.
Screening of SIHs – After the hazards and energy sources were identified, the CHA team determined whether any potential hazards could be screened from further consideration. Common, everyday hazards are not addressed in this HA. Examples of hazards common to everyday activities include trips and falls while walking or climbing stairs. The SIHs are defined as hazard sources (material or energy), or events that involve hazards that are routinely encountered by the general public or in general industry and construction. Recognized National consensus codes or standards, as shown in Attachment A, govern handling or use of hazard sources without the need for special analysis to define safety design and operational parameters. These types of hazards were carried forward into the What-If/HA development only if they could lead to a release of radiological materials or hazardous chemicals. If there was uncertainty as to whether a hazard should be screened, it was carried forward to be evaluated more thoroughly.

Examples of SIH are as follows:

- Specific materials that have their own control program (e.g., lead, asbestos)
- Thermal energy sources (potential for burns)
- Forklift use not involving radiological material
- Crane use not involving radiological material
- Fires not involving radiological or hazardous materials
- Commercial radiation-generating devices

3.3.1.2 Hazard Evaluation

The purpose of this hazard evaluation was to assess the potential radiological and chemical hazards associated with the facility and to determine the proper hazard categorization based on the guidance and requirements of 10 CFR 830 [CFR 2011a], DOE-STD-3009-94 [DOE 2006a], and DOE-STD-5506-2007 [DOE 2007].

The scope of the hazard evaluation includes identified hazard events associated with the following:

- Activities in defined areas involving TA-54, Area G operations
- External events, both natural and man-made phenomena

Assumptions for the facility HA were determined and documented in the TA-54, Area G CHA (Appendix 3H). Assumptions are general statements that govern the boundaries of the analysis. Inputs are specific conditions that are a part of the facility operations or parameters used in the analysis. Inputs and assumptions requiring protection are identified in the HA and AA.

The CHA Process team estimated the bounding MAR for each applicable defined area, numbered and grouped the events, and assessed selected controls for adequacy. Unique and representative events were chosen based on the risk, MAR values, and control sets. Bounding implies the highest risk to the public. Since control sets vary by event, the bounding event may not identify all the unique control sets. Therefore, unique events must be identified to capture those unique control sets. Scenarios with Low unmitigated consequences and Low or Minimal unmitigated risk (Risk Rank III or IV) were not evaluated further. Scenarios with the highest consequences and risks to the public, collocated workers, and the workers (Risk Rank I or II) were evaluated. This information is provided in the HE Tables in Appendix 3H, Section 9.4 of this chapter.
The HA contains information on the following:

- Event Scenario Number – unique ID number
- Event Description – includes a description of the event (including event progression information) and the release mechanism (e.g., fire, pressurized release, or spill) or other consequence mechanism (e.g., direct exposure)
- Initiators to the Event Scenario – as identified from the list of individual event scenarios
- Event Frequency Bin (unmitigated)
- Consequence Level (unmitigated)
- Risk rank (unmitigated)
- Preventive Controls (potential safety-class SSC, safety-significant SSC, potential Specific Administrative Control [SAC], and Administrative Controls [ACs])
- Mitigative Controls (potential safety-class SSC, safety-significant SSC, potential SAC, and ACs)
- Event Frequency Bin (mitigated)
- Consequence Level (mitigated)
- Risk rank (mitigated)

### 3.3.1.2.1 Frequency Category Estimates

A postulated event resulting from identified causes is expressed as occurring within an expected frequency range. The event scenario frequencies are qualitative and based primarily on engineering judgment. When available, site-specific data is used if it provides added insight.

A frequency level is assigned to each event in the HE Tables based on the event causes, based on DOE-STD-3009-94 [DOE 2006a]. Table 3-1, *Qualitative Risk Ranking Bins*, presents the frequency categories that are assigned to the various postulated event scenarios (Appendix 3H, Section 9.4). These estimates are based on an interpretation of unmitigated to mean that no special safety controls are implemented above and beyond standard industrial practices and that many of the LANL institutional procedures are not credited. That is, the unmitigated frequency estimates do not take credit for safety controls that could lower the frequency.
Table 3-1. Qualitative Risk Ranking Bins

<table>
<thead>
<tr>
<th>Consequence Level</th>
<th>Beyond Extremely Unlikely (BEU) Below 10^{-6}/yr</th>
<th>Extremely Unlikely (EU) 10^{-4} to 10^{-6}/yr</th>
<th>Unlikely (U) 10^{-2} to 10^{-4}/yr</th>
<th>Anticipated (A) 10^{-1} to 10^{-2}/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Consequence</td>
<td>III</td>
<td>II</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Moderate Consequence</td>
<td>IV</td>
<td>III</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Low Consequence</td>
<td>IV</td>
<td>IV</td>
<td>III</td>
<td>III</td>
</tr>
</tbody>
</table>

1. Industrial events that are not initiators or contributors to postulated events are addressed as a SIH.
2. For external events, the frequency of occurrence below 10^{-6}/year conservatively calculated, or 10^{-7}/year realistically calculated, is binned as Beyond Extremely Unlikely.

The frequency of an event scenario is a function of the frequency of the initiating event and the frequency of enabling events. Enabling events are those events that must occur following the initiating event to cause the postulated accident. For example, in the scenario of an earthquake resulting in a fire in a building, the initiating event is the earthquake, and an enabling event could be some type of electrical equipment failure that starts the fire. Unmitigated frequency estimates for event scenarios are generally taken to be the frequency of the initiating event only, with the probability of the enabling event assumed to be 1.0 (i.e., the event happens). However, under certain circumstances where the probability of the enabling event is clearly less than 1.0 (e.g., fire subsequent to vehicle accident); the overall scenario frequency estimate would be less than the initiating event frequency.

3.3.1.2.2 Consequence Category Estimates

As with frequency categories, qualitative consequence severity categories were assigned to each of the postulated event scenarios. These consequence severity categories are qualitatively assessed and consider such factors as radiological inventory, material form, and energy of release; toxic factors include toxicity, inventory, and volatility. The evaluation used a qualitative or semi-quantitative assessment based on the quantities of radionuclides (Table 3-3) released as a result of each postulated event. In addition, these quantities were dependent on the release fractions associated with each combination of material form and event type. When semi-quantitative consequences were determined, bounding release fractions were used.

Guidance on the consequence levels for public, onsite collocated worker, and worker receptors is provided in DOE-STD-5506-2007 [DOE 2007] and is shown in Table 3-2.

Worker dose consequences are estimated to be the same or one bin higher than consequences calculated for the collocated worker. Some initiating events themselves have the potential to directly inflict significant physical worker consequences independent of the release of radiological material during events. Such events include a building structural failure due to a natural phenomena hazard (NPH) event, fires, deflagrations, an airplane crash, a lightning strike, etc. For events of this type, worker physical and dose consequences would be estimated to be higher than those for collocated workers. Some slowly-progressing events, such as a low energy spill or a gradually spreading fire, allow the trained facility worker adequate time to recognize the hazard and safely exit the area well before experiencing significant
or life-threatening consequences. For such events, the worker consequence bin is estimated to be equal to that for the collocated worker.

### Table 3-2. Consequence Levels Guideline

<table>
<thead>
<tr>
<th>Consequence Level (Abbreviation)</th>
<th>Public (P)</th>
<th>Collocated Worker (CW) (at 100 m)</th>
<th>Worker (W) (Involved worker within facility boundary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (H)</td>
<td>Considerable offsite impact on people or the environs. ( \geq 10 \text{ rem}^\star \text{ TED} )</td>
<td>Significant onsite impact on people or the environs. ( \geq 100 \text{ rem TED} )</td>
<td>For safety-significant designation, consequence levels such as prompt death, serious injury, or significant radiological and chemical exposure, must be considered.</td>
</tr>
<tr>
<td>Moderate (M)</td>
<td>Only minor offsite impact on people or the environs. ( \geq 1 \text{ rem TED} )</td>
<td>Considerable onsite impact on people or the environs. ( \geq 25 \text{ rem TED} )</td>
<td>No distinguishable threshold</td>
</tr>
<tr>
<td>Low (L)</td>
<td>Negligible offsite impact on people or the environs. ( &lt; 1 \text{ rem TED} )</td>
<td>Minor onsite impact on people or the environs. ( &lt; 25 \text{ rem TED} )</td>
<td>No distinguishable threshold</td>
</tr>
</tbody>
</table>

*When using source term/consequence analysis parameters in DOE-STD-5506, public dose consequences greater than or equal to 10 rem are considered to challenge the EG [DOE 2007].

Although the HA is mostly a qualitative process, the radiological consequences (dose) to the public are estimated using a quantitative determination using the five-factor Source Term (ST) equation [DOE 2000a]. The ST equation is described fully in Section 3.4. Preliminary calculations were used to estimate consequences for the remainder of the HA events. The dose to the public for each postulated event scenario is estimated by the product of the ST and the Dose-to-Source-Term (DST) ratio, as calculated in Section 3.4. The ST parameters used for each event scenario are from those listed in DOE-STD-5506-2007 [DOE 2007]. For the unique and representative event scenarios that were carried forward into the AA (Section 3.4), the dose consequences to the public and collocated worker were calculated more precisely based on detailed scenario development, quantitative models of physical phenomena, and consideration of the differing waste compositions in the ST analysis.

For some event scenarios, it is anticipated that the dose consequence analyzed in Section 3.4 could result in calculated doses that are less than the consequence category assigned in the HA (Appendix 3H); this will not invalidate the results of the HA.

To simplify the unmitigated HA, the MAR is presented in terms of Plutonium-equivalent curies (PE-Ci), except for tritium. The PE-Ci is generally recognized as the standard unit for expressing radiological material quantities for TRU waste and for evaluating inhalation human health consequences due to TRU releases.
Table 3-3. Upper-Bound MAR Values for Hazard Analysis Consequence Estimates

<table>
<thead>
<tr>
<th>Affected Location/Component</th>
<th>MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-54, Area G Site – Above-ground storage</td>
<td>(\leq 57,000) PE-Ci</td>
</tr>
<tr>
<td>TRU Compliant (metal) Container Storage Area</td>
<td>(\leq 22,000) PE-Ci</td>
</tr>
<tr>
<td>TRU Non-metal Container Storage Area</td>
<td>(\leq 2,000) PE-Ci</td>
</tr>
<tr>
<td>Below Grade Storage (buried waste, including pits, shafts)</td>
<td>(\leq 111,000) PE-Ci</td>
</tr>
<tr>
<td>Single TRU Waste Container – direct loaded</td>
<td>(\leq 553) PE-Ci</td>
</tr>
<tr>
<td>TRU Waste Process Areas</td>
<td>(\leq 1,100) PE-Ci HE-RTR Area, and</td>
</tr>
<tr>
<td></td>
<td>(\leq 1,100) PE-Ci per other individual</td>
</tr>
<tr>
<td></td>
<td>Process Area (e.g., for Drum Venting,</td>
</tr>
<tr>
<td></td>
<td>Head Gas Sampling, ISOCs, Mobile Loading),</td>
</tr>
<tr>
<td></td>
<td>(\leq 4,000) PE-Ci total for all</td>
</tr>
<tr>
<td></td>
<td>NDA/NDE equipment (e.g., Temperature</td>
</tr>
<tr>
<td></td>
<td>Equilibration, RTR, HENC, Super HENC)</td>
</tr>
<tr>
<td></td>
<td>and associated staging within Pad 10</td>
</tr>
<tr>
<td></td>
<td>Process Area</td>
</tr>
<tr>
<td>Standard Waste Box (SWB), or Ten-Drum Overpack (TDOP) (Direct</td>
<td>560 PE-Ci</td>
</tr>
<tr>
<td>Loaded)</td>
<td></td>
</tr>
<tr>
<td>Transportation of TRU, Low-Level, or Tritium Waste Containers</td>
<td>(\leq 1,100) PE-Ci of compliant metal</td>
</tr>
<tr>
<td></td>
<td>containers</td>
</tr>
<tr>
<td></td>
<td>(\leq 615) PE-Ci of non-compliant or</td>
</tr>
<tr>
<td></td>
<td>non-metal containers</td>
</tr>
<tr>
<td></td>
<td>(\leq 35) PE-Ci of low-level or mixed</td>
</tr>
<tr>
<td></td>
<td>low-level waste</td>
</tr>
<tr>
<td></td>
<td>(\leq 3,000) Ci Tritium of tritium-</td>
</tr>
<tr>
<td></td>
<td>contaminated waste</td>
</tr>
<tr>
<td></td>
<td>(\leq 1,000,000) Ci Tritium of tritium</td>
</tr>
<tr>
<td>SSSR Area (equivalent combustible)</td>
<td>(\leq 18) PE-Ci</td>
</tr>
<tr>
<td>Open container, in process</td>
<td>(\leq 18) PE-Ci</td>
</tr>
<tr>
<td>Closed container(s), staged</td>
<td></td>
</tr>
<tr>
<td>Defined Areas within Building 54-412 combined total within the</td>
<td>(\leq 56) PE-Ci</td>
</tr>
<tr>
<td>building (equivalent combustible)</td>
<td></td>
</tr>
<tr>
<td>Tritium Areas (TA-54, Area G site total)</td>
<td>(\leq 4,000,000) Ci Tritium</td>
</tr>
<tr>
<td></td>
<td>((\leq 1,000,000) Ci Tritium per area)</td>
</tr>
<tr>
<td>Low Activity Areas containing LLW, MLLW and low-level tritium</td>
<td>((\leq 100) PE-Ci and (\leq 3,000)</td>
</tr>
<tr>
<td>contaminated waste - total above ground or exposed in pits or</td>
<td>Ci Tritium)</td>
</tr>
<tr>
<td>shafts (TA-54, Area G site total)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3-3. Upper-Bound MAR Values for Hazard Analysis Consequence Estimates

<table>
<thead>
<tr>
<th>Affected Location/Component</th>
<th>MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Metal Pipe (CMP)</td>
<td>11,000 PE-Ci</td>
</tr>
<tr>
<td>Retrieval Pit 9 or Trenches A through D (exposed)</td>
<td>≤ 1,500 PE-Ci</td>
</tr>
</tbody>
</table>

3.3.1.2.3 Risk Ranking

Risk ranking methodology for the public, collocated worker, and worker followed the guidance in DOE-STD-5506-2007 [DOE 2007] for the unmitigated as well as mitigated events, Table 3-1.

3.3.1.2.4 Control Description and Type

Controls that are applicable to a given event scenario are listed in the HA tables for that scenario. Each control is identified as preventive (reduction in frequency of an event) or mitigative (reduction in consequence of an event).

For control evaluation, the CHA Process team reviewed the complete set of available controls and identified those effective in reducing the frequency or the consequences to the public, collocated worker, and worker. In some cases, control selection was based on a control’s implementation and effectiveness balanced against the limited lifetime of TA-54, Area G. Note that in the CHA (Appendix 3H), each event scenario was also analyzed for mitigated frequency, consequence, and risk binning to ensure that the control selection meets DOE-STD-5506-2007 [DOE 2007] requirements with respect to reducing the overall risk.

In general, in determining the amount of credit given to a control for each event scenario, the following approximations were used:

- A SAC is an AC that is evaluated per DOE-STD-1186-2004 [DOE 2004] to perform as effectively as a safety SSC. Depending on the frequency or consequence of an event scenario, a SAC may be judged to sufficiently reduce the risk by a factor of 100 (one bin).
- Engineering controls that are passive may reduce the frequency by a factor of 100 (one frequency bin), unless specific data available for the control indicates otherwise.

3.3.1.2.5 Mitigated Frequency, Consequence, and Risk Ranking Estimates

The final step in completing the HA tables is to estimate the mitigated scenario frequency and consequence categories (public, collocated worker, and worker). The mitigated frequency or consequence category estimate is based on crediting all the preventive and mitigative controls that are selected as effective controls for the scenario. Control effectiveness is described above, Section 3.3.1.2.4. The analysis of unique and representative events in Section 3.4 will quantify, where possible, the effectiveness of selected controls and refine the mitigated dose consequence estimates.

3.3.2 HAZARD ANALYSIS RESULTS

This section presents the results of the HA. The CHA (Appendix 3H) contains the postulated TRU and non-TRU event scenarios.
As noted earlier, for the purpose of the HA, the major operations at TA-54, Area G are divided and analyzed as follows:

- Above-ground TRU operations (HA Identifier: AGTRU)
- LLW/MLLW/Tritium Contaminated Waste Activities (HA Identifier: LLW, H3)
- Below-ground TRU operations (HA Identifier: BGTRUCMP, BGTRUCSK, BGTRUPIT)
- Building 54-412 operations (HA Identifier: BLDG412)
- Movement of TRU waste between TA-54, Area G and RANT (HA Identifier: RANTTOG)

Within each major operation at TA-54, Area G, several process operations/activities occur in defined areas. The process operations were provided with a unique identifier for the purpose of relating event scenarios to a defined area. A summary of defined areas and the applicable process activities that occur within the major TA-54, Area G operations is provided in Chapter 2 of this BIO.

3.3.2.1 Hazard Identification

The CHA (Appendix 3H) contains the completed Hazard ID Checklist. Based on hazard identification, screening, and facility judgment, significant hazards were identified as requiring further evaluation in the HA. The following sections discuss the major hazards that were identified for further evaluation, including hazards not screened as SIHs, and considered as initiating events. Examples of these types of hazards include missiles created by compressed gases, flammable gases, etc. Hazards that address the transportation of radiological material to and from the RANT facility along Mesita del Buey Road are also evaluated in the HA, although the RANT facility and Mesita del Buey Road are not within the TA-54, Area G boundary. Hazards related to adjacent facilities were also evaluated, and it was determined that there are no facilities close enough to affect TA-54, Area G.

3.3.2.1.1 Radiological Waste Materials

A large number of different radionuclides are present in the waste materials at TA-54, Area G. The radionuclides of primary concern are the TRUs and tritium. Radionuclides are found in a variety of forms, including the following:

- Surface contamination on paper and plastic waste products
- Contaminated personal protective equipment (PPE)
- Surface and fixed contamination on metallic components, such as gloveboxes
- Constituent mixes in sludges and cementitious solids (cemented matrix)
- Salt cake
- Metals, concrete
- Contaminated filters and sieves

Radiological material is isolated and confined inside waste containers as described in Chapter 2 and the CHA (Appendix 3H).

Newly generated waste containers received into TA-54, Area G must meet the current LANL Waste Acceptance Criteria (WAC) [LANL 2012a] or an approved exception. Legacy waste containers (i.e., waste containers that existed on site before the current LANL WAC), may contain greater quantities than
allowed by the current LANL WAC. Exemption requests are negotiated with Environmental Waste Management Operations management. If the exemption request impacts intra-LANL shipping Transportation Safety Document [LANL 2010a] requirements, negotiation with LANL Packaging and Transportation management may also be necessary.

Waste generators must document requests for an exemption from a WAC requirement and provide the justification. An Unreviewed Safety Question Determination (USQD) evaluation is performed on the WAC exemption request, and, if negative (within safety basis analyzed limits and permit requirements), the waste can be accepted. If the USQD is positive, then the request is submitted to DOE for review and approval before acceptance of the waste at Area G.

If the LANL WAC undergoes revision, all of the LANL nuclear facilities must perform a USQD evaluation before the issue of the revised LANL WAC.

The TA-54, Area G Waste Inventory Database contains information describing the content of every TRU waste container at TA-54, Area G. Details on the TRU waste inventory at TA-54, Area G are discussed in Section 3.4.1. The waste type, form, location, and quantity information from the waste database analysis are factored into the CHA event, event MAR, frequency, and consequence determination. The inventory is reviewed annually to ensure that the assumptions in the accident analysis are not challenged.

Newly generated TRU waste containers are shipped to TA-54, Area G each year for storage before shipment to the Waste Isolation Pilot Plant (WIPP). Accounting for the projected flow of MAR in and out of Area G through July 2013, the MAR that is retrieved from underground burial at Pit 9 or in CMPs, and the current above-ground MAR, a conservative, upper-bound estimate of the total inventory was used for the HA. Retrievals of drums from Trenches A through D may impact the bounding estimates used in the HA; an initial condition is that, before retrieving drums from Trenches A-D, the impact on the above-ground inventory will be determined.

Low-level waste is received in TA-54, Area G for disposition; it can be directly disposed of in the shafts and pits. Some of the LLW may also be temporarily stored before disposition. Selected LLW may be shipped offsite for disposal.

- Tritium-contaminated waste is received in TA-54, Area G for disposition. Containers with a low concentration of tritium-contaminated waste can be directly disposed of in the LLW shafts and pits. Containers with a higher concentration of tritium waste are temporarily stored above ground awaiting disposition.

Mixed LLW and HW are received in TA-54, Area G for storage pending shipment offsite.

Waste items received that present a significant worker hazard from ionizing radiation are placed into disposal (LLW) and storage (TRU waste) shafts. These items can have radiation fields of up to several hundred roentgens per hour at contact and are handled in accordance with Radiation Protection Plan (RPP) (SMP) requirements (e.g. dirt overburden, shielding) to minimize exposures for workers.

### 3.3.2.1.2 Nondestructive Assay/Nondestructive Examination Radioactive Sources

The Nondestructive Assay (NDA)/ Nondestructive Examination (NDE) operations at TA-54, Area G utilize a variety of radioactive sources. The ionizing radiation from these sources represents an operational hazard. Table 3-4 summarizes the NDE/ NDA operations and identifies the radioactive sources associated with each. Table 3-4 characterizes the potential hazard to personnel from these sources.
<table>
<thead>
<tr>
<th>System*</th>
<th>Housing/ Location</th>
<th>Waste Containers Processed</th>
<th>Source Type and Strength</th>
<th>System Safety Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTR-1 and -2</td>
<td>Self-contained mobile trailers</td>
<td>TRU waste drums and SWBs, small crates</td>
<td>Ionizing radiation (x-ray at 320/450 keV, 100 Amp, 208 V)</td>
<td>Shielding, surveillance camera, in operation indication warning lights (amber and red, x-ray on), emergency shutdown switch, vault door safety interlocks</td>
</tr>
<tr>
<td>HE-RTR</td>
<td>TA54-577 Vault</td>
<td>TRU waste drums and SWBs,</td>
<td>Ionizing radiation (3MEV and 6MeV X-rays)</td>
<td>Shielding, surveillance camera, in operation indication warning lights (amber and red, x-ray on), emergency shutdown switch, vault door safety interlocks</td>
</tr>
<tr>
<td>HERCULES</td>
<td>TA-54-2</td>
<td>Suspect LLW assay</td>
<td>Calibration sources (Am-241/C-137 1.99 µCi, Ba-133 528 µCi, Ba-133/Eu-152 2.77 µCi, Eu0154/155 1.01 µCi, Ho-166 8.44 µCi)</td>
<td>None—passive system</td>
</tr>
<tr>
<td>Zeus</td>
<td>TA-54-2</td>
<td>Suspect LLW assay</td>
<td>Calibration sources (Am-241/C-137 1.99 µCi, Ba-133 528 µCi, Ba-133/Eu-152 2.77 µCi, Eu0154/155 1.01 µCi, Ho-166 8.44 µCi)</td>
<td>None—passive system</td>
</tr>
<tr>
<td>HENC</td>
<td>Self-contained mobile truck</td>
<td>TRU waste drum</td>
<td>Ionizing radiation (Cf-252 at 20 µCi)</td>
<td>Automated shielded add-a-source operation, indication warning lights (green lamp—source safe in shield, red lamp—emergency shutdown), emergency shutdown switch, safety sensors in shield door edges</td>
</tr>
<tr>
<td>Super HENC</td>
<td>Self-contained mobile truck</td>
<td>SWB</td>
<td>Ionizing radiation (Cf-252 at 20 µCi)</td>
<td>Automated shielded add-a-source operation, indication warning lights (green lamp—source safe in shield, red lamp—emergency shutdown), emergency shutdown switch, safety sensors in shield door edges</td>
</tr>
</tbody>
</table>

*RTR — Real-time radiography (mobile trailers)
HERCULES — High-Efficiency Radiation Counters for Ultimate Low-Emission Sensitivity system
HENC — High-Energy Neutron Counter
### 3.3.2.1.3 Hazardous Materials

Most of the hazardous materials present in TA-54, Area G are associated with radiological waste forms. The waste shipped to TA-54, Area G must meet the LANL WAC [LANL 2012a] for Resource Conservation and Recovery Act (RCRA)-controlled substances; otherwise, they are stored until treated or until a treatment process is developed. Waste generators of RCRA-controlled substances may at times require an exemption request to the LANL WAC. The exemption process discussed in Section 3.3.2.1.1 also addresses the management of such waste streams. The RCRA Land Disposal Restriction requires DOE sites to treat HW (including the hazardous component of MLLW) to meet certain standards before disposal. These materials are typically found in the MLLW.

Historically, for the legacy waste, precise quantities of hazardous material in each waste container were not recorded by the generators and are not known. The following general characterization of the hazardous constituents in the waste is based on waste-generating process knowledge.

- Quantities of organic solvents might be present in the aqueous waste that was treated and solidified at the Radioactive Liquid Waste Treatment Facility, though the amounts are expected to be at trace levels. The solidified sludge might also contain trace amounts of metal hydroxides from the neutralization and precipitation treatment process. Heterogeneous waste forms do not contain spent solvents, but could contain rags with absorbed solvents.

- RCRA-regulated metals are reported to be in the waste, but are not present in a respirable particulate form. Lead is the predominant metal, but is primarily present in monolithic form. Other RCRA-regulated metals include cadmium, mercury, chromium, and arsenic; none in respirable form. These heavy metals are typically constituents of tools, equipment, and metal containers. None of the HW constituents associated with mixed waste is likely to be of a particulate form, or, if subjected to energy sources present at TA-54, Area G, to be capable of generating a particulate form. Although precise quantities are unknown, the facility inventory indicates that the quantities of these hazardous materials are below the Laboratory thresholds for a low-hazard, non-nuclear facility. This conclusion is based on knowledge of HW (non-radiological) containers at Area L and knowledge that the waste in the containers at TA-54, Area G is from many of the same waste streams as the containers at Area L. Therefore, these hazardous materials are screened from the HA.

- LLW contaminated with Polychlorinated Biphenyls (PCBs) and asbestos waste is normally handled separately for disposal. The asbestos waste is disposed of in pits/shafts. The LANL WAC [LANL 2012a] provides packaging requirements and content limitations for these materials. These materials are not a hazard of concern at TA-54, Area G because they are present in relatively small quantities and because they remain packaged until they are buried.

### 3.3.2.1.4 Combustible/ Flammable Materials

**Waste Container Contents**

Combustible material within the waste inventory consists primarily of paper, cloth, plastic, and other ordinary combustible materials. Quantities of the combustible materials may also be co-contaminated with organic solvents (e.g., ethanol, acetone), reactive flammable materials (e.g., lithium metals or hydrides), or Class 1 oxidizers (e.g., nitrate salts), though these quantities are expected to be small. Class 1 oxidizers slightly increase the burning rate, but do not cause spontaneous ignition when they come in contact with combustible materials. Reactive flammable materials may react readily with air or water. All stored waste is packaged within metal containers, except for certain large metallic objects (e.g., gloveboxes) that are stored in metal, metal-encased wood crates, or fiberglass-reinforced plywood (FRP).
boxes. The facility is permitted under RCRA to store MLLW and mixed TRU waste within designated storage areas.

Pyrophoric materials contained in an oil-based solution are received and stored at TA-54, Area G before shipment offsite. Legacy waste (waste generated before the implementation of the LANL WAC [LANL 2012a] banning pyrophorics) could contain pyrophoric materials. Pyrophoric materials are considered as initiators for fires and deflagrations when handling or processing waste.

In addition, Class 2 and 3 combustible liquids and water-reactives may be stored in Tritium Areas as tritium-contaminated waste. This waste is stored in non-combustible containers.

Waste contents encountered during repackaging activities include carboy-sized containers (approximately 5 gal) with residual liquids. The types of liquids that have been encountered include industrial cleaning solutions and organic solvents (e.g., ethanol, acetone, and xylene). Other organic liquids (e.g., a discarded pump with oil, oil-based paint) have also been encountered. Aerosol cans with some residual contents that have not been depressurized by puncture have also been removed from containers. Waste drums may be completely filled with contaminated aerosol cans as the waste contents, as these drums are generated during SSSR activities to remove prohibited items.

**Hydrogen Gas/ Volatile Organic Compounds**

Hydrogen may be present at TA-54, Area G in the form of tritium waste stored in metal or plastic containers. The tritium is chemically bound to the metallic material in sieves or metal components in a hydride form at room temperature. Tritium waste is stored in tritium areas located away from main site roadways and other structures.

Hydrogen gas may also be present in TRU waste containers; it is primarily formed by radiolytic reactions within the waste material. Volatile organic compounds (VOCs) may also be found in waste containers. In addition, both sealed and unsealed inner containers can be found within the parent waste container. The inner containers may be filled with various types of radioactive and HW. Flammable concentrations of hydrogen gas or VOCs may be present in the inner sealed containers. Metal TRU waste containers in an above-ground storage are vented in order to prevent the buildup of flammable gas. However, TA-54, Area G does contain unvented legacy TRU waste containers. These will be dispositioned to meet the WAC for shipment to WIPP.

Radiological waste received at the TA-54, Area G site must comply with the LANL WAC or an approved LANL exception; therefore, all newly generated waste shipped to TA-54, Area G is received in approved and vented waste containment.

Retrieved drums from Pit 9 are unvented. The burial and waste composition of Pit 9 drums are comparable to those buried and retrieved during the Transuranic Waste Inspection Project (TWISP). Process knowledge from TWISP supports the presumption that drum contents do not contain large amounts of solvents/VOCs. An electronic database used in the preparation for the TWISP Basis for Interim Operation [LANL 2001] identified 441 containers, or roughly 6% of all containers on Pad 2, as containing toxic material in the form of RCRA metals, VOCs, and nitrate salts. VOCs/solvents are present in the solidified aqueous waste that was treated at the Radioactive Liquid Waste Treatment Facility at TA-50. Sludge was stabilized with gypsum or Portland cement before final packaging. Analysis of this sludge indicated that the concentrations of organic solvents are very low to nondetectable: “None of the solid wastes contain spent solvents, i.e., solvents in liquid form that potentially could be reclaimed by processing” [LANL 2001]. The headspace samples were taken in July 1997 from three drums classified as visibly bulging due to elevated temperature conditions. The samples
indicated up to 15,000 ppm methyl ethyl ketone. The three drums were from the same waste stream, indicating that certain waste streams have a propensity to emit VOCs under conditions of changing pressure or temperature. Monitoring in drum storage areas has shown concentrations ranging from 0.2 to 126 ppm at 1 ft from the drum vents. VOC sampling analysis has indicated the presence of methylene chloride and carbon tetrachloride in the breathing zone of workers in storage domes [LANL 1998].

**Liquefied Propane Gas**

Most forklifts used to handle or transport waste containers onsite are powered by liquefied propane gas (LPG). Each LPG fuel tank has a full capacity of about 33.5 lb. The fuel system on these vehicles satisfies the applicable U.S. Department of Transportation (DOT) requirements. The government-furnished equipment (GFE) service vehicle carrying the replacement LPG tanks is permitted to enter TA-54, Area G to deliver refilled replacements to designated storage racks. The GFE service vehicle typically carries 20 to 25 cylinders when making deliveries to the designated tank storage locations, and the risk from these deliveries is bounded by that from the diesel/gasoline delivery truck. The LPG tanks on the propane-powered forklifts are replaced throughout TA-54, Area G, as needed.

The unmitigated event frequency level of a boiling liquid expanding-vapor explosion (BLEVE) or vapor cloud explosion (VCE) occurring near TRU waste storage areas has been qualitatively assessed to be Extremely Unlikely, based on the unique circumstances required for a BLEVE/ VCE occurrence and on the observed frequency of their occurrence in the public sector. The available flammable compressed gas cylinders are limited in number and consist of the small propane bottles and acetylene or oxyacetylene compressed gas cylinders that are used for welding and cutting. Additionally, the need for welding and cutting for maintenance activities in the vicinity of stored wastes is limited.

**Diesel Fuel**

There are several sources of diesel fuel in TA-54, Area G, primarily in vehicle fuel tanks. In addition, earth-moving equipment and cranes are powered with diesel fuel. Large vehicles and heavy equipment can have fuel tank capacities of approximately 100 gal. The GFE service tanker trucks that hold up to 5,000 gal of liquid fuel are used for refueling of TA-54, Area G vehicles/equipment. The refueling is done at designated locations, or the tanker truck is escorted up to the equipment to be refueled.

**Hydraulic Fluids**

Hydraulic fluid is used to power the hydraulic system of the forklift trucks. The fluid that is used has a flash point greater than 200° C (390° F), and volumes are nominally less than 20 gal.

Other miscellaneous equipment (e.g., hand trucks, pallet jacks, and drum lifts) contains insignificant quantities of hydraulic fluid.

**Acetylene**

Acetylene gas may be used in TA-54, Area G during maintenance activities, if MAR is not stored, handled, or processed. When used, the acetylene is provided in standard industrial high-pressure cylinders which are equipped with flashback arrestors. (Also see the discussion for LPG).

Acetylene may not be used in defined areas where MAR is present, or within 50 feet of a defined area where MAR is present.
Gasoline

There are several sources of gasoline in TA-54, Area G, primarily in vehicle fuel tanks. The gasoline-powered vehicles used at TA-54, Area G, consist of small utility vehicles, vans, and small flatbed trucks. Source volumes of gasoline range from 5 gal to 40 gal, and are contained in on-board steel tanks. The GFE service tanker trucks that hold up to 1,000 gal of unleaded gasoline (in addition to 5,000 gal of diesel fuel) are used for refueling of TA-54, Area G vehicles/equipment. (Also see the discussion for Diesel Fuel).

High Voltage Transformer Fluid

High-voltage electric transformers containing heat-transferring fluid may be mounted on a utility pole or pad mounted in various site locations. Source volumes of transformer fluid range from about 15 gal to 280 gal.

3.3.2.1.5 Combustible Loading

Facility walkthroughs identified typical combustibles such as bagged LLW, spill kits on plastic pallets, PPE, eyewash stations, and various other materials needed to support operations.

Large wood crates and FRPs are located in two of the TRU waste storage domes. These wood crates contain large metal components such as contaminated gloveboxes. Most of the wooden crates are coated with fiberglass, a very effective material to prevent ignition [INEL 1979]. The fiberglass will not ignite unless it is exposed to sustained heat. Other crates are made of plain plywood, but are encased in metal (either placed inside transportainers or clad in metal) to protect them from fire. The wood component of crates varies from 100 to 5,000 lb.

The fabric (e.g., a Tedlar® brand) used in the outer membrane of the dome structures also represents a low combustible loading of less than about 0.3 lb/ft² [LANL 2013c]. According to its manufacturer, Tedlar is a fire-retardant fabric that does not readily burn or support combustion. Experience with similar dome structures elsewhere at the Laboratory during the Cerro Grande fire of May 2000 shows that the fabric will burn if exposed directly to embers, but will not propagate a fire.

Landscaping and vegetation growth within TA-54, Area G and buffer areas surrounding the area are maintained to a low combustible loading as a part of general operations and housekeeping to reduce fire risk.

Wooden or combustible pallets are no longer used in TRU waste container storage or TRU waste defined areas in any of the TA-54, Area G locations. (This process requirement is not credited in the HA or AA, but protected in the TSRs as a SMP element.) A wooden or combustible pallet transporting waste to TA-54, Area G is removed or replaced with a non-combustible pallet before receipt into TA-54, Area G. A few plastic pallets with spill kits are located at the ends of waste storage domes away from the waste. Tritium storage sheds also have a few plastic storage racks. The presence of these potentially combustible items is addressed in the Fire Hazards Analysis (FHA) [LANL 2013c] and combustible loading evaluations/programs.

3.3.2.1.6 Review of Past Relevant Operating History

No major accidents or hazardous situations have occurred during the operating history of TA-54, Area G. There have been a number of incidents and reportable occurrences; however, few of these have resulted in...
workers receiving reportable contamination. Examples of incidents and reportable occurrences include the following:

- Forklift fall into a LLW pit
- Dome door blown off restraints by high wind
- Workers contaminated by waste container leakage
- Water discharge from the failure of a fire suppression system
- Improperly packaged LLW
- Drum deflagration during venting operations
- Dropped waste container
- Storage of legacy TRU waste containers with fissile gram equivalent (FGE) limits that exceeded the LANL WAC

### 3.3.2.2 Hazard Categorization

This section presents the results of the Hazard Categorization as specified in DOE-STD-1027-92 [DOE 1997]. This Standard describes the manner in which the HC is determined for non-reactor nuclear facilities. TA-54, Area G contains a very large amount of radiological material in storage, disposal, and waste management operations. In accordance with Section 3.0 of DOE-STD-1027-92, and using the tables in Attachment 1 of the Standard, TA-54, Area G exceeds the TQs for a HC-2 nuclear facility. Therefore, TA-54, Area G is classified as a HC-2 nuclear facility.

### 3.3.2.3 Hazard Evaluation

The TA-54, Area G CHA (Appendix 3H) provides the detail on the HA development originating from the Hazard ID, event scenarios, and ID of initiating causes. The CHA (Appendix 3H) Section 9.1, shows the results of the Hazard ID for each of the TA-54, Area G operations and specific process activities. The Hazard ID results are tied to the postulated event scenarios documented in the CHA Report, Appendix 3H, Section 9.4, which identifies initiators with reference to the applicable event scenario types. The Hazard Evaluation (HE) Tables (Appendix 3H, Section 9.4) document the unmitigated consequences for the following:

- Public exposures to radiological or hazardous material
- Collocated worker exposures to radiological or hazardous material
- Worker exposed to radiological or hazardous material

The HE Tables (Appendix 3H, Section 9.4) also show the consequences due to worker injury from physical hazards (e.g., deflagration, internal pressure in waste containers, falling waste containers).

### 3.3.2.3.1 Planned Design and Operational Safety Improvements

As required by surveillance requirements and controls described in BIO sections 5.5.1.1 and 5.5.2.1.10, the effect of changes in above-ground MAR inventory or average TRU waste composition will be
monitored to ascertain impacts to the Area G BIO bounding MAR assumptions and Source Term calculations to determine whether existing MAR controls need revision, or whether other new controls, control level/classification changes, etc., may be required.

3.3.2.3.2 Defense-In-Depth

This section summarizes significant aspects of defense-in-depth and identifies the safety controls that are credited in the HA (Appendix 3H) for public, collocated worker, and worker protection.

The Design Features (DFs) that are credited as major contributors to defense-in-depth are as follows:

- Metal TRU waste containers that provide containment of hazardous or radiological materials
- Vehicle barriers at high-risk locations to protect waste containers in defined areas

No building structures were identified for the mitigation of uncontrolled hazardous or radiological material releases, or potential energy release (i.e., deflagration) upon containment failure. TA-54, Area G operations are primarily conducted outdoors or in structures not designed to mitigate these potential releases.

The ACs are linked to SMPs that directly control operations. The ACs that are credited for defense-in-depth include the following aspects of operator interfaces:

- Procedural restrictions or limits imposed
- Manual monitoring of critical parameters
- Equipment support functions
- Responses or actions counted on to limit abnormal conditions, accident progression, or potential personnel exposure.

These controls have been credited in the HE Tables (Appendix 3H, Section 9.4) as base assumptions to reduce the frequency or the consequences of an event scenario. The preventive and mitigative controls, both credited and available, provide defense-in-depth for postulated event scenarios. A few controls are not credited for frequency or consequence bin reduction in the HA, but are recognized as providing defense-in-depth in the control strategy for an event scenario, and are discussed in this section. Most safety controls discussed in this section provide a major or minor contribution to defense-in-depth; they are designated as safety-significant SSCs, SACs, or programmatic ACs that are credited for providing reduction in risk to event scenarios in the HA. These controls require Technical Safety Requirement (TSR) coverage. Controls that are designated as safety-class in the AA include the controls selected for risk reduction in the HA, initial conditions, or identified supporting controls to augment the implementation of the HA-selected controls.

The defense-in-depth strategy afforded by initial conditions and HA-selected controls for each accident type is discussed below. The controls are grouped by accident type and are described with respect to the prevention and mitigation of event scenarios.

Controls that are credited in the HA and AA are further developed in Chapters 4 and 5, and protected in the TSRs.

Terms used within the following discussion are defined as follows:
Table 3-5. Terms and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>A device used to support facility activities and processes (e.g., crane, manlift, pallet jack, generator or compactor).</td>
</tr>
<tr>
<td>Handling</td>
<td>The movement of waste containers within a defined area, or between two defined areas that are collocated within the same building, dome, or pad. Container handling may be done with direct hand contact.</td>
</tr>
<tr>
<td>High-Risk Location</td>
<td>Any area identified in Area G where a TRU waste storage area, TRU retrieval area, SSSR area, or TRU process area is perpendicular to a designated vehicle roadway and can be impacted head-on if a vehicle continued traveling in a straight path. An area where the designated vehicle roadway would only result in a glancing impact (i.e., not a straight path) is not considered a high-risk location.</td>
</tr>
<tr>
<td>Transport</td>
<td>The movement of waste containers by Transportation / Equipment (forklift), outside of a defined area and beyond the paved floor surface of the building, dome, or pad if two or more defined areas are located within a single building, dome, or pad, or offsite.</td>
</tr>
<tr>
<td>Vehicle</td>
<td>A motorized unit used to transport personnel, equipment, or TRU waste containers (e.g., truck, car, or forklift).</td>
</tr>
<tr>
<td>Equivalent Combustible PE-Ci</td>
<td>The quantity of any other waste stream which would provide the equivalent source term (ST) to 1 PE-Ci of waste contained in a 100% combustible waste matrix. Other waste streams discussed in this BIO are non-combustible, dispersible, or non-combustible, non-dispersible. All of the waste compositions within TRU waste drums are grouped and bounded by these waste matrices. For example, in an unconfined waste burn, and presuming unity for the damage ratio and leak path factor in a source term calculation, 1 equivalent combustible PE-Ci will result in the same source term as 8.3 PE-Ci in a non-combustible, dispersible waste matrix or 500 PE-Ci in a non-combustible, non-dispersible waste matrix. The equivalent combustible PE-Ci values are determined by the source term factors of a bounding event scenario.</td>
</tr>
<tr>
<td>Compliant</td>
<td>Meets DOE-STD-5506 criteria for a TRU waste container of sound integrity.</td>
</tr>
<tr>
<td>Non-Compliant</td>
<td>Does not meet DOE-STD-5506 criteria for a TRU waste container of sound integrity.</td>
</tr>
</tbody>
</table>

3.3.2.3.2.1 General

A. Radiological Inventory Management

The Radiological Waste Inventory Management control specifies the radiological material limit for each type of defined area and administratively monitors the amount of radiological inventory within each defined area to ensure that its limit is not exceeded. This control is credited for fire, deflagration, loss of confinement/containment, external, and NPH events. Restricting the quantity of radiological waste within a defined area ensures that the consequences of a given event within that area are limited. Whether to protect initial conditions of the HA, or as a derived control in the HA, this control provides a major contribution to defense–in-depth for all receptors, depending on the scenario, and is protected in the TSRs as a SAC.

The following facilities and areas were defined, and the quantity of MAR permitted within each facility or defined area is specified:
SSSR areas are limited to less than or equal to 18 PE-Ci equivalent combustible waste in process, and less than or equal to 18 PE-Ci equivalent combustible waste in closed container(s) awaiting processing or removal to limit the radiological consequences to the public.

LAAs are limited to a total exposed MAR of less than or equal to 100 PE-Ci and less than or equal to 3,000 Ci tritium to limit the public and collocated worker consequences.

Transportation Vehicles transporting low-activity waste containers are limited to a MAR of less than or equal to 35 PE-Ci and less than or equal to 3,000 Ci tritium to limit the public and collocated worker consequences.

The defined areas within Building 54-412 have a total MAR limit of less than or equal to 56 equivalent combustible PE-Ci to limit the public and collocated worker consequences.

Transportation Vehicles transporting all compliant (metal) TRU waste containers have a MAR limit of less than or equal to 1,100 PE-Ci based on waste transport vehicle limits. During the CHA, event scenarios postulated that a vehicle/truck is transporting 48 compliant (metal) waste containers with a statistically calculated MAR equal to 892 PE-Ci (including the four statistically high MAR drums). The selection of 48 containers is based on the volume dimensions of a transport vehicle bed and the number of drums that can be contained within the bed volume. Because the selection of 48 containers is based on the number of containers that can be physically contained without stacking, the value of 48 containers is not a protected assumption.

Transportation vehicles transporting one or more non-compliant metal or non-metal TRU waste containers are limited to less than or equal to 615 PE-Ci. This MAR limit in non-compliant TRU provides a comparable source term to the source term associated with 1,100 PE-Ci in compliant containers in a vehicle accident with fuel pool fire.

Process Areas (other than Pad 10) are limited to a MAR of less than or equal to 1,100 PE-Ci (each).

The MAR limit for the Process Area on Pad 10 (which houses RTR, HENC, and other characterization equipment, plus staging of containers awaiting characterization) is 4,000 PE-Ci.

Retrieval Areas are limited to a MAR of less than or equal to 1,500 PE-Ci, based on known inventories within Pit 9 and Trenches A through D. (CMPs are not required to have a MAR limit due to the low consequences involving all of the CMP MAR in a bounding event scenario.)

Non-compliant TRU Metal or Non-Metal Container Storage Areas are limited to a MAR of less than or equal to 2,000 PE-Ci each, based on known inventories of above and below-ground non-metal containers.

Tritium Areas are limited to less than or equal to 1,000,000 Ci tritium each to limit the public consequences.

Transportation Vehicles are limited to less than or equal to 1,000,000 Ci tritium to limit the public consequences.

TRU Compliant (metal) Container Storage Areas are limited to a MAR of less than or equal to 22,000 PE-Ci each based on current maximum storage area inventories.

TA-54, Area G is limited to a MAR of less than or equal to 57,000 PE-Ci above-ground TRU waste and less than or equal to 4,000,000 Ci tritium, based on current inventory and projected operations.

Radiological waste inventory is controlled to the quantities indicated in Table 3-6.
# Table 3-6. Radiological Waste Inventory Limits

<table>
<thead>
<tr>
<th>Defined Area(^6) or Facility</th>
<th>Material-at-Risk Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSSR Area</td>
<td>(\leq 18) equivalent combustible(^1) PE-Ci</td>
</tr>
<tr>
<td>Open container(s), in process</td>
<td>(\leq 18) equivalent combustible(^1) PE-Ci</td>
</tr>
<tr>
<td>Closed container(s), staged</td>
<td>(\leq 18) equivalent combustible(^1) PE-Ci</td>
</tr>
<tr>
<td>LAA (exposed, total Area G)</td>
<td>(\leq 100) PE-Ci and (\leq 3,000) Tritium Ci</td>
</tr>
<tr>
<td>Transportation of Low-Activity Waste</td>
<td>(\leq 35) PE-Ci and (\leq 3,000) Tritium Ci</td>
</tr>
<tr>
<td>Building 54-412</td>
<td>(\leq 56) equivalent combustible(^1) PE-Ci</td>
</tr>
<tr>
<td>TRU Transportation Vehicle</td>
<td>(\leq 1,100) PE-Ci (all compliant [metal] containers)</td>
</tr>
<tr>
<td></td>
<td>(\leq 615) PE-Ci (1 or more non-metal containers)</td>
</tr>
<tr>
<td>Process Areas</td>
<td>(\leq 1,100) PE-Ci</td>
</tr>
<tr>
<td>HE-RTR Process Area(^3)</td>
<td>(\leq 1,100) PE-Ci</td>
</tr>
<tr>
<td>Drum Venting Process Areas</td>
<td>(\leq 1,100) PE-Ci, each</td>
</tr>
<tr>
<td>Mobile Loading Process Areas</td>
<td>(\leq 1,100) PE-Ci, each</td>
</tr>
<tr>
<td>Pad 10 Process Area(^4)</td>
<td>(\leq 4,000) PE-Ci, total</td>
</tr>
<tr>
<td>Other Process Areas(^5)</td>
<td>(\leq 1,100) PE-Ci, each</td>
</tr>
<tr>
<td>Retrieval Area</td>
<td>(\leq 1,500) PE-Ci</td>
</tr>
<tr>
<td>TRU Non-Metal Container Storage Area(^2)</td>
<td>(\leq 2,000) PE-Ci</td>
</tr>
<tr>
<td>Tritium Area</td>
<td>(\leq 1,000,000) Tritium Ci</td>
</tr>
<tr>
<td>Tritium Transportation Vehicle</td>
<td>(\leq 1,000,000) Tritium Ci</td>
</tr>
<tr>
<td>TRU Compliant (metal) Container Storage Area</td>
<td>(\leq 22,000) PE-Ci</td>
</tr>
<tr>
<td>TA-54, Area G total above-ground TRU and Tritium</td>
<td>(\leq 57,000) PE-Ci TRU and (\leq 4,000,000) Tritium Ci</td>
</tr>
</tbody>
</table>

1. See equivalent combustible PE-Ci definition in Table 3-5 of this BIO.
2. Compliant (metal) containers can be stored in TRU Non-Metal Container Storage Areas.
3. For the HE-RTR Process Area, the MAR limit applies to the vault and an area within 20 ft surrounding the vault because of the potential for seismic collapse.
4. The total MAR limit for the Pad 10 Process Area accommodates the inventory staged for, or undergoing one or more NDA/NDE characterization processes (e.g., RTR, HENC, Super HENC, and Temperature Equilibrium Units).
5. Other individual Process Areas (such as those areas devoted to head gas sampling or characterization activities) that are not located within the defined Pad 10 Process Area.
6. All above-ground MAR is required to be located inside a Defined Area appropriate to the waste and container type, except for MAR in transport or MAR inside certified Type B containers.

## B. Maintenance Program

### B.1 Vehicle / Equipment

The Maintenance Program ensures that LANL vehicles and equipment operating in TA-54, Area G are periodically inspected and maintained to reduce the frequency of equipment malfunction, and is protected
Vehicles and equipment are expected to respond to operator direction through steering and braking. Proper maintenance of vehicles and equipment reduces the frequency that they would initiate event scenarios that could result in insults to radiological waste containers. This administrative program performs the preventive function of reducing the frequency of vehicle/equipment malfunctions and therefore preventing accident consequences to all receptors.

The majority of vehicles and equipment operating within TA-54, Area G are government owned and operated and, therefore, are maintained in accordance with LANL programs and procedures. A small percentage of vehicles permitted within TA-54, Area G are not government owned and operated. These vehicles are expected to be maintained by their owners; however, there is no reasonable means to verify compliance. The non-government vehicles are expected to have a significantly lower gross vehicle weight rating than the maximum government vehicle (i.e., water truck). A lower-weight vehicle is anticipated to have better handling characteristics than the maximum-weight vehicle. Since this control works in conjunction with driver training and qualification, the reduction in the handling of non-governmental vehicles is judged not to significantly increase the frequency of vehicle accidents due to equipment malfunction.

B.2 Lightning Protection System

A LANL study [LANL 2004] concluded that the current code-compliant lightning protection system (LPS) does not provide a significant reduction in the frequency of lightning-induced fires at LANL. As such, the hazard analysis considers the LPS as providing defense-in-depth for lightning-related event scenarios. However, the hazard analysis does not credit the LPS for risk reduction.

C. Training and Qualification Program

C.1 Qualifications

The Training and Qualification Program provides assurance that personnel maintain applicable LANL certifications for vehicle/ equipment operation and have met a minimum standard of capability and knowledge in the operation of vehicles/ equipment; it is protected in the TSRs as a SMP. This control provides defense-in-depth for fire, deflagration, and loss-of-confinement/ containment events. Qualification of vehicle/ equipment operators reduces the frequency of vehicular accidents that could result in impacts to radiological waste containers. The qualification of vehicle/ equipment operators was determined to provide protection to all receptors and is protected in the TSRs as an element of the Training and Qualification SMP.

C.2 Hazards Recognition

The Training and Qualification Program also provides assurance that personnel authorized to operate equipment and processes and handle radiological waste are aware of the facility hazards, designated routes of travel, job hazard analysis, identification of adverse (abnormal) events, response to adverse conditions, and use of approved procedures, and is protected in the TSRs as a SMP. This control provides defense-in-depth for fire, deflagration, and loss-of-confinement events. The control for a job hazard
analysis process was determined to provide protection to all receptors and is protected in the TSRs as an SMP element.

D. Emergency Preparedness Program

The Site EPP integrates emergency planning, preparedness, training, response, and recovery activities into a comprehensive Emergency Management Program to protect Laboratory employees, emergency responders, neighboring communities, national security information, facilities, lands, and the environment from the consequences of an emergency incident. Specifically, at TA-54, Area G, the EPP provides assurance that adverse conditions are recognized by workers and reported to the Operations Center, which notifies facility and site personnel and directs the response. The EPP, in conjunction with RPP controls, is considered to reduce the exposure of workers in the facility. The EPP is also reduces the exposure of collocated workers. Exposure of collocated workers to releases of radiological material is mitigated by alerting Operations Center personnel of the condition, and then directing the workers to locations where their exposure is reduced. Reducing exposure time to releases of radiological waste ensures that the consequences of a given event are limited. This control was determined to provide protection to all receptors and is protected in the TSRs as an SMP.

E. Hazardous Material and Waste Management – Inclement Weather Control

The Inclement Weather Control provides assurance that outdoor activities associated with the handling or transportation of radiological waste are suspended during inclement weather (sustained high winds, lightning, etc), which reduces the frequency of weather-related accidents. This control provides defense-in-depth for fire, deflagration, and loss-of-confinement/containment events, although it is not credited for specific risk reduction in the HA. Adverse weather can reduce visibility, affect attention, and create conditions that can lead to unexpected facility upsets. Restricting activities involving radiological waste reduces the frequency of weather-related accidents. The defense-in-depth control was determined to provide protection to all receptors, and is protected in the TSRs as an SMP element.

F. Radiation Protection Program

The RPP provides assurance that defined areas involving radiological materials are posted and that radiological activities and conditions are evaluated for the identification of proper PPE and/or compensatory measures. This ensures that workers are familiar with radiological hazards within their work areas, wear the proper PPE, and comply with established radiological work permits. This control is credited for reducing the consequences to workers due to exposure from ionizing radiation as well as inhalation exposures from releases. Although this control is primarily for worker protection, it was determined to also provide some protection to all receptors, and is protected in the TSRs as an SMP.

G. Hazardous Material and Waste Management – Waste Acceptance Criteria

The LANL WAC provides assurance that newly generated radiological and HW received into TA-54, Area G complies with the requirements of the LANL WAC [LANL 2012a] or an approved exception. This control provides defense-in-depth for fire, deflagration, and criticality events. This control was determined to provide protection to all receptors, and is protected in the TSRs as an SMP element.

H. Waste Packaging Control

The Radiological Waste Container Control provides assurance that radiological waste is packaged, except as permitted within SSSR areas. This control provides defense-in-depth for fire, external fires, and NPH events resulting in a fire. Packaged waste burns at a slower rate and releases less radiological material to
the environment, resulting in a lower uptake by all receptors. This control was determined to provide a major contribution to defense-in-depth for all receptors, and is protected in the TSRs as a performance criteria requirement for compliant and non-compliant TRU waste containers.

I. Hazardous Material and Waste Management Program

I.1 TRU Waste Container Integrity

The compliant metal TRU waste containers control provides assurance that above-ground metal TRU waste containers are of sound integrity. This control is credited for fire, deflagration, loss-of-confinement, external, and NPH events. A container of sound integrity limits the amount of radiological material that would be released if the container was subjected to the energy pulse of an external deflagration or was impacted. In addition, closed metal waste containers do not propagate fires and thus reduce the consequence that the container contents would spontaneously ignite if subjected to a heat flux.

Maintaining TRU waste in compliant (metal) containers, except as otherwise permitted (e.g., FRPs, SSSR), protects the assumptions of the analysis. Compliant metal TRU waste containers are a safety-significant SSC and are protected in the TSRs as a Design Feature (DF). TRU waste container inspection for sound integrity is protected in the TSRs as a SMP element through the Hazardous Material and Waste Management Program. The TSR SMP element lists the DF in-service inspection (ISI) requirements for compliant metal TRU waste containers.

I.2 Hazardous Material and Waste Management - Overpacking TRU Waste Drums

Because of the legacy nature of the waste containers at Area G, drums that are found to be of suspect integrity are overpacked. This control provides assurance that a drum in a degraded or suspect-degraded state is packaged into a larger outer container with sound integrity. This control provides defense-in-depth for loss-of-confinement/containment events and to protect initial conditions of the analysis for drums of sound integrity. Placement of a degraded or suspect-degraded drum within an outer larger container of sound integrity maintains the damage ratio (DR) within analyzed conditions for all event types that are used to calculate event consequences for these drums. This control is protected in the TSRs as an SMP element.

J. Radiological Inventory Management

J.1 Doublepack

The doublepacking of TRU waste drums with MAR ≥ 200 PE-Ci provides assurance that a drum of sound integrity with a MAR greater than or equal to 200 PE-Ci is packaged into an outer secondary container of sound integrity. This control is credited for providing defense-in-depth for fire, deflagration, loss-of-confinement/containment, external, and NPH events. The outer container provides an additional layer of defense against the release of radiological material in an upset condition, as it provides additional protection of the inner primary container against mechanical and thermal insults. The HA credits this control as a major contributor to defense-in-depth and is protected in the TSRs as a SAC.

J.2 Trenches A-D Doublepacking

Many containers that are currently stored in Trenches A through D contain > 200 PE C. These containers are not currently doublepacked and cannot be doublepacked until they are removed from the trench. The hazard analysis credits doublepacking of Trenches A-D Drums with MAR ≥ 200 PE-Ci before retrieval of an additional TRU waste drum in the defined area to mitigate the consequences of involving more than
one drum in fire, deflagration, and NPH events. The hazard analysis credits this control as a major contributor to defense-in-depth; therefore, this control is protected in the TSRs as a SAC.

K. Corrugated Metal Pipe

The CMPs provide assurance that radiological materials contained within a solid concrete matrix are not readily releasable. If the CMPs degrade, the RPP or RCRA permit requires that the degraded CMPs be wrapped in plastic or other material to confine radiological contamination. Because of the cemented waste form and the associated low damage ratio, airborne release, and respirable fractions, source terms are negligible from CMPs subjected to hazard events involving fire, deflagration, loss-of-confinement/containment, external, or NPH events. Retaining radiological waste within a concrete aggregate within a CMP ensures that the consequences of any given event are negligible; thus CMPs are not required to be protected in the TSRs, other than the controls provided by safety management programs.

L. Pipe Overpack Container

The Pipe Overpack Containers (POCs) provide assurance that radiological material contained within a sealed metal pipe and packaged within a structurally sound container are not readily releasable. This control is an initial condition in the hazard analysis for providing protection to waste contents against fire, deflagration, loss-of-confinement/containment, external, and NPH events. Retaining radiological waste within POCs ensures that the consequences of any given event are negligible. DOE-STD-5506, Table 4.4.4-1 [DOE 2007] indicates that, for the majority of accident stresses, a DR=0 is applied to MAR stored within POCs. The accident stress involving a forklift tine puncture of a waste container with contaminated solids results in a DR=0.05; forklift tine puncture of a waste container with sand-like materials results in a DR=0.1. Therefore, for waste material that is stored within a POC at Area G, a DR=0.1 is conservatively applied. The POC is credited in the Area G TSRs as a safety-class DF to protect the initial condition that its performance criteria and an ISI meet WIPP criteria.

M. Type B Containers

Type B containers (e.g., TRUPACT II, HalfPACT, Model 10-160B) provide assurance that radiological materials within such containers are not readily releasable during accidents. This control is an initial condition in the hazard analysis for providing protection to waste contents against fire, deflagration, loss-of-confinement/containment, external, and NPH events. Retaining radiological waste within these containers ensures that the consequences of any given event are zero. There are no accidental insults to these containers in their sealed configuration in accordance with the appropriate Safety Analysis Report for packaging, that would release the material to the environment. The Type B containers are protected in the TSRs as a DF to protect the initial condition for a DR=0 if the containers meet 49 CFR 173.416 [CFR 2010] testing requirements, as per their respective Safety Analysis Report and Certificate of Compliance.

N. Certified Sealed Sources

Certified Sealed Sources provide assurance that the radiological materials in these containers are not readily releasable. Containment of radiological material within a Certified Sealed Source ensures that the consequences of any given event are negligible. Typically a DR=0 could be assigned to these containers, if there are no accidental insults to these containers that would release the material to the environment. Certified sealed sources or special form capsules that conform to 49 CFR 173.469 [CFR 2010] or American National Standards Institute (ANSI) N43.6 [ANSI 2007] provide for defense-in-depth by ensuring that the radiological material is not releasable.
It must be noted that some sealed sources at Area G cannot be verified as being certified to 49 CFR173.469 and ANSI N43.6 requirements and able to withstand all credible accident conditions. Sealed sources are stored and managed via an Area G source control policy that complies with the source control policy specified in Article 431 of the DOE RadCon Manual [DOE 1994] through the Radiation Protection Program. Because the sealed sources at Area G have not been certified to resist release of radiological material under accident conditions, all sealed sources will be tracked and counted against the site MAR limits for TRU waste. Only sealed sources stored within a Pipe Overpack Container will be subject to the reduced Damage Ratio allowed by DOE-STD-5506.

O. Controls for Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities

There is a population of sealed containers with bolted lids/flanges inside other containers scheduled for SSSR processing. The following suite of controls is established to reduce the likelihood and consequences of a deflagration during SSSR operations involving the opening of sealed containers with bolted lids/flanges and are protected as SACs.

- Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts.
- Workers and the sealed container shall be grounded or bonded prior to loosening the lid/flange bolts.
- Loosening the lid/flange bolts shall be performed using non-sparking processes or tools.
- The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange and allow venting without completely removing the bolts.
- The container shall be positioned such that the opening(s) is at the high point of the container.
- Spark-generating operations shall not be resumed until the container has vented and the hydrogen levels at the openings are measured and demonstrated to be below the LFL (4% for hydrogen).

3.3.2.3.2.2 Fire

The strategy to reduce the risk of fires at TA-54, Area G consists of reducing the frequency of fires and minimizing the consequences in the event of occurrence. Because of the proximity of TA-54, Area G to the site boundary, fires involving relatively low quantities of MAR result in High consequences to the public. Controls specific to fire event risk reduction, and major contributors to defense-in-depth, are described in Table 3-7. The controls shown in Table 3-7 also provide defense-in-depth in the control strategy for deflagration, loss-of-confinement, external hazards, and NPH hazard events. Other controls that provide defense-in-depth for this accident type are shown in Table 3-14b.
<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combustible/ Flammable Liquids Control</strong></td>
<td>Defined areas containing only metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in areas containing nonmetal containers shall be attended, and limited to a total of 100 gal.</td>
<td>Reduce probability of fire by identifying fire initiators and incipient fires and eliciting an appropriate response. Reduce radiological consequences by limiting amount of MAR involved</td>
<td>SAC</td>
</tr>
<tr>
<td><strong>Fire Protection– Thermal Separation Distances</strong></td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>Reduces likelihood of fire progression between defined areas. Reduces radiological consequences by limiting amount of MAR involved</td>
<td>SAC</td>
</tr>
<tr>
<td><strong>Fire Protection – Control of Transient Combustibles – Fuel Package Limit</strong></td>
<td>Transient combustible controls within defined areas and associated thermal separation distances. Transient fuel packages (\geq 100) lb are attended. Unattended transient fuel packages are separated from metal containers by a minimum of 3 ft and from nonmetal containers and other fuel packages by a minimum of 9 ft in order to reduce fire progression</td>
<td>Reduces the likelihood of a fuel package being involved in a fire. Reduces consequences of a fire by limiting fire progression within a defined area and the amount of MAR involved.</td>
<td>SAC</td>
</tr>
<tr>
<td><strong>Stationary Fire Watch During Hot Work</strong></td>
<td>Hot work is prohibited without a stationary fire watch within TRU waste storage areas.</td>
<td>Reduces likelihood for ignition of flammables/combustibles</td>
<td>SAC</td>
</tr>
<tr>
<td><strong>Stationary Fire Watch During SSSR Activities</strong></td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
<td>Reduces consequences of a fire by limiting the amount of MAR involved.</td>
<td>SAC</td>
</tr>
<tr>
<td><strong>Fire Protection Program – Good Housekeeping and Inspections</strong></td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections) to include inspection by LANL fire protection engineer (FPE)</td>
<td>Reduces likelihood of fire progression and limits fuel loading in portions of the Area G site beyond the defined areas to which the Fire Protection SACs apply.</td>
<td>SMP-AC</td>
</tr>
<tr>
<td><strong>Fire Protection Program – Ignition Source control</strong></td>
<td>Ignition source control within defined areas</td>
<td>Reduces likelihood for ignition of flammables/combustibles</td>
<td>SMP-AC</td>
</tr>
</tbody>
</table>
Table 3-7. Supporting Controls Unique to Fire Event Risk Reduction

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole-Mounted Transformer Distance From TRU Waste Storage Areas</td>
<td>Liquid pole-mounted transformers containing flammable/combustible liquids are a safe distance away from the TRU waste storage areas as determined by the height of the transformer.</td>
<td>Preserves the initial condition in the accident analysis that the post-seismic fire will not involve non-metal storage areas, and reduces the likelihood of post-seismic fire in TRU waste storage areas caused by the pole-mounted transformer falling onto waste containers during a seismic event.</td>
<td>SAC</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management–Overburden/Soil Barrier Control</td>
<td>Establishes &gt; 3 in. of ground cover or equivalent between below-ground and above-ground MAR inventory.</td>
<td>Reduces radiological consequences by limiting amount of MAR involved.</td>
<td>SAC</td>
</tr>
<tr>
<td>Escort of Transportation Vehicle–Between TA-54, Area G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is traveling between Area G and the RANT entrance gate with MAR onboard.</td>
<td>Reduces the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
<td>SAC</td>
</tr>
<tr>
<td>Escort of &gt;100 gal Flammable Liquid Inventory Vehicles within TA-54, Area G</td>
<td>Vehicles/equipment with greater than the total of 100 gal of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel, except for emergency response vehicles.</td>
<td>Reduces likelihood of fuel interaction with MAR.</td>
<td>SAC</td>
</tr>
<tr>
<td>Vehicle/Equipment Safety Control – Refueling Location</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
<td>Reduces frequency of a refueling accident involving a fuel pool fire impacting TRU waste.</td>
<td>SAC</td>
</tr>
<tr>
<td>Vehicle Refueling Prohibition</td>
<td>Vehicles/equipment transporting MAR are not to be refueled.</td>
<td>Reduce likelihood for a fire from a refueling accident involving MAR on a transportation vehicle.</td>
<td>SAC</td>
</tr>
</tbody>
</table>

The following sections provide details of the specific controls to mitigate risk in fire events.

A. Stationary Fire Watch during Hot Work

A stationary fire watch is required when hot work (e.g., welding, grinding or cutting of metal, or other operations that produce flames or sparks) is performed in TRU waste storage area. This control is credited for fire events to reduce ignition sources and thereby reduce the frequency of fires. The control provides a safety significant function and is protected in the TSRs as a SAC.

B. Fire Protection Program –Ignition Source Control

The ignition source control in areas containing MAR helps to provide assurance that the potential for fire is limited. Certain maintenance activities require the use of equipment that produces flames or sparks, or otherwise generates heat, and the use of radiant heaters is sometimes required in winter months.
Additional review and control of these maintenance and ambient heating activities limits the frequency that an ignition source is available to start a fire within the defined areas. The control of ignition sources was identified in the HA as providing some defense-in-depth and is protected in the TSRs as a SMP-AC.

C. Combustible/Flammable Liquid Control

The combustible/flammable liquid control specifies the amount of fuel and/or vehicles/equipment permitted within defined areas to ensure that, in the event of an accidental spill with fire, the amount of radiological material involved in the fire is limited. This control is credited for fire events. Restricting the quantity of combustible/flammable liquids in a defined area limits the quantity of radiological waste involved in the event, and therefore ensures that the consequences of a given event within that area are limited. In the hazard analysis, this control was determined to be a major contributor to defense-in-depth, and is therefore protected in the TSRs as a SAC. The elements of this control are:

Defined areas containing only metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles.

All flammable/combustible liquids in defined areas which contain non-metal containers shall be attended, and limited to a total of 100 gal.

Implementation of this combustible/flammable liquid control reduces radiological consequences by limiting the amount of MAR involved in a fuel pool fire. Vehicles/equipment that utilize combustible/flammable liquids for fuel, hydraulics, or lubrication are required to be in proximity to TRU waste to conduct required operations. Since combustible/flammable liquids are required, event scenarios involving the spill and ignition of these liquids can be mitigated only by limiting the amount of radiological material that would be involved in the spill and pool fire event scenario. This is accomplished by limiting the amount of available combustible/flammable liquid; this, in turn, limits the amount of MAR involved in the fuel pool fire and, thereby limits the consequences to all receptors. Requiring attendance of combustible/flammable liquids in excess of 7 gal within a defined area performs two functions. First, the attendee can watch for and respond to upsets involving the combustible/flammable liquids. For example, if a leak is observed, the attendee can direct the removal of the vehicles/equipment and/or clean-up of the spill to prevent its ignition. Second, attendance requires the physical presence of an individual and implies an operational constraint on the activity. The attendant reduces the frequency and consequences of fire by identifying fire initiators and incipient fires and eliciting an appropriate response.

The 7-gal *de minimus* limit for flammable and combustible liquids is based upon National Fire Protection Association (NFPA) 5000 [NFPA 2009] requirements for Maximum Allowable Quantities (MAQ) of hazardous materials. The MAQ permitted by NFPA 5000 for a Class IA flammable liquid in an open container for a storage occupancy is 10 gal. A 7-gal limit is conservative.

Given the radius of the 7-gal spill based on conservative presumptions, a number of drums can be calculated as impacted by the 7-gal fuel pool spill. The *SFPE Handbook* [NFPA 2008] guidance on small spills < 25 gal is based on 0.7 mm pool depth and results in 57 ft²/gal area. A 7-gal spill would cover 399 ft² and involve 51 dense-packed 55-gal drums per tier in half that area. This number of drums in a fuel pool fire, using the methodology of DOE-STD-5506 [DOE 2007] and ignoring the (over-) conservatisms in the fire model, would result in Moderate to High consequences. A discussion of the conservatisms in the methodology is warranted, see below. This discussion centers on the expectation that small spills of flammable or combustible liquids (7 gal or less) will not produce the steady-state burning conditions required to initiate confined burning of enough MAR to exceed offsite dose consequences.
Depending on the surface area, and how flat or rough it is (e.g., concrete or asphalt), a small spill could rapidly burn out in less than 10 sec and not ignite any container contents. For smooth surfaces (e.g. concrete), given a fuel burn or pool regression rate of .074 mm/sec and an initial pool depth of 0.7 mm, the fire would burn for 9.7 sec.

The *SFPE Handbook* [NFPA 2008] cites two references (Chambers and Gottuck) that observed increases in burning fuel spill areas after the liquid spill was ignited. Given a flame spread rate of between 100 and 200 cm/sec for flammable liquids, it could be expected to take from 5 to 10 sec to establish steady-state pool burning conditions – that is, the amount of time to achieve steady-state pool burning conditions, which cause release of radioactive material, is comparable to the time that the fire burns out. This indicates that the 7-gal fuel pool spill will burn out before steady-state burning conditions are achieved; therefore, the release of radioactive material will not occur.

Increased surface roughness, e.g. spills on asphalt, is not expected to result in confinement of the spill. Spill confinement is a necessary condition for fuel depths capable of resulting in burn times that approach 70 sec. Further it is assumed that increasing surface roughness will reduce the heat release rate because, as the pool depth recedes, there would be less fuel surface area available for burning.

Although the burn times would not meet the 70-sec criterion for lid loss, under worst-case conditions it would not preclude ignition of combustibles inside the drums and confined burning at 5E-4 Airborne Release Fraction (ARF) × Respirable Fraction (RF), or approximately 6 rem. However, this value is still (overly-) conservative for the following reason:

Note that packaging of waste that is considered combustible includes packaging in several layers of heavy plastic bags and other material that is not highly ignitable. A combustible waste container will not typically be full of highly ignitable combustible waste, based on waste streams from the plutonium facility, the main generator of these waste containers. It is expected that the contents of up to 10% of the 51 exposed drums exposed to a 10-sec pool fire could be ignited and result in confined burning, corresponding to Low dose consequences (approximately < 1 rem to the public, or < 25 rem to the collocated worker). This control is protected in the TSRs as a SAC.

**D. Fire Protection – Control of Transient Combustibles – Fuel Package Limit**

The fire analysis in reference LANL 2011a indicates that 10 kW/m² of thermal radiant energy is present at 2.6 m (8.5 ft) from a burning 100-lb fuel package. Waste in a non-metal container that is more than 9 ft from the burning fuel package will not ignite because the thermal radiant energy is not sufficiently high enough for ignition. Similarly, the radiant energy thermal output of the same size fire at 3 ft is below 45 kW/m², which is sufficient to prevent failure of a metal container. The Fire Protection – Control of Transient Combustibles, Fuel Package Limit controls the amount of transient combustible within applicable defined areas. Transient fuel packages > 100 lb must be attended. Unattended transient fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal TRU waste containers by a minimum of 3 ft to prevent fire propagation within applicable defined areas. Transient fuel packages include, for example, cardboard trash boxes, plastic bags, cardboard/ wooden shipping cartons, etc., that weigh more than 20 lbs and are not permanent fixtures of the facility. The *de minimus* value of 20 lbs as the fuel package weight subject to the transient combustible control is supported by the 25 lb minimum fuel package analyzed in reference LANL 2011a. Combustible materials that constitute part of a TRU waste package or introduced to remediate waste packages in-situ are considered to be part of the TRU waste package once affixed to the waste package and not subject to this control. The control also excludes flammable/combustible liquids, materials used to package and ship radioactive waste from Area G, and contamination control materials required for radiation protection. This control reduces the likelihood of a fuel package being involved in a fire and
prevents the propagation of fires within applicable defined areas, and is credited for fire, external, and NPH hazard events. The hazard analysis credited this control as a major contributor to defense-in-depth for fires, and, therefore, this control requires protection within the TSRs.

E. Fire Protection Program – Good Housekeeping and Inspections

Transient combustible controls (e.g., housekeeping, vegetation control, and periodic inspections) in conjunction with thermal separation distance, provide assurance that fires initiated outside a defined area do not propagate into large fires that could involve radiological material within defined areas. Regular inspections by a LANL FPE ensure the implementation of this control. The hazard analysis credited this control for providing defense-in-depth, and this control is credited in the TSRs as a SMP-AC.

F. Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, Area G.

This control provides assurance that vehicles with greater than the total of 100 gal of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, or fuel cans), except for emergency response vehicles, travel along designated routes and are escorted. This control is credited for fire events. Restricting the travel of large-liquid-fuel capacity vehicles reduces the probability of vehicle accidents that result in fuel pools of >100 gal within a defined area. Data available from the U.S. Department of Transportation, Traffic Safety Facts [USDOT 2010], indicates a probability of 1.6E-4/yr, averaged over 5 yr, that a large truck in an accident will result in a fire when compared to all vehicle accidents with fire occurrence on public roads. Because Area G is a controlled area, and vehicles are escorted to ensure low speeds, the probability of a vehicle accident with fuel leak and subsequent fuel pool fire becomes Beyond Extremely Unlikely. The requirement to escort vehicles with a fuel capacity greater than 100 gal helps to ensure that the even the heaviest vehicles (e.g., the water truck) would follow designated routes and not exceed a speed that would challenge the capacity of the vehicle barriers at high risk locations. This control addresses the situation when a large-fuel-volume vehicle, such as a refueling vehicle, must enter Area G on the rare occasions that vehicle equipment, such as a crane, cannot be easily moved to a refueling station. The refueling vehicle will travel along designated routes, and may pass TRU waste defined areas. For most refueling cases, the refueling vehicle will be at a designated refueling station that is a far enough distance away from TRU-waste defined areas. The distance will be determined by the volume of a possible refueling spill and the thermal separation distance between the leading edge of the spill and the TRU-waste defined area.

This control was identified in the HA as providing a major contribution to defense-in-depth and is protected in the TSRs as an SAC.

G. Escort of transportation vehicle between TA-54, Area G and TA-54 RANT

This BIO also covers transportation vehicle transports of MAR along Mesita del Buey Road between TA-54, Area G and TA-54 RANT. This control is no longer in effect when the transport vehicle crosses the RANT facility boundary at the RANT entrance gate. This control is credited for fire and loss-of-confinement events. Speed limits along Mesita del Buey Road range from 25 to 35 mph, and the vehicle escort ensures that the transport vehicle travels at low speeds to reduce the probability of a vehicle impact that could involve a fuel leak and fuel pool spill. With the escort, the probability is Beyond Extremely Unlikely that a vehicle impact with fuel pool fire will occur. The escort minimizes the potential for another vehicle impacting the Transportation Vehicle, and also minimizes the speed with which the Transportation Vehicle travels to minimize the potential for the TRU Transportation Vehicle to cause an accident.
The hazard analysis credited this control as providing a major contribution to defense-in-depth; therefore, this control is protected in the TSRs as a SAC.

**H. Vehicle/Equipment Safety Control – Refueling Location**

When a refueling location is stationed within TA-54, Area G, TRU-waste defined areas require a thermal separation distance from the refueling location. That is, based on the fuel capacity of the refueling vehicle, a minimum separation distance, per Section 4.5.13, must be maintained between the potential flame front and any TRU-waste defined area. This separation distance ensures that the fuel pool will not engulf the TRU-waste defined area and ensures that the heat of the pool fire would not result in the ignition of TRU waste that is in proximity to the fuel pool. The separation distance does not apply to the hose connecting refueling vehicle and vehicle/equipment to be refueled because the fueling operation is attended. Leaks from the refueling hose would be immediately addressed.

Refueling vehicles typically enter TA-54, Area G on a weekly basis to provide fuel for both gasoline and diesel-powered equipment operated within the area. The refueling vehicle is typically parked at a location near the primary access point, and vehicles needing to be fueled are brought to this refueling location. If a TRU-waste container defined area is near the refueling location, there is the potential that a fuel pool fire involving the refueling vehicle could affect any TRU-waste defined areas near the refueling location.

Refueling vehicles may contain as much as 5,000 gal of fuel. As such, this control requires that the refueling location will be separated from MAR in defined areas by the thermal separation distance. This control is credited for fire events. The HA credited this control as providing a major contribution to defense-in-depth. Therefore, this control is protected in the TSRs as a SAC.

**I. Vehicle Refueling Prohibition**

Vehicles/equipment transporting TRU waste are not to be refueled. This ensures that MAR in TRU waste containers on transport vehicles undergoing refueling is not involved in a fuel pool fire as a result of a refueling accident. This control was identified in the HA as also providing a major contribution to defense-in-depth. Therefore, this control is protected in the TSRs as an SAC.

**J. Fire Protection - Thermal Separation Distance**

The thermal separation distance control provides assurance that a combustible or fuel pool fire will not affect nearby stored TRU waste containers. This control is credited for fire, deflagration, loss-of-confinement, external hazards, and NPH events. Establishing a thermal separation distance barrier between a potential source of fuel for a fire and a defined area ensures that a fire in a defined area does not spread to another area as a result of radiant heat effects. The thermal separation distance may be modified when used in conjunction with a liquid impediment that would prevent fuel spills up to 100 gal from intruding into the separation distance. If credited for reduction of the minimum thermal separation distance, the configuration of the liquid impediment (e.g., berm, curb, ditch, or slope) must be sufficient to contain or divert a fuel leak of up to 100 gal, leaking at an average rate of up to 25 gallons per minute (gpm), away from the defined area. The 25-gpm leak rate is rounded up from the 24.24 gpm average leak rate determined for a forklift tine puncturing a 100-gal fuel tank in reference LANL 2011b. This control is described in the HA as a thermal separation distance that limits heat flux to radiological waste containers.

The heat flux generated by a fire causes the temperature to rise in nearby objects. A sufficient heat flux over a period of time will result in the flammable/combustible materials reaching a temperature at which they will burn. The establishment of a thermal separation distance or equivalent barrier reduces the
frequency and the consequences so that sufficient heat flux will not be transmitted to the radiological material.

The HA credits this control as providing a major contribution to defense-in-depth, and therefore the control is credited in the TSRs as a SAC. This control is developed further in Chapter 4.

K. Hazardous Material and Waste Management – Overburden/ Soil Barrier Control

The Overburden/ Soil Barrier Control provides assurance that buried waste inventory in active pits and shafts with >3 in. of ground cover, soil, or equivalent thermal barrier is separated from the above-ground radiological waste inventory. This initial condition control is credited as providing defense-in-depth for fires, external hazards, and NPH events. Limiting the amount of exposed radiological waste ensures that the consequences of a given event within that area are limited. This control was determined to provide defense-in-depth protection to all receptors.

Soil and concrete have approximately the same coefficient of heat transmission [ENG 2011]. The minimum thickness of concrete required to provide a 1-hr fire barrier is approximately 2.5 in. [IBC 2006]. Soil is expected to perform as well as concrete (for purposes of heat insulation because the conductivity is similar [ENG 2011]). Greater than 3 in. of soil is conservatively expected to offer a 1-hr fire resistance, similar to the recognized fire rating of concrete, and is deemed adequate as an overburden. Therefore, greater than 3 in. of soil would prevent the below ground material from being exposed to thermal insults, especially since structural stability is not required after a fire. This control is protected in the TSRs as a SAC.

L. Pole-Mounted Transformer Distance from TRU Waste Storage Areas

This control ensures that pole-mounted transformers containing flammable/combustible liquids are located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste in storage areas. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool possible from the spilled transformer flammable/ combustible oil, and the associated thermal separation distance necessary to prevent the TRU non-metal containers from becoming affected by the transformer fuel pool fire. Alternatively, the pole-mounted transformer can fall behind a berm, curb, or ditch, or equivalent liquid impediment, that is sized to contain the liquid content of the transformer and is a safe thermal separation distance away from a TRU waste storage area. A post-seismic fire involving spilled transformer fuel is assumed to result in substantial dose consequences; therefore, this initial condition is protected in the TSRs as a SAC.

M. Stationary Fire Watch During SSSR Activities

A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed. This control is credited to reduce the consequences of a fire event. The control provides a safety significant function and is protected in the TSRs as a SAC.

3.3.2.3.2.3 Deflagrations

The strategy to reduce the risk of deflagrations at TA-54, Area G consists of reducing the frequency of deflagrations, deflagrations with subsequent fires, and incidental impacts, and minimizing the consequences of the event. Due to the proximity of TA-54, Area G to the site boundary, deflagrations involving MAR could result in high consequences to the public. Controls specific to deflagration event scenario risk reduction are described in Table 3-8, and are major contributors to defense-in-depth. Other controls that provide defense-in-depth for this accident type are shown in Table 3-14b.
<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene Cylinder Control</td>
<td>The storage or use of acetylene cylinders inside or within 50-feet of a defined area is prohibited.</td>
<td>Reduces likelihood of an accident involving an acetylene cylinder explosion impacting TRU waste.</td>
<td>SAC</td>
</tr>
<tr>
<td>TRU Waste Container Management – Isolate Unvented Containers</td>
<td>Unvented containers are isolated to prevent inadvertent interaction between personnel/ equipment handling and/or performing activities in the vicinity of the unvented container</td>
<td>Reduces likelihood for deflagration</td>
<td>SAC</td>
</tr>
<tr>
<td>Prohibition on opening sealed inner TRU waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages* found within a parent TRU waste container during SSSR activities shall not be opened. The sealed inner TRU waste packages shall be placed in a vented TRU waste drum. (* Except for inner containers with bolted lids/flanges which are opened with additional controls.)</td>
<td>During SSSR activities, a prohibition on opening sealed inner TRU waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
<td>SAC</td>
</tr>
<tr>
<td>TRU Waste Container Management – Unvented Containers are not Stacked</td>
<td>Unvented TRU waste containers are not stacked</td>
<td>Reduce likelihood of inadvertent container toppling</td>
<td>SAC</td>
</tr>
<tr>
<td>TRU Waste Container Management – Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and either blast shields, or safe standoff distance of ≥30 ft between the unvented TRU waste container and the worker</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td>SAC</td>
</tr>
<tr>
<td>Non-Sparking Equipment/Process during venting</td>
<td>The equipment or process used to penetrate the lid of an unvented TRU waste drum must be of the type that does not produce mechanically-induced sparks. A vented 55-gallon, 85-gallon, or 110-gallon TRU waste drum that contains an unvented inner drum is considered an unvented drum for the purposes of this SAC.</td>
<td>Reduces the likelihood of a deflagration by reducing the likelihood of a mechanically-induced (frictional) spark that could ignite a flammable gas mixture that may exist within the unvented TRU waste drum.</td>
<td>SAC</td>
</tr>
</tbody>
</table>
### Table 3-8. Supporting Controls Unique to Deflagration Event Risk Reduction

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast-Mitigation Device During Venting</td>
<td>An unvented TRU waste drum with MAR ≤ 480 PE-Ci equivalent combustible waste shall use a blast-mitigation device (e.g., doublepack, DVS enclosure or lid restraint). An unvented TRU waste drum with MAR &gt; 480 PE-Ci equivalent combustible waste shall use a doublepack as a blast-mitigation device. A vented 55-gallon, 85-gallon, or 110 gallon TRU waste drum that contains an unvented inner drum is considered an unvented drum for the purposes of this SAC.</td>
<td>Reduces the potential radiological consequences to all potential receptors in the event of a deflagration during the venting of an unvented TRU waste drum.</td>
<td>SAC</td>
</tr>
<tr>
<td>Standoff During Venting</td>
<td>A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting. Spread of contamination is controlled according to radiation protection requirements.</td>
<td>Reduce potential consequences to facility workers from a drum deflagration.</td>
<td>SAC</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Cease spark-generating operations</td>
<td>Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts on the sealed container.</td>
<td>Reduce the likelihood of a deflagration</td>
<td>SAC</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Grounding/ Bonding</td>
<td>Workers and the sealed container shall be grounded or bonded prior to loosening the lid/flange bolts.</td>
<td>Reduce the likelihood of a deflagration</td>
<td>SAC</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Non-Sparking processes or tools</td>
<td>Loosening the lid/flange bolts shall be performed using non-sparking processes or tools.</td>
<td>Reduce the likelihood of a deflagration</td>
<td>SAC</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Lid/flange bolt loosening</td>
<td>The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange and allow venting without completely removing the bolts.</td>
<td>Reduce the consequences of a deflagration</td>
<td>SAC</td>
</tr>
</tbody>
</table>
Table 3-8. Supporting Controls Unique to Deflagration Event Risk Reduction

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Container positioning</td>
<td>While the sealed container is venting, the container shall be positioned such that the opening(s) is at the high point of the container.</td>
<td>Reduce the likelihood of a deflagration</td>
<td>SAC</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR Activities - Resumption of spark-generating operations</td>
<td>Spark-generating operations shall not be resumed until the container has been vented and the hydrogen levels at the opening are measured and demonstrated to be below the LFL (4% for hydrogen).</td>
<td>Reduce the likelihood of deflagration</td>
<td>SAC</td>
</tr>
</tbody>
</table>

The following sections provide information on the specific controls to mitigate risk in deflagration events.

A. **TRU Waste Container Management – Unvented Containers are Not Stacked**

This control ensures that deflagration due to toppling of unvented drums or sympathetic deflagrations involving stacked, unvented containers are prevented. This control is credited for deflagration events. Prohibiting the stacking of unvented containers ensures that the consequences of a deflagration event are limited or that the event is prevented. The HA credited this control as providing a major contribution to defense-in-depth. Therefore, this control is protected in the TSRs as a SAC.

Unvented containers have the potential for the build-up of hydrogen gas or other VOCs that could deflagrate in the presence of an ignition source. Some legacy TRU waste containers may not be adequately vented for various reasons and are considered unvented. If found, unvented TRU waste drums are stored in a defined isolation area, segregated from normal operations until they can be vented or overpacked into a vented container of sound integrity. An unvented container placed in storage or discovered in storage stacked above another unvented container has the potential for a sympathetic deflagration. That is, a deflagration in the lower unvented container results in an upward-directed impact upon the upper unvented container, which could result in a sympathetic deflagration.

B. **TRU Waste Container Management - Isolate Unvented Containers**

This control provides assurance that the frequency of deflagrations is reduced by isolating unvented radiological waste containers. Within the isolation area, unvented containers can be stored next to each other, but they shall not be stacked. This control on isolating unvented drums is credited for deflagration events. Requiring isolation of unvented TRU waste drums reduces the frequency of inadvertent impact of unvented containers, and thereby reduces the frequency of a deflagration event.

The hazard analysis credited this control as a major contributor to defense-in-depth. Therefore, this control is protected in the TSRs as a SAC. Access restrictions for the isolation area where unvented drums are stored are protected in the TSRs as a TSR AC. The access restrictions are not credited in the HA, but are considered to provide defense-in-depth for the isolation of unvented drums.
B.1 Hazardous Material and Waste Management – Compressed Gas Cylinders

Compressed gas cylinders are stored in designated locations when not in use. Proper storage minimizes the potential for cylinders to become missiles or for an explosion occurring that impacts waste. Compressed gas cylinders in storage, in transport, or in use are secured. Securing cylinders reduces the probability that a cylinder could fall over and rupture the nozzle. Compressed gas cylinders in storage are closed with the valve cap secured. Closure of the valve prevents accumulation of flammable vapor which could lead to a vapor cloud explosion and the valve cap or guard prevents the nozzle from being ruptured or sheared creating a missile. Some compressed cylinders are designed with a guard in lieu of a valve cap to protect the nozzle. The valve guard was qualitatively determined to provide the same protection as a valve cap.

The incorrect handling or storage of pressurized gas cylinders may result in gas cylinders that become missiles. A gas cylinder missile impact upon a payload of drums will result in the release of radiological material. This administrative control reduces the frequency for this accident event. This control contributes to defense-in-depth for loss of confinement events and is protected in the TSRs as a Hazardous Material and Waste Management SMP element.

C. TRU Waste Container Management – Unvented TRU Waste Drum Handling and Transportation

This control provides assurance that when unvented containers are handled and/or transported, use of lid restraints, blast shields, and/or a safe standoff distance is required. This control is credited for deflagration events. Requiring the use of lid restraints, blast shields, and/or a safe standoff distance when TRU waste containers are handled and transported reduces the radiological consequences of a deflagration to all receptors and the physical consequences to workers. This control was determined to provide a major contribution to defense-in-depth for all receptors and is protected in the TSRs as a SAC.

The use of lid restraints requires that an operator approach the unvented drum and apply the lid restraint. However, lid-restraint application does not jar or perturb the unvented drum to cause its deflagration. DOE–STD-5506 [DOE 2007] cites the results of several empirical studies that the movement of an unvented drum will not cause a deflagration. A blast shield may be comprised of blast-proof forklift cab windows. The safe stand-off distance may be accomplished by use of a crane that lifts and moves an unvented drum.

D. Venting

D.1 Non-Sparking Equipment/Process during Venting

The requirement that tools and processes used to penetrate/breach an unvented TRU waste drum must be non-sparking (e.g., low-speed drilling) minimizes the frequency for spark generation. This requirement is credited for reducing the frequency for ignition of flammables/combustibles. This control is credited for deflagration events. This control is considered a major contributor to defense-in-depth for deflagration events and is protected in the TSRs as a SAC.

D.2 Blast-Mitigation Device During Venting

The requirement for use of a lid restraint or other blast-mitigation device (e.g., Doublepack, DVS enclosure or lid restraint) mitigates dose consequences by lowering the ARF*RF from that of unconfined burning to one of confined burning. Radiological consequences are mitigated to all receptors.
The Radiation Protection Program provides for worker safety by ensuring that workers are protected from potential releases of radiological material. The requirement for venting through a doublepack, DVS restraint or lid restraints, or other blast-mitigating device minimizes potential consequences from radiological exposures.

The requirement for a venting through a doublepack, DVS restraint or lid restraint, or other blast-mitigation device is credited as a major contributor to defense-in-depth, and is therefore a TSR SAC.

D.3 Standoff During Venting

The requirement to establish safe standoff distance during drum venting provides for worker safety by ensuring that workers are protected from a blast wave caused by a deflagration accident during the venting of unvented drums. This requirement is credited for reducing the frequency of worker physical injury.

The Radiation Protection Program provides for worker safety by ensuring that workers are protected from potential releases of radiological material. The requirement for establishing a safe standoff distance also helps to limit the amount of radiological material available for uptake by facility workers.

The requirement for establishing a safe standoff distance is credited as a major contributor to defense-in-depth, and is therefore a TSR SAC.

E. Vehicle/Equipment Safety Controls – Forklift Recharging Locations

This control provides assurance that electric-powered vehicles are charged in locations away from stored TRU waste containers, thereby reducing the frequency of deflagrations external to waste containers. This control is applicable to deflagration events. Requiring electric-powered vehicles/equipment to be charged in locations where hydrogen cannot accumulate ensures that the frequency of a deflagration event is reduced. Hazard events involving deflagrations external to waste containers due to an electric-powered forklift showed unmitigated Low consequences. Therefore, this control is considered as providing defense-in-depth.

Battery charging results in the release of small quantities of hydrogen gas. The accumulation of hydrogen gas in a confined area could lead to a deflagration, resulting in a pressure wave or missile-generated impact to TRU waste containers. Charging vehicles/equipment in locations where hydrogen cannot accumulate reduces the frequency at which MAR would be affected by an external container deflagration. Such a deflagration is considered to be Extremely Unlikely due to the open-air configuration of structures and pits containing TRU waste.

E. Prohibition on opening sealed inner TRU waste packages discovered during SSSR activities

During SSSR activities, a prohibition on opening sealed inner TRU waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages. This control is protected in the TSRs as a SAC. Controls for an exception to this prohibition are described in section G, below.

F. Acetylene Cylinder Control

The hazard analysis includes event scenarios involving an acetylene cylinder leak or a flashback that causes a vapor cloud explosion and/or deflagration affecting TRU waste. The unmitigated analysis shows a Risk Rank I for this accident. The HA considers that acetylene cylinders located inside a defined area
containing MAR will be equipped with flashback arrestors to provide a defense-in-depth function, although this control is not credited for risk reduction. To eliminate the possibility of a fire or deflagration involving MAR due to an acetylene cylinder leak or flashback, acetylene cylinders will not be stored or used inside or within 50 feet of defined areas when MAR is present. The control is carried forward into the TSRs as a SAC.

G. Controls for Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities

This suite of controls reduces the likelihood of a deflagration occurring during the opening of sealed containers with bolted lids/flanges that are inside other containers scheduled for SSSR processing. The sealed containers are internally contaminated and may contain accumulated flammable gases. These sealed containers will be opened in a controlled manner within the SSSR Area to allow for the safe dispersion of flammable gases before proceeding with SSSR processing. Only those sealed inner containers that have bolted lids or bolted flanges will be opened. Other types of sealed containers that may be encountered will be removed from the SSSR Area for future disposition. In addition to the established stationary fire watch requirements and MAR limits for SSSR Areas, the controls for this activity include use of non-sparking tools/equipment, bonding or grounding, cessation of any spark-generating activities in the area, lid/flange bolt loosening, and container positioning requirements. This suite of controls is protected in the TSRs as a SAC.

3.3.2.3.2.4 Loss of Confinement

The strategy to reduce the risk of loss of confinement at TA-54, Area G consists of reducing the frequency of loss of confinement and minimizing the consequences in the event of occurrence. Due to the proximity of TA-54, Area G to the site boundary, loss-of-confinement events have the potential to result in High consequences to the public. Controls specific to loss-of-confinement event risk reduction are described below (Table 3-9). Other controls that provide defense-in-depth for this accident type are shown in Table 3-14b.

| Table 3-9. Supporting Controls Unique to Loss-of-Confinement Event Risk Reduction |
|-----------------|-----------------|-----------------|----------------|
| **Control Title** | **Attribute/Description** | **Safety Function** | **Control Type** |
| Elevated Waste Movements and Critical Lifts – Critical Lift Plan | A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 ft above the surface directly below the waste container (excluding mobile loader payload lifts) | Reduce likelihood for load drops resulting in release of radiological material | SAC |
| Elevated Waste Movements and Critical Lifts – Critical Lift Plan for FRPs | A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci | Reduce likelihood for load drops resulting in release of radiological material | SAC |
| Elevated Waste Movements and Critical Lifts – Spotter | Spotter supports forklift/ rigger/crane operations during elevated (≥ 4 to < 12 ft) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers | Reduce likelihood for container puncture, topple, and impacts | SAC |
### Table 3-9. Supporting Controls Unique to Loss-of-Confinement Event Risk Reduction

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Loader Payload Restriction – Lifts</td>
<td>Mobile loader payloads shall not be lifted over TRU waste</td>
<td>Reduces radiological consequences of limiting amount of MAR involved</td>
<td>SAC</td>
</tr>
<tr>
<td>Mobile Loader Payload Restrictions – MAR Limit</td>
<td>Mobile loader payloads with MAR &gt; 925 PE-Ci not lifted more than 12ft, measured from the bottom of the payload to the ground</td>
<td>Reduces radiological consequences of limiting the source term in payload drop</td>
<td>SAC</td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt; 800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>SAC</td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>SAC</td>
</tr>
<tr>
<td>Vehicle Barriers – High-Risk Locations</td>
<td>Vehicle barrier systems installed at high-risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in.</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers. Mitigates the consequences if a loaded transportation vehicle is prevented from impacting stored TRU waste.</td>
<td>SAC</td>
</tr>
</tbody>
</table>

A. Vehicle Barriers

A.1 High-Risk Locations

Vehicle barriers at high-risk locations provide assurance that vehicles traveling with a momentum less than or equal to 3.3E6 ft-lb/s are stopped before they impact TRU waste containers. A momentum of 3.3E6 ft-lb/s is equivalent to a vehicle weighing 150,000 lb (e.g., the water truck) traveling at 15 mph (with the speed limited by the required escort for a vehicle with > 100 gal of flammable liquid fuel). Vehicle barriers at high-risk locations are designed for vehicles having an ground clearance of less than or equal to 40 in. This control is credited for fire, deflagration, and loss-of-confinement/containment events. Restricting the quantity of radiological waste affected by a vehicle accident ensures that the radiological consequences of a given vehicle accident are negligible if the vehicle is not carrying radiological material, or are limited to only the MAR being transported. The hazard analysis identified this control as providing a major contribution to defense-in-depth and it is therefore protected in the TSRs as a design feature.

Vehicle barriers are required to be strategically positioned away from waste storage areas to provide an effective separation distance between radiological material and postulated vehicle accidents.

A.2 Vehicle/Equipment Safety Control – Vehicle Barriers at Non-High-Risk Locations
An additional control requires installation of other vehicle barriers between roadways adjacent to defined areas and the defined areas (non-high-risk locations). This control provides assurance that, in case of accidents involving vehicles traveling on those road sections in the vicinity of defined areas, the vehicles are deflected away from the waste in the defined areas. This control was qualitatively determined to provide some defense-in-depth, because the control simply deflects vehicles. Other controls, such as the design-feature vehicle barriers at high-risk locations and the vehicle escort requirements, provide a significant reduction in risk in vehicle accidents. As a defense-in-depth control, vehicle barriers at non-high-risk locations are protected in the TSRs as an SMP-AC.

**B. Vehicle/Equipment Safety Controls**

**B.1 Speed Limits**

Posting that vehicle speeds within TA-54, Area G are limited to less than or equal to 15 mph provides assurance that drivers operate their vehicles at low speeds, thereby reducing the frequency of collisions and limiting the impact energy in the event of a collision. Posting vehicle speed limits can reduce the frequency of vehicular accidents that could result in impacts to radiological waste containers.

Vehicle/ equipment users in TA-54, Area G that operate vehicles/ equipment are expected to follow and obey the traffic postings for speed, which reduces the frequency of moderate and high-energy impacts that could affect radiological waste containers in storage or transport.

Because of the size of Area G and the number of roads, the hazard analysis recognized this control as providing defense-in-depth, although this control was not credited for providing any risk reduction. Other credited controls (e.g., vehicle escort requirements and vehicle barriers) ensure that TRU-waste defined areas are protected from vehicle accidents that result in significant consequences. As a defense-in-depth control providing no credited risk reduction, the posted speed limit control is protected in the TSRs as an SMP-AC.

**B.2 Escort of High MAR TRU Waste Transport within TA-54, Area G – Compliant and Non-Compliant Containers**

For vehicles transporting MAR > 800 PE-Ci in compliant metal containers, or > 450 PE-Ci in non-compliant metal or non-metal containers, this control is required to be implemented as a rolling roadblock/ escort, in front and back, to ensure that the speed limits for these higher-risk activities are enforced and to prevent vehicle collisions/ accidents. In addition to loss of confinement, this control is also credited for fire and deflagration events. The hazard analysis identified this control as providing a major contribution to defense-in-depth, and it is therefore protected in the TSRs as a SAC.

**C. Elevated Waste Movements and Critical Lifts**

**C.1 Spotter**

The requirement for a spotter provides assurance that a spotter supports forklift and crane operations during elevated (> 4 ft but < 12 ft) placement or removal (e.g., stacking/ unstacking or loading/ unloading) of TRU waste containers. This control is credited for loss-of-confinement/containment events. Spotters support these operations by assisting in directing movements of elevated loads. Operators of forklifts and cranes may not be able to directly view their load or the complete load travel path, or maintain depth perspective. Spotters provide an additional source of observation to ensure the safe movement of loads. Use of spotters reduces the frequency for container puncture, toppling, or adverse
impacts leading to spills or deflagrations. This control was credited in the hazard analysis as providing a major contribution to defense-in-depth and is protected in the TSRs as a SAC.

C.2 Critical Lift Plan

The requirement for a critical lift plan control provides assurance that, when TRU waste containers are lifted so that the bottom of the container is > 12 ft higher than the surface directly below the container (i.e., ground or waste container), the lift is considered a critical lift. The minimum lift height requiring a critical lift is set at 12 ft because DOE-STD-5506 [DOE 2007] evaluates drop drops from the fourth tier of stacked drums (nominally 12 ft) to be low impact and to result in a damage ratio of 0.1 or less [LANL 2010b]. This control is credited for loss-of-confinement/containment events. Performing lifts of TRU waste material of > 12 ft using a critical lift plan reduces the frequency of a loss-of-confinement event. This control was identified in the hazard analysis as providing a major contribution to defense-in-depth, and is therefore protected in the TSRs as a SAC. (This control does not apply to mobile loader payload lifts with MAR > 925 PE-Ci – see D.2 below.)

C.3 FRPs with MAR > 150 PE-Ci

The hazard analysis has credited a critical lift plan for lifts of FRPs with MAR > 150 PE-Ci. Below this MAR value, any drops of FRPs during a lift result in Low consequences. Because lifts with higher MAR values will have to occur as part of the Area G closure, to reduce the frequency and thus the risk of the lift, the critical plan is required. This control is credited for loss-of-confinement/containment events. The hazard analysis credited this control for providing a major contribution to defense-in-depth; therefore, this control is protected in the TSRs as a SAC.

D. Mobile Loader Payload Restrictions

D.1 Lifts

Lifting of assembled payloads using mobile loader equipment is required during packaging and shipping activities. Controls are imposed to ensure that these lifts are performed safely. Precluding the lifting of an assembled payload over any other TRU waste MAR reduces the consequences of a drop, since it eliminates MAR above that which is involved in the assembled payload lift. This control is credited in the hazard analysis for loss-of-confinement/containment events. The hazard analysis credits this control as providing a major contribution to defense-in-depth; therefore, this control is protected in the TSRs as a SAC.

D.2 MAR Limit

Drops of assembled payloads using mobile loader equipment may be considered high-energy impacts and require application of a high damage ratio and high ARF × RF values, resulting in High consequences. As a result, assembled payloads with MAR > 925 PE-Ci (and up to the 1,100 PE-Ci MAR limit) shall not be lifted more than 12 ft, as measured from the bottom of the payload to the ground. This control is credited in the hazard analysis for loss-of-confinement/containment events. The hazard analysis credits this control as providing a major contribution to defense-in-depth; therefore, this control is protected in the TSRs as a SAC.

E. Fire Protection Program – Non-Combustible Pallets

Although the pallets used to store TRU waste containers are non-combustible, this program element is not credited for limiting the frequency or consequences of fire events, nor for providing stability and
preventing toppling of stacked drums within a storage array. This good practice is identified as an element of the Fire Protection Program in the TSR.

F. **Hazardous Material and Waste Management – Drum Banding**

DOE-STD-5506 [DOE 2007] indicates that a factor-of-2 reduction in dose consequences can be assigned for drums that are banded within a storage array. Because drums that fall from a second tier can be assigned a DR=0, the control for banding could reduce the material release due to falls from a third tier or higher. The hazard analysis considers this control as providing defense-in-depth for loss-of-confinement/containment and NPH events; therefore, this control is protected in the TSRs as a SMP-AC.

G. **Hazardous Material and Waste Management – Secure Transport**

It is noted that facility procedures require the waste containers to be secured during transport, if necessary, and this is therefore identified in the hazard analysis as providing defense-in-depth. This is performed to further reduce the potential for adverse events through means such as banding, tie-downs or stake bed rails, although this function is not credited in the hazard analysis.

3.3.2.3.2.5 **Exposure**

The strategy to reduce the risk of exposure events at TA-54, Area G consists of reducing the frequency and consequence of exposure (external ionizing radiation, or internal through inhalation). Controls to prevent or mitigate exposure are identified in Table 3-10 and discussed below.

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and process for worker protection.</td>
<td>Reduces radiological consequences due to exposure.</td>
<td>SMP</td>
</tr>
</tbody>
</table>

A. **Radiation Protection Program**

Workers are protected from harmful effects due to direct exposure to ionizing radiation through the LANL Radiation Protection Program (RPP). The RPP is implemented through LANL P121, *Radiation Protection*, or successor document [LANL 2009a], in compliance with the requirements of 10 CFR 835 [CFR 2011b]. There are no feasible engineering controls that could be pre-selected for the potentially varying conditions that may result in high worker exposures. As a result, the facility relies on the RPP to determine the need for additional controls (e.g., lead blankets, shielding, monitoring, remote handling, etc.) on a case-by-case basis. Worker safety, regulatory compliance, and oversight for the implementation of 10 CFR 835 are the specific responsibility of LANL’s Radiation Protection Division. LANL P121 provides specific requirements for implementing integrated work management where radiological hazards are involved.

3.3.2.3.2.6 **Criticality**

The strategy to reduce the risk of criticality at TA-54, Area G consists of reducing the frequency of occurrence. Controls unique to criticality event risk reduction are described in Table 3-11, and discussed below. Other controls that may provide defense-in-depth for this accident type are shown in Table 3-14b.
Table 3-11. Supporting Controls Unique to Criticality Event Risk Reduction

<table>
<thead>
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<tbody>
<tr>
<td>Nuclear Criticality Program</td>
<td>Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)</td>
<td>Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible</td>
<td>SMP</td>
</tr>
</tbody>
</table>

A. Nuclear Criticality Program

The Nuclear Criticality Program provides assurance that the transport, handling, processing, and storage of radiological waste containers containing fissile material is performed in accordance with established guidelines to prevent the occurrence of a criticality event. This control is credited for criticality events. Compliance with the Nuclear Criticality Program reduces the frequency of a criticality event to Beyond Extremely Unlikely. This control was determined to perform a safety function for the workers and is protected in the TSRs as a SMP.

The Nuclear Criticality Program provides for defense-in-depth by ensuring that the transport, handling, processing, and storage of radiological waste containers that contain fissile material is performed in accordance with established guidelines to prevent the occurrence of a criticality event. The Nuclear Criticality Program establishes administrative guidance for process and emergent nuclear criticality safety issues (e.g., special disposal conditions, safety evaluations, or limits). In addition, the Nuclear Criticality Program ensures that a Nuclear Criticality Safety Evaluation [LANL 2011c] is completed before placing waste containers in defined areas.

3.3.2.3.2.7 External Hazards

The strategy to reduce the risk of external events at TA-54, Area G consists of reducing the consequences of such an event. No controls unique to external hazard risk reduction were identified; see Table 3-12. Controls that do provide defense-in-depth for this accident type, though not specific to external hazards, are shown in Table 3-14b.

Table 3-12. Supporting Controls Unique to External Hazard Event Risk Reduction for External Hazards

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None Identified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2.3.2.8 Natural Phenomena Hazards

The strategy to reduce the risk of NPH-initiated events at TA-54, Area G consists of reducing the consequences of such an event. No controls unique to NPH event risk reduction were identified; see Table
3.13. Controls that provide defense-in-depth for this accident type, though not specific to NPH, are shown in Table 3-14b.

Table 3-13. Supporting Controls Unique to External Hazard Event Risk Reduction for NPH

<table>
<thead>
<tr>
<th>Control Title</th>
<th>Attribute/Description</th>
<th>Safety Function</th>
<th>Control Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None Identified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2.3.2.9 Other Potential Controls

A review of other potential or available controls was conducted to identify those that could be effective in reducing the frequency or the consequences to the public, the collocated worker, and the worker. In some cases, control selection was based on implementation, associated cost, and effectiveness, balanced against the limited lifetime of TA-54, Area G. Potential engineered controls were reviewed. Appendix 3G provides an assessment of the controls that are selected versus the DOE-STD-5506 [DOE 2007] preferred or alternate controls.

During the development of the Area G BIO, the following potential engineered controls were considered:

1. **Vehicle Engine Governor Systems** – Vehicle engine governor systems were considered for installation on LANL-owned/operated vehicle engines (gasoline, diesel, and propane-powered) that are used in or would enter TA-54, Area G to limit the speed at which the vehicle would travel. Several postulated event scenarios were developed where speed is the major contributor to impact energy (low to moderate and moderate to high [high-energy impacts are discussed in Section 3.4 as BDBA]). Engine governors would ensure that the actual speed of a vehicle would be restricted to a relatively low-impact speed. A low vehicle speed associated with low impact energy would ensure that the risks remained low to all receptors. A large number of GFE outside of TA-54 G Area operations are required to conduct work activities in TA-54, Area G to which this engineered control could not be applied. Therefore, applying this control to a limited number of TA-54, Area G vehicles reduces, but does not eliminate, this risk. Most of the vehicles used at TA-54, Area G (5 to 40-gal fuel capacity) do not have the mass, even at elevated speeds, to challenge the implemented controls (i.e., vehicle barriers). Due to the cost of installation, maintenance, and testing of such an engineered control, timely implementation on the wide variety of vehicles, and the relatively short life cycle of the facility, vehicle engine governor systems were deemed not to be a viable engineered control for TA-54, Area G.

2. **Electric-Powered Vehicles/Equipment** – The use of only electric-powered vehicles (forklifts, trucks, and transports) was considered in TA-54, Area G to reduce the risk of pool fire event scenarios to all receptors. These types of vehicles do not carry a volume of liquid fuel or propane, which can contribute to major event scenario consequences when spilled and ignited. Electric forklifts lack the power to lift certain containers and do not function well on non-asphalt roads or storage areas. Replacing the current vehicle inventory, as well as providing support services such as battery charging and service areas, is unnecessarily costly when considering the operational and implementation challenges. Therefore, electric vehicles were deemed not a viable engineered control for TA-54, Area G, which covers 64 acres of open terrain.
3. **Above-ground Inventory Doublepack** – An engineered control to doublepack the entire above-ground inventory, the retrieved below-ground inventory, and all newly generated waste with a greater value than or equal to 56 PE-Ci was considered. This engineered control would reduce fire, deflagration, and impact event scenario consequences to all receptors. All waste contained in drums would be doublepacked into larger metal containers (e.g., 85-gal drums) of sound integrity to ensure a significant risk reduction. A problem is that doublepacked waste containers will not fit into waste characterization equipment, which is designed for a 55-gal drum. Also, the large number and type of containers to be procured, the associated handling risk to doublepack the required inventory, and the storage space taken up by increased container size is not operationally feasible. As a result, this engineered control to doublepack all drums with MAR above 56 PE-Ci was deemed not viable for TA–54, Area G.

4. **Fire Protection Systems** – Fire protection systems, (e.g., dry-pipe sprinkler systems) were considered as an engineering control to reduce the risk of all fire event scenarios in defined areas. Not all TA-54, Area G defined areas have an associated physical structure (e.g., dome structure or block building) to provide system protection, structural support for installation, or seismic qualification for stability. Sprinkler systems would be required to be installed in every defined area where waste containers were stored or processed to ensure that the consequences from fires were significantly reduced to all receptors. The engineered design of these sprinkler systems would require leak-proof piping for the contained air pressure due to dome structure flexibility or lack of a structure or fixed mounting framework. The supporting water system would need to be upgraded and new lines installed. These lines would need to be resistant to wind and temperature conditions. In addition, reliable inspection, functional testing, and system maintenance would be required to ensure operability. Based on a review of the existing elements of fire suppression systems, their inoperable condition, the cost required for implementation and maintenance of the number of sprinkler systems needed, and the limited coverage provided by existing inoperable systems, fire protection systems were deemed not a viable engineered control for most of the facilities within TA-54, Area G.

5. **Onsite Waste Shipments in a TRUPACT II** – To provide safe and secure onsite transportation of waste from TA-54, Area G to the RANT facility and within Area G, the use of TRUPACT II confinement was considered. Transporting waste contained in a TRUPACT II of robust design ensures that the consequences and risk from fire, deflagration, and impact event scenarios are significantly reduced to all receptors. Due to the procurement cost and the lead time for implementation of the equipment/ material required for use of the TRUPACT II, and the risk associated with the waste container loading/ unloading process, the use of a TRUPACT II for onsite and RANT facility transfer transportation activities was deemed not a viable engineered control.

6. **Drum Venting Structure** – A qualified Performance Category (PC) hardened structure for the storage and processing of unvented waste containers was considered. This structure would be required to prevent or mitigate deflagration event scenario consequences related to the process of venting drums, and provide controlled storage to protect unvented waste containers from potential insults leading to a deflagration. The drum venting structure would be seismically qualified, along with a High-Efficiency Particulate Air (HEPA) ventilated air exhaust system, to protect all receptors from the risk associated with a radiological release from a drum deflagration. Due to the expected facility closure, engineering, lead time, and construction costs, a qualified drum venting structure with a ventilation system was deemed not viable for TA-54, Area G.

7. **Refueling Truck Entry Restrictions** – A potential SAC was considered to restrict the LANL refueling vehicle from entering TA-54, Area G. Restricting the refueling vehicle from entering
would prevent the frequency of potential pool fire event scenarios from large sources of liquid fuels. Pool fire event consequences, due to the large amount of liquid fuel transported, were postulated to affect all receptors. The effect of this SAC would require that all LANL owned/operated vehicles in TA-54, Area G must exit the facility to be refueled. This would constitute a significant increase in the frequency of potential accidents involving transported or stored waste while the vehicle was being relocated to receive fuel. This significant increase in potential accident frequency would lead to unacceptable risk; therefore, this approach was deemed not viable as a SAC.

8. **Drum Lid Restraining Device for Unvented Containers** – Installing drum lid restraining devices for all of the unvented containers that are stored in TA-54, Area G was considered to reduce the consequence of a drum deflagration. A drum deflagration was shown in the CHA (Appendix 3H) to have High consequences to all receptors. The current above-ground and below-ground container inventory contains multiple unvented containers in storage that would require this device to be installed. Application of the drum lid restraint will provide some mitigation of deflagration consequences; however, the extent of mitigation cannot be quantified. An alternative SAC was developed that requires unvented metal TRU waste drums that are retrieved from underground storage or a stacked array to have a lid restraint applied, and have an engineered barrier or standoff distance, when being handled or transported to an isolation area.

9. **Area G Lightning Protection System Upgrades** – TA-54, Area G has a lightning protection system compliant with NFPA 780 [NFPA 2011]. An upgrade to the system for lightning protection for TA-54, Area G waste storage and process areas to prevent the consequences of lightning strikes to TRU waste containers was considered. Several NPH events postulated during the CHA (Appendix 3H) assumed Moderate to High consequences to all receptors. Preventing a lightning strike to a TRU waste container would reduce the risk. However, a LANL study [LANL 2004] concluded that the current code-compliant lightning protection system does not provide a significant reduction in frequency of lightning-induced fires at LANL. Considering the facility footprint (64 acres) of TA-54, Area G, the TRU waste storage and process area size and locations, the cost of procuring potentially safety-class material and maintaining the qualification of the systems, in conjunction with the scheduled closure of the facility, this engineered control upgrade was deemed not to be a viable engineering control.

### 3.3.2.3.3 Worker Safety

The activities and processes performed within TA-54, Area G primarily involve SIHs to workers. The worker hazard from the radiological component of TA-54, Area G activities is primarily addressed through the controls identified in Section 3.3.2.3.2. The primary hazard to the worker that is not addressed as a SIH is a physical injury resulting from the energetic expulsion of a container lid and contents due to an internal deflagration during vent installation, unvented drum opening, or unvented drum movements. Worker radiological exposures are limited by the safety standoff distance and other controls on venting.

A container deflagration or an energetic missile event could be physically and radiologically hazardous to workers in the immediate area of the event. The physical injuries to these workers could result in severe injury or death. Because of these hazards, controls have been identified for worker protection (in Section 3.3.2.3.2.3 Deflagrations), and are protected in the TSRs as SACs. These controls also provide protection to the public and collocated worker receptors.
3.3.2.3.4 Environmental Protection

Protection of the environment is accomplished through the credited controls that prevent or mitigate the release of radiological material to the environment. The preventative and mitigative controls identified in this BIO for the protection of the public and the worker adequately address the impacts to the environment.

3.3.2.3.5 Summary

Table 3-14a summarizes the credited safety-significant controls from the HA. Table 3-14b summarizes the controls selected in the HA, as a function of accident type, that are identified as contributing to the overall defense-in-depth strategy for each accident type. Details of these controls are discussed above and are further developed in Chapter 4. The MAR limit controls are either initial conditions or are a major contributor to defense-in-depth for reducing consequences. The listed defense-in-depth controls are not credited for risk reduction, though they may be protected in the TSRs as SMP-ACs.
## Table 3-14a. Summary of Safety-Significant Controls

<table>
<thead>
<tr>
<th>Title</th>
<th>Attribute</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specific Administrative Controls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetylene Cylinder Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
</tr>
<tr>
<td>Combustible/Flammable Liquids Controls in Defined Areas and associated Thermal Separation Distance</td>
<td>Metal container storage areas are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in non-metal container storage areas shall be attended, and limited to a total of 100 gal.</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Control of Liquid Run-On</td>
<td>Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.</td>
<td>Prevent fuel spills from the liquid fueled retrieval equipment from entering the pit or trench, and thereby prevent the radiant heat flux from a potential fuel pool fire from impacting waste containers at a lower elevation within the pit or trench</td>
</tr>
<tr>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
<td>Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.</td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts – Critical Lift</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 ft above the ground surface directly below the waste container (excluding Mobile loading payload lifts)</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts – FRPs with MAR &gt; 150 PE-Ci</td>
<td>A critical lift plan will be used for planned crane lifts of FRPs with MAR &gt; 150 PE-Ci</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts – Spotter</td>
<td>Spotter supports forklift/rigger/crane operations during elevated (&gt; 4 to &lt; 12 ft) placement/ removal (stacking/unstacking, loading/unloading) of TRU waste containers</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
</tr>
<tr>
<td>Escort of Transportation Vehicle Between TA-54, Area G and RANT</td>
<td>TRU transportation vehicle escort between Area G and RANT will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Metal Containers</td>
<td>TRU transportation vehicles with compliant metal containers and &gt; 800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
</tbody>
</table>
Table 3-14a. Summary of Safety-Significant Controls

<table>
<thead>
<tr>
<th>Title</th>
<th>Attribute</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant or Non-metal Containers</td>
<td>TRU transportation vehicles with one or more non-compliant metal or non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Escort of &gt; 100-gal Flammable Liquid Inventory Vehicles within TA-54, Area G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable liquid on board (i.e., fuel tanks, , fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
</tr>
<tr>
<td>Fire Protection - Control of Transient Combustibles - Fuel Package Limit</td>
<td>Transient combustible controls within defined areas. Transient fuel packages &gt; 100 lbs are separated from TRU waste in non-metal containers or other fuel packages by a minimum of 9 ft in order to reduce fire progression. Separation of fuel packages from metal containers will be at least 3 ft.</td>
<td>Reduce radiological consequences of a fire by limiting fire progression within a defined area and the amount of MAR involved or Reduce the likelihood of a fuel package being involved in a fire.</td>
</tr>
<tr>
<td>Fire Protection - Thermal Separation Distances</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>Reduce radiological consequences by limiting amount of MAR involved or Reduce the likelihood of fire progression between defined areas.</td>
</tr>
<tr>
<td>Mobile Loading Payload Lifts – Lifting Restriction</td>
<td>Mobile loading payloads shall not be lifted over TRU waste (except another payload within a Type B container)</td>
<td>Reduces radiological consequences of limiting amount of MAR involved</td>
</tr>
<tr>
<td>Mobile Loading Payload Lifts - MAR Limit</td>
<td>Mobile loading payloads with MAR &gt; 925 PE-Ci to &lt; 1,100 PE-Ci not lifted more than 12 ft, measured from the bottom of the payload to the ground</td>
<td>Reduces radiological consequences of limiting the source term in payload drop</td>
</tr>
<tr>
<td>Pole-Mounted Transformer Distance from TRU Waste Storage Areas</td>
<td>Pole-mounted transformers SHALL be located a safe distance away from TRU WASTE STORAGE AREAs as determined by the height of the pole-mounted transformers</td>
<td>Limit amount of MAR involved due to fire after a seismic event.</td>
</tr>
<tr>
<td>Prohibitions on Opening Sealed Inner TRU Waste Packages Discovered During SSSR Activities</td>
<td>Sealed inner TRU waste packages* found within a parent TRU waste container during SSSR activities shall not be opened. The sealed inner TRU waste package shall be placed in a vented TRU waste container. (*With exceptions for containers with bolted lids/flanges)</td>
<td>Protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
</tr>
<tr>
<td>Radiological Inventory Management - Area G Site Above-Ground MAR Limits</td>
<td>Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>Radiological Inventory Management – Transportation Vehicle Limits - Compliant Metal Containers</td>
<td>The total TRU MAR inventory on a compliant TRU transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci</td>
<td>Reduce radiological consequences by limiting MAR involved.</td>
</tr>
</tbody>
</table>
### Table 3-14a. Summary of Safety-Significant Controls

<table>
<thead>
<tr>
<th>Title</th>
<th>Attribute</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – SSSR Area Process Controls</td>
<td>Limit MAR in SSSR Areas</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Radiological Inventory Management – Storage Area, Tritium Area and Process Area MAR</td>
<td>Limit MAR in Storage Areas, Tritium Areas and Process Areas. TRU Storage Areas not collocated with SSSR Areas</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Radiological Inventory Management - Low Activity Area (LAA)</td>
<td>Limit LAA MAR to:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td></td>
<td>• total exposed tritium-contaminated waste at Area G is ≤ 3,000 tritium Ci, and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• total LAA exposed MAR at Area G is ≤ 100 PE-Ci. Buried waste within an LAA shall be covered with &gt; 3 inches of overburden fill material (dirt or equivalent barrier).</td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Radiological Inventory Management – Above-ground MAR is located inside a defined area</td>
<td>All above-ground MAR shall be located inside a defined area appropriate to the waste and container type.</td>
<td>Protects accident analysis assumptions related to the evaluation of offsite dose consequences.</td>
</tr>
<tr>
<td>Radiological Inventory Management – TRU Waste Transportation vehicle with non-compliant metal or metal containers MAR Limit</td>
<td>The total TRU MAR inventory on a TRU transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
</tr>
<tr>
<td>Radiological Inventory Management - Retrieval Areas</td>
<td>The exposed MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
</tr>
<tr>
<td>Stationary Fire Watch During Hot Work Control</td>
<td>Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.</td>
<td>Reduce the frequency for ignition of flammables/combustibles.</td>
</tr>
<tr>
<td>Stationary Fire Watch During SSSR Activities</td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
<td>Reduce the consequences of a fire.</td>
</tr>
<tr>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container</td>
<td>Reduces likelihood for deflagration</td>
</tr>
<tr>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste containers are not stacked</td>
<td>Reduce likelihood of inadvertent container toppling. Reduces the radiological consequences from a sympathetic deflagration</td>
</tr>
</tbody>
</table>
## Table 3-14a. Summary of Safety-Significant Controls

<table>
<thead>
<tr>
<th>Title</th>
<th>Attribute</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce</td>
</tr>
<tr>
<td>and Transportation</td>
<td>restraints and blast shields or a safe standoff distance of &gt; 30 feet</td>
<td>physical consequences by limiting debris dispersion</td>
</tr>
<tr>
<td></td>
<td>between the unvented TRU waste container and the worker</td>
<td></td>
</tr>
<tr>
<td>Vehicle/ Equipment Safety Control – Refueling Location</td>
<td>Refueling location will be separated from MAR in defined areas by the</td>
<td>Reduces frequency of a refueling accident involving a fuel pool fire impacting TRU waste</td>
</tr>
<tr>
<td></td>
<td>thermal separation distance.</td>
<td></td>
</tr>
<tr>
<td>Vehicle Refueling Prohibition</td>
<td>TRU waste transportation vehicles transporting MAR are not to be refueled</td>
<td>Reduce likelihood for involvement of MAR in event</td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>Spark-generating operations in the SSSR Area shall cease prior to loosening</td>
<td>Reduce the likelihood of a deflagration</td>
</tr>
<tr>
<td>Activities - Spark-generating operations</td>
<td>the lid/flare bolts on the sealed container.</td>
<td></td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>Workers and the sealed container shall be grounded or bonded prior to</td>
<td>Reduce the likelihood of a deflagration</td>
</tr>
<tr>
<td>Activities - Grounding/Bonding</td>
<td>loosening the lid/flare bolts.</td>
<td></td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>Loosening the lid/flare bolts shall be performed using non-sparking</td>
<td>Reduce the likelihood of a deflagration</td>
</tr>
<tr>
<td>Activities - Non-Sparking processes or tools</td>
<td>processes or tools.</td>
<td></td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>The lid/flare bolts of each lid/flare shall be loosened sufficiently to</td>
<td>Reduce the consequences of a deflagration</td>
</tr>
<tr>
<td>Activities - Lid/flare bolt loosening</td>
<td>break the seal on the lid/flare and allow venting without completely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>removing the bolts.</td>
<td></td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>While the sealed container is venting, the container shall be positioned</td>
<td>Reduce the likelihood of a deflagration</td>
</tr>
<tr>
<td>Activities - Container positioning</td>
<td>such that the opening(s) is at the high point of the container.</td>
<td></td>
</tr>
<tr>
<td>Opening sealed containers with bolted lids/flanges during SSSR</td>
<td>Spark-generating operations shall not be resumed until the container has</td>
<td>Reduce the likelihood of deflagration</td>
</tr>
<tr>
<td>Activities - Resumption of spark-generating operations</td>
<td>been vented and the hydrogen levels at the opening are measured and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>demonstrated to be below the LFL (4% for hydrogen).</td>
<td></td>
</tr>
<tr>
<td>Engineered Controls (SSCs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRU Waste Containers</td>
<td>Metal TRU waste container in good and unimpaired condition (sound integrity)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
</tr>
<tr>
<td></td>
<td>Waste is packaged</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>packaged</td>
</tr>
</tbody>
</table>
### Table 3-14a. Summary of Safety-Significant Controls

<table>
<thead>
<tr>
<th>Title</th>
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<th>Safety Function</th>
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<tbody>
<tr>
<td>Vehicle Barriers at High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers Reduces amount of MAR involved.</td>
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<tr>
<td>Safety Management Programs (SMPs)</td>
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<tr>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td>Reduce the consequences of an accident for the worker and collocated worker</td>
</tr>
<tr>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include inspections by LANL FPE</td>
<td>Reduces the likelihood of fire progression</td>
</tr>
<tr>
<td>Fire Protection Program – Ignition Source Control</td>
<td>Ignition source control within radiological waste defined areas</td>
<td>Reduce likelihood for ignition of flammables/combustibles</td>
</tr>
<tr>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift) and lightning protection system</td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>Nuclear Criticality Safety Program</td>
<td>Establishes administrative guidance for process and emergent nuclear criticality safety issues (e.g., special disposal conditions, safety evaluations, limits)</td>
<td>Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible.</td>
</tr>
<tr>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for all receptors</td>
<td>Reduce radiological consequences by controlling contamination and limiting radiological material released</td>
</tr>
<tr>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
</tr>
<tr>
<td>Training and Qualification Program – Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
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Table 3-14b. Summary of Controls in Hazard Analysis Contributing to Overall Defense-In-Depth per Accident Type

<table>
<thead>
<tr>
<th>Control Title</th>
<th>General</th>
<th>Fire</th>
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<th>Exposure</th>
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<th>External Hazards</th>
<th>NPH</th>
<th>Worker</th>
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<td>Combustible/ Flammable Liquids Control</td>
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<td>Elevated Waste Movements and Critical Lift</td>
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<td>Stationary Fire Watch during Hot Work</td>
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<td>Stationary Fire Watch During SSSR Activities</td>
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<td>Maintenance Program – Vehicle/Equipment</td>
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<td>Mobile Loader Payload Restriction – Lifts</td>
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<td>Radiation Protection Program – drum venting performed in a contamination controlled environment</td>
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<td>Radiological Inventory Management – Doublepack</td>
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<td>Radiological Inventory Management – Transportation Vehicle Mixed Load MAR Limit</td>
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<td>Radiological Inventory Management – Retrieval Area MAR Limit</td>
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</table>
### Table 3-14b. Summary of Controls in Hazard Analysis Contributing to Overall Defense-In-Depth per Accident Type

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<th>Worker</th>
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<td>Doublepacking TRU Waste Drums with MAR ≥ 200 PE-Ci During Trenches A-D Retrieval Activities</td>
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<td>Prohibition on opening sealed inner TRU Waste packages discovered during SSSR activities</td>
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<td>Training and Qualification Program – Hazards Recognition</td>
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<td>Pole-Mounted Transformer Distance from TRU Waste Storage Areas</td>
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<td>Escort of Transportation Vehicle between TA-54, Area G and TA-54 RANT</td>
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<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
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<td>Escort of &gt;100 gallons Flammable Liquid Inventory Vehicles within TA-54, Area G</td>
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3.3.2.3.6 Accident Selection

This section discusses the process and criteria used in selecting unique and representative event scenarios (i.e., the Design Basis Accidents [DBAs]) for the AA (Section 3.4) in this BIO. The DBAs are those events judged to present sufficiently high risk that further quantitative examination is needed (e.g., a single fire whose specific parameters result in approaching the EG; or situations of major concern). Representative event scenarios bound a number of similar events of lesser risk (e.g., the worst fire for a number of similar fires). Unique event scenarios are those that are not bounded by representative events (Appendix 3A, Table 3A-1).

The primary purpose of the DBA analysis is to identify safety SSCs that warrant safety-class designation for public protection. Comparison of the unmitigated consequences to the EG determines if the need for designation of safety-class SSCs exists. If the EG value is challenged or exceeded, safety-class SSCs or SACs are required. The DBA analysis in this BIO also evaluates the need for safety SSCs for the protection of collocated workers. Some postulated event scenarios were qualitatively evaluated to result in Moderate consequences to the public, while consequences to collocated workers were evaluated to be High. These event scenarios were also included in the selection of events for AA. Controls selected for the public that are deemed safety-class provide protection to the collocated worker as well. Controls designated as safety-class or safety-significant within the summary tables of each DBA are specific to public protection; however, credited controls are also safety-significant for the protection of collocated workers.

There is no predetermined frequency cutoff value, such as 1.0E-6 per year, for excluding low-frequency operational accidents (i.e., internally initiated). In fact, for operational accidents, there is no explicit need for an assigned frequency of the accident for the unmitigated release calculations, since the determination of need is solely driven by the bounding consequence potential.

The process for selecting HA event scenarios that are carried forward for a formal AA was focused on event scenarios with the potential to challenge or exceed the EG (designated as events with unmitigated public risk ranking of I or II). Because of the number of HA events that challenged or exceeded the EG, a systematic process was used to reduce the number of potential DBAs to be evaluated, while assuring an adequate analysis of facility risk and selection of the appropriate controls to minimize the risk. The Unique and Representative Event Selection table (Appendix 3A, Table 3A-1) presents the summary of the event selection process. The HA grouped events into one of the following seven Event Types (per
guidance from DOE-STD-3009-94 [DOE 2006a]) which are listed in column 1, Event Types, of Table 3A-1:

E-1 Fire
E-2 Explosion
E-3 Loss of Confinement and/or Containment
E-4 Direct Exposure to Radiation
E-5 Criticality
E-6 Externally Initiated
E-7 Natural Phenomena Hazard

DOE-STD-5506-2007 [DOE 2007], Table 3.3-1, provides a further breakdown of the seven Event Types into 25 event classes which are listed in column 2, titled “5506 Hazard Evaluation Event”, of Table 3A-1.

The HA events that challenge the EG (> 10 rem) were first binned into one of these 25 event classes. Some event class bins resulted in no events due to the nature of TA-54, Area G activities. Event classes into which multiple events were binned were then further examined. Each event within a bin was examined for unmitigated frequency and consequences, MAR, and the controls selected by the HA for potential risk reduction. This examination ordered the events based on the number of HA-selected controls. Events that selected the same or a subset of the selected controls of a given event were grouped and bounded to the event with the highest risk and largest number or comparable set of selected controls. Events that were not bounded by the representative (bounding) event due to risk or selected controls were separated and further evaluated as unique events. The binning of the HA events is shown in Table 3A-1, and resulted in the identification of at least 13 DBAs to address the DOE-STD-5506-2007 [DOE 2007], Table 3.3-1, event classes.

The number of candidate unique and representative events after this exercise was still large; therefore, a further review of the candidate unique and representative events was performed. This selection process consisted of listing each candidate unique and representative event in Appendix 3A. This table is grouped by the identified 13 DBAs. Each candidate unique and representative event was listed by DBA along with its description and unmitigated MAR, and the controls selected by the HA for risk reduction. Candidate unique and representative events were then evaluated to determine which events credited the same or subset of a specific control set for a significant reduction (typically at least one bin) in event frequency or consequences. Where a set of unique and representative events credited the same or a subset of a specific control set, a representative event was selected based on unmitigated risk and the larger credited control set. In some cases, a few bounded scenarios credited controls for some events that were not identified for the bounding events. These safety-class controls are identified in the discussion of the DBA and are carried forward in the summary table for each DBA.

3.4 ACCIDENT ANALYSIS

Section 3.3 discusses the process by which unique and representative CHA (Appendix 3H) events are selected for further quantitative analysis. This section of the BIO documents the formal analysis of the design basis operational, external, and natural phenomena events. These unique and representative events, also known as bounding events, become the DBAs for TA-54, Area G. Some of these events have
consequences that challenge or exceed the EG for the public or have significant impact to the collocated workers. The principal purpose of the AA is to identify safety-class SSCs and TSRs, including SACs, needed for the protection of the public. The consequences for onsite workers are also presented in this section. Quantitative analysis for the collocated worker is required in DOE–STD-5506 [DOE 2007]. Safety-class controls that protect the public will also protect the collocated worker, and are identified in the TSR control summary for each DBA, along with safety-significant and defense-in-depth controls for public and workers.

This BIO section is based on the following general guidance documents:


The chemical hazards associated with TRU waste handling in TA-54, Area G were screened as SIHs in the CHA. The chemical toxicity of $^{239}$Pu reviewed in the CHA bounds all the chemicals studied, and the controls associated with protecting receptors from radiological hazards also protect from the chemical hazards. Therefore, no chemical hazard events were brought forward into the AA.

3.4.1 AA METHODOLOGY

Analysis of a DBA or BDBA involves the calculation of consequences and the expected frequency of occurrence for the accident. This section describes the methods used to develop the scenario and ST, and quantify the consequences and risk of operational accidents, NPH events, and external events analyzed in Sections 3.4.2 and 3.4.3. In addition, this section describes the approach and application of models and computer codes to support the various phenomenological evaluations needed for the analysis of the selected postulated accident scenarios.

The presentation of the analysis for each DBA scenario follows the approach described in DOE-STD-3009-94 [DOE 2006a] and consists of the following information:

- Accident Title
- Scenario Development
- ST analysis
- Consequence analysis
- Comparison to the EG
- Summary of TSR Safety Controls

**Selection of DBAs**

The selection of event scenarios for analysis is primarily based on the unmitigated public consequences of the accident in comparison to the corresponding EG. There is no intent to perform AA for the worker.
The CHA (Appendix 3H) was evaluated for the identification of several unique and representative events that were selected for AA, as summarized in Section 3.3 and in Appendix 3A, Table 3A-1. All of these events were grouped into one of seven event types per guidance from DOE-STD-3009-94 [DOE 2006a]. DOE-STD-5506-2007 [DOE 2007] identifies a further breakdown of the seven Event Types into 25 event classes listed below:

- **Fire Events (E-1)**
  - Fuel Pool Fire
  - Small Fire
  - Enclosure Fire
  - Large Fire

- **Explosion Events (E-2)**
  - Ignition of Fumes Results in a Deflagration/Detonation
  - Waste Container Deflagration
  - Multiple Waste Container Deflagration
  - Enclosure Deflagration

- **Loss of Confinement (E-3)**
  - Vehicle/ Equipment Impacts Waste/Waste Containers
  - Drop/ Impact/Spill Due to Improperly Handled Container, etc.
  - Collapse of Stacked Containers
  - Waste Container Overpressurization

- **Direct Exposure to Radiation Events (E-4)**

- **Criticality Events (E-5)**

- **External Events (E-6)**
  - Aircraft Impact with Fire
  - External Vehicle Accident
  - External Vehicle with Fire (Combustible or Pool)
  - External Explosion
  - External Fire

- **NPH-Initiated Events (E-7)**
  - Lightning
  - High Wind
  - Tornado
  - Snow/ Ice/ Volcanic Ash Build-up
  - Seismic Event (Impact Only)
  - Seismic Event with Fire
Unique and representative CHA events within each accident category were selected as DBAs based on the following criteria: bounding accidents must (1) cover all initiators, (2) bound the worst-case unmitigated consequence from all of the bounded events, (3) be made up of sub-scenarios with similar characteristics, and (4) use the same, a subset, or a comparable set of the credited controls. The DBAs resulting from the accident selection process are identified in Table 3-15. While all DOE-STD-5506-2007 [DOE 2007] event types were considered, some of them resulted in no events.

Table 3-15. Design Basis Accidents Selected for Analysis

<table>
<thead>
<tr>
<th>Section No.</th>
<th>DBA No.</th>
<th>CHA Event No.</th>
<th>DBA Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4.2.1</td>
<td>1A</td>
<td>AGTRU-1-025</td>
<td>Vehicle Accident With Fuel Pool Fire</td>
</tr>
<tr>
<td>3.4.2.2</td>
<td>1B</td>
<td>AGTRU-1-044</td>
<td>Fuel Pool Fire From Container Leak</td>
</tr>
<tr>
<td>3.4.2.3</td>
<td>1C</td>
<td>AGTRU-1-048</td>
<td>Refueling Vehicle Accident With Fuel Pool Fire</td>
</tr>
<tr>
<td>3.4.2.4</td>
<td>1D</td>
<td>BGTRUPIT-1-016</td>
<td>Fuel Pool Fire in Pit 9</td>
</tr>
<tr>
<td>3.4.2.5</td>
<td>2A</td>
<td>AGTRU-1-031</td>
<td>Vehicle Accident with Combustible Fire</td>
</tr>
<tr>
<td>3.4.2.6</td>
<td>2B</td>
<td>BGTRUPIT-1-003</td>
<td>Combustible Fire in Trenches</td>
</tr>
<tr>
<td>3.4.2.7</td>
<td>3</td>
<td>AGTRU-1-041</td>
<td>Large Combustible Fire</td>
</tr>
<tr>
<td>3.4.2.8</td>
<td>4A</td>
<td>AGTRU-2-028</td>
<td>Single Container Deflagration Caused by Shock</td>
</tr>
<tr>
<td>3.4.2.9</td>
<td>Deleted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.2.10</td>
<td>4C</td>
<td>AGTRU-2-015</td>
<td>Single Container Deflagration Caused by Puncture</td>
</tr>
<tr>
<td>3.4.2.11</td>
<td>4D</td>
<td>AGTRU-2-030</td>
<td>Single Container Deflagration During Accident</td>
</tr>
<tr>
<td>3.4.2.12</td>
<td>4E</td>
<td>BGTRUCSK-2-011</td>
<td>Single Container Deflagration Caused by Fire in Proximity</td>
</tr>
<tr>
<td>3.4.2.13</td>
<td>4F</td>
<td>BGTRUCSK-2-014</td>
<td>Container Deflagration Caused by a Forklift Puncture</td>
</tr>
<tr>
<td>3.4.2.14</td>
<td>5A</td>
<td>AGTRU-2-007</td>
<td>Multiple Above-Ground Waste Container Deflagration</td>
</tr>
<tr>
<td>3.4.2.15</td>
<td>5B</td>
<td>BGTRUCSK-2-007</td>
<td>Multiple Trenches A-D Waste Container Deflagration</td>
</tr>
<tr>
<td>3.4.2.16</td>
<td>6</td>
<td>BGTRUPIT-2-011</td>
<td>Below-Ground Waste Container Deflagration Caused by External Flame</td>
</tr>
<tr>
<td>3.4.2.17</td>
<td>7A</td>
<td>AGTRU-3-012</td>
<td>Vehicle Transporting Waste Impacts Storage Array</td>
</tr>
<tr>
<td>3.4.2.18</td>
<td>7B</td>
<td>AGTRU-3-016</td>
<td>Crane Topplies Onto Staged TRU Waste</td>
</tr>
<tr>
<td>3.4.2.19</td>
<td>8</td>
<td>AGTRU-3-017</td>
<td>Crane Drops TRUPACT II Payload Assembly</td>
</tr>
<tr>
<td>3.4.2.20</td>
<td>9</td>
<td>AGTRU-6-001</td>
<td>Aircraft Impacts TRU Waste in Area G with Follow On Pool Fire</td>
</tr>
<tr>
<td>3.4.2.21</td>
<td>10</td>
<td>AGTRU-6-002</td>
<td>External Fire Propagates to Area G</td>
</tr>
<tr>
<td>3.4.2.21a</td>
<td>10a</td>
<td>AGTRU-7-002</td>
<td>Lightning Strikes Multiple TRU Waste Containers</td>
</tr>
<tr>
<td>3.4.2.22</td>
<td>11</td>
<td>AGTRU-7-005</td>
<td>High Wind Damages Multiple TRU Waste Containers</td>
</tr>
<tr>
<td>3.4.2.23</td>
<td>12</td>
<td>AGTRU-7-007</td>
<td>Seismic Event Affects Area G With Follow On Fire</td>
</tr>
<tr>
<td>3.4.2.24</td>
<td>13</td>
<td>AGTRU-2-034a</td>
<td>Acetylene Gas Explosion</td>
</tr>
<tr>
<td>3.4.3</td>
<td>BDBA</td>
<td>———</td>
<td>High Speed Vehicle Accident With Fuel Pool Fire</td>
</tr>
</tbody>
</table>
3.4.1.1 Scenario Development

The scenario description and causes identified in the CHA are described to define the accident scenario progression of each DBA. Key assumptions related to the specific accident scenario are also identified as necessary.

3.4.1.2 Source Term Analysis

The basic methodology used for determining the amount of radioactive or other hazardous material released from TA-54, Area G to the atmosphere during an accident is based on techniques described in DOE-HDBK-3010-94 [DOE 2000a] on airborne releases. DOE-HDBK-3010-94

- Summarizes experimental data related to airborne radionuclide releases and ST development;
- Describes the DOE ST methodology (this methodology is briefly summarized below); and
- Provides recommended methods for estimating the parameters employed to calculate STs, such as MAR, DR, ARF, LPF, and RF.

The ST released to the environment under accident conditions is determined from the multiplication of the ST parameters, as follows:

\[ ST = MAR \times DR \times ARF \times RF \times LPF \]

where:

\[ MAR = \text{Material at Risk – The amount of radioactive material or other hazardous material available (curies or mass) to be acted upon by a given physical stress.} \]

\[ DR = \text{Damage Ratio – The fraction of MAR impacted by the accident-generated conditions.} \]

\[ ARF = \text{Airborne Release Fraction – The coefficient used to estimate the amount of a radioactive or hazardous material that can be suspended in air and available for transport under a specific set of accident conditions.} \]

\[ RF = \text{Respirable Fraction – The fraction of airborne particles that can be transported through air and inhaled into the human respiratory system.} \]

\[ LPF = \text{Leak Path Factor – The fraction of radionuclides or hazardous material in air transported through some confinement, deposition, or filtration mechanism.} \]

The ARF and RF are derived from DOE-HDBK-3010-94 [DOE 2000a] and summarized in DOE-STD-5506 [DOE 2007] for TRU waste facilities. The next several sections describe how the values of the factors in the ST equation are determined for TA-54, Area G.

Material-at-Risk (MAR)

The MAR is the amount of radionuclides (TRU PE-Ci or Ci of tritium) available to be acted on by a given physical stress. The MAR is a value representing some maximum quantity of radionuclide present or reasonably anticipated for the process or defined area being analyzed. Different MARs were assigned for different accidents, as it is only necessary to define the material in those discrete physical locations that are exposed to a given stress. For example, a spill may involve only the contents of a single drum or a
pallet of drums. Conversely, a seismic event may involve all of the waste containers within Area G (DOE-HDBK-3010-94 [DOE 2000a]).

The MAR used in this BIO is based on the projected TA-54, Area G above-ground inventory as of July 2013 [LANL 2013b] and the Pit 9 underground inventory as of July 2009 [LANL 2009b]. The inventory in any defined area or storage area is subject to day-to-day fluctuations from the routine container transfers necessary to support waste operations. The overall site inventory is subject to variations as containers are transferred to and from the site, including retrieval. To protect the Initial Condition upon which the above-ground inventory assumptions are based, a specific administrative control will require verification of the projected Area G above-ground inventory statistics before retrieval of underground waste from Trenches A through D.

If the DBA postulates the involvement of a number of containers, the methodology provided in DOE-STD-5506-2007, Section 4.3.2 [DOE 2007], is used to determine the amount of MAR involved in the accident. DOE-STD-5506-2007, Table 4.3.2-1 provides an algorithm of MAR values based on the number of containers impacted by a DBA (single container, payload, building, etc.), and inventory knowledge (e.g., whether the inventory has been sufficiently or insufficiently characterized).

For this evaluation, the above-ground inventory is sufficiently characterized so that the DOE-STD-5506-2007 guidance for an additional 20% margin to the single-container accident scenarios does not apply. A sufficiently characterized container meets the DOE-STD-5506 definition of a fully characterized container. This is because, in general, its waste contents meet other characterization techniques that would have been necessary for waste container transport to Area G. However, when a number of containers are involved in an accident, the statistical analysis for containers of Limited Characterization is utilized to calculate the MAR. Therefore, the MAR in DBAs that consider a number of waste containers involved in the accident is conservative.

For below-ground inventory, 20% is added to the highest MAR container for single-container event scenarios. DOE-STD-5506-2007 requires a statistical distribution be developed. The statistical distribution for the PE-Ci content for the TA-54, Area G above-ground inventory is projected for July 2013 [LANL 2013a], and the Pit 9 below-ground inventory is as of July 2009 [LANL 2009b]. For the containers in Trenches A-D waste retrieval operations, the bounding single-container MAR value (750 PE-Ci – this MAR value includes an additional 20% margin) is used and is treated as all-combustible waste per DOE-STD-5506. As indicated in the results section of the CHA, consequences from the CMP accidents were considered negligible and not carried forward to be analyzed in the AA. For LLW and tritium-contaminated waste, statistical analysis for each container is not used because the analysis considers defined area MAR limits and not single-container accidents.

As DOE-STD-5506-2007 instructs, “...For those inventory populations with only limited or partial characterization, the MAR value should be based on the nonparametric estimate of the 95% upper tolerance limit (UTL95) for the specified percentiles and the 95% upper confidence limit (UCL95) for the mean” [DOE 2007, pg 22]. A summary of the statistical analysis [LANL 2013a] for the Area G above-ground inventory is shown in Table 3-16.
Table 3-16. Statistical Analysis for the Area G Above-Ground TRU Inventory, July 2013

<table>
<thead>
<tr>
<th>Container Statistics</th>
<th>All Containers (Composite)</th>
<th>Metal</th>
<th>Non-metal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>w/zeros</td>
<td>wo/zeros</td>
<td>w/zeros</td>
</tr>
<tr>
<td>Total Number of Containers</td>
<td>13,065</td>
<td>11,329</td>
<td>12,954</td>
</tr>
<tr>
<td>Mean (PE-Ci)</td>
<td>3.96</td>
<td>4.57</td>
<td>3.85</td>
</tr>
<tr>
<td>UCL95 (PE-Ci)</td>
<td>4.30</td>
<td>4.96</td>
<td>4.19</td>
</tr>
<tr>
<td>50th percentile (PE-Ci)</td>
<td>0.00029</td>
<td>0.00056</td>
<td>0.00029</td>
</tr>
<tr>
<td>90th percentile (PE-Ci)</td>
<td>11.41</td>
<td>13.57</td>
<td>11.30</td>
</tr>
<tr>
<td>95th percentile (PE-Ci)</td>
<td>18.56</td>
<td>20.17</td>
<td>18.43</td>
</tr>
<tr>
<td>UTL95/95 (PE-Ci)</td>
<td>19.45</td>
<td>21.22</td>
<td>19.21</td>
</tr>
<tr>
<td>99th percentile (PE-Ci)</td>
<td>48.89</td>
<td>52.20</td>
<td>43.01</td>
</tr>
<tr>
<td>UTL95/99 (PE-Ci)</td>
<td>58.76</td>
<td>62.80</td>
<td>49.90</td>
</tr>
<tr>
<td>Max (PE-Ci) (single container)</td>
<td>552.84</td>
<td>552.84</td>
<td>552.84</td>
</tr>
</tbody>
</table>

Note 1: The Metal container population w/zeros includes 7 with PE-Ci values less than zero
Note 2: There were no "non-metal" containers with 0 PE-Ci content
Note 3: Total number of Non-metal containers not enough to calculate UTL95/99 value

For DBAs using the statistical analysis for the *All Containers (composite)*, the difference between the data w/zeros and wo/zeros is the number of containers (as shown in the TA-54, Area G waste inventory database) that have zero radioisotopic inventory. For example, for the *All Containers (composite)* inventory, there are 13,065-11,329= 1,736 containers with a MAR value of ≤ 0. In the DBA MAR calculations, the data wo/zeros is used for conservatism, so the MAR and consequence calculations are slightly higher than if the total number of containers (w/zeros) in the inventory were considered.

Table 3-17 shows the Pit 9 Below-Ground Inventory statistics [LANL 2009b].

Table 3-17. Statistical Analysis for the Area G Pit 9 TRU Waste Containers, July 2009

<table>
<thead>
<tr>
<th>Container Statistics</th>
<th>Compliant (metal) Containers</th>
<th>Non-metal Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>w/zeros</td>
<td>wo/zeros</td>
</tr>
<tr>
<td>Total Number of Containers</td>
<td>3880</td>
<td>2959</td>
</tr>
<tr>
<td>Mean (PE-Ci)</td>
<td>1.43</td>
<td>1.88</td>
</tr>
<tr>
<td>UCL95 (PE-Ci)</td>
<td>1.57</td>
<td>2.05</td>
</tr>
<tr>
<td>50th percentile (PE-Ci)</td>
<td>0.09</td>
<td>0.24</td>
</tr>
<tr>
<td>90th percentile (PE-Ci)</td>
<td>3.21</td>
<td>5.11</td>
</tr>
<tr>
<td>95th percentile (PE-Ci)</td>
<td>7.90</td>
<td>10.99</td>
</tr>
</tbody>
</table>
Table 3-17. Statistical Analysis for the Area G Pit 9 TRU Waste Containers, July 2009

<table>
<thead>
<tr>
<th>Container Statistics</th>
<th>Compliant (metal) Containers</th>
<th>Non-metal Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>w/zeros</td>
<td>wo/zeros</td>
</tr>
<tr>
<td>UTL_{95/95} (PE-Ci)</td>
<td>9.27</td>
<td>12.36</td>
</tr>
<tr>
<td>99th percentile (PE-Ci)</td>
<td>17.29</td>
<td>19.95</td>
</tr>
<tr>
<td>UTL_{95/99} (PE-Ci)</td>
<td>20.06</td>
<td>28.02</td>
</tr>
<tr>
<td>Max (PE-Ci) (single container)</td>
<td>196.13</td>
<td>196.13</td>
</tr>
</tbody>
</table>

For accident scenarios involving a number of containers with limited characterization, Table 3-18 identifies the algorithm to calculate the MAR as a function of the number of containers involved in the DBA (DOE-STD-5506-2007, Table 4.3.2-1) [DOE 2007].

Table 3-18. Bounding MAR Limits for TRU Operations; from DOE-STD-5506-2007, Table 4.3.2-1

<table>
<thead>
<tr>
<th>MAR Description</th>
<th>Limited Characterization¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Container</td>
<td>Maximum container + 20%</td>
</tr>
<tr>
<td>Two Containers</td>
<td>One at maximum container, one at UTL_{95} for the 99th percentile</td>
</tr>
<tr>
<td>Three Containers</td>
<td>One at Maximum container, one at UTL_{95} for the 99th percentile, one at UTL_{95} for the 95th percentile</td>
</tr>
<tr>
<td>Four Containers</td>
<td>One at Maximum container, one at UTL_{95} for the 99th percentile, two at UTL_{95} for the 95th percentile</td>
</tr>
<tr>
<td>Greater than four containers</td>
<td>One at Maximum container, one at UTL_{95} for the 99th percentile, two at UTL_{95} for the 95th percentile, Remainder at UCL_{95} for the mean each, Or Applicable Facility/area/payload Limit²</td>
</tr>
<tr>
<td>TRUPACT II Payload</td>
<td>N/A</td>
</tr>
</tbody>
</table>

¹ Waste has limited characterization data and relies on measures such as process knowledge.
² Bounding MAR limit determined based on operational needs and inventory profile. If the maximum container limit to be shipped is well below the WIPP WAC limit, then the 14 containers must be at the maximum inventory limit.
³ 20% margin was not used for above-ground waste, which is sufficiently characterized.

As an example of using this algorithm for above-ground inventory, if the accident scenario postulates that ten metal containers are involved, the MAR is calculated as follows:

\[
\text{MAR (PE-Ci)} = 552.84 + 56.20 + (2 \times 20.90) + (6 \times 4.84) = 679.88 \text{ PE-Ci}
\]

Table 3-19 shows the results of the algorithm repeated for a number of containers.
The material waste type of the TRU waste is also considered in the ST analysis. For DBAs involving large quantities of waste or an array of metal and non-metal containers, it is assumed that the MAR is composed of the same material form distribution (in percentages) as the total site inventory. For single containers, it is assumed that the MAR is composed of the combustible material form that will yield the most conservative (highest) ARF × RF.

Tables 3-20, 3-21, and 3-22 show the waste composition distributions of the above-ground and the Pit 9 below-ground inventories respectively [LANL 2013b and LANL 2009b]. The waste composition assumed for the DBA analysis is identified in each DBA.
Table 3-21. Below-Ground TRU Waste Summary of Pit 9 Compliant (Metal) Containers by Waste Category, July 2009

<table>
<thead>
<tr>
<th>Waste Matrix</th>
<th>MAR (PE-Ci) in Waste Matrix</th>
<th>% of MAR in Waste Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible</td>
<td>1221.84</td>
<td>22.0</td>
</tr>
<tr>
<td>Dispersible, Non-combustible</td>
<td>2669.13</td>
<td>48.1</td>
</tr>
<tr>
<td>Non-dispersible, Non-combustible</td>
<td>1663.54</td>
<td>29.9</td>
</tr>
<tr>
<td>Pit 9 Total</td>
<td>5554.51</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 3-22. Below-Ground TRU Waste Summary of Pit 9 Non-metal Containers by Waste Category, July 2009

<table>
<thead>
<tr>
<th>Waste Matrix</th>
<th>MAR (PE-Ci) in Waste Matrix</th>
<th>% of MAR in Waste Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible</td>
<td>0.33</td>
<td>0.1</td>
</tr>
<tr>
<td>Dispersible, Non-combustible</td>
<td>427.96</td>
<td>99.9</td>
</tr>
<tr>
<td>Non-dispersible, Non-combustible</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Pit 9 Total</td>
<td>428.29</td>
<td>N/A</td>
</tr>
</tbody>
</table>

DR

The DR is the fraction of the MAR actually impacted by the accident-generated conditions. The DRs are scenario-dependent, and their derivations will be described in each accident scenario section.

DOE-STD-5506-2007 [DOE 2007] provides specific guidance on scenario-dependent DRs. The use of DRs within this analysis is primarily based on containers of sound integrity that meet the WIPP inspection criteria summarized in DOE-STD-5506-2007. In addition, application of the data provided in DOE-STD-5506-2007 “assumes container integrity can be verified through an inspection program or process knowledge.” As described in DOE-STD-5506-2007, “When purchased, TRU waste containers are certified to DOT specifications. However, containers can degrade over time, and DOT certification is only effective for one year after packaging. Therefore, legacy TRU waste containers greater than one year have lost their DOT certification, but have not stopped performing their intended function.”

For containers that do not meet the sound integrity requirements, a DR equal to 1.0 is used. DOE-STD-5506-2007 also cites that, where the determination of sound integrity cannot be met, such as from the TRU waste retrieval from a burial ground, a DR of < 1 requires explicit justification.

ARF/RF

The ARF represents the fraction of the impacted MAR that becomes airborne or suspended in air as an aerosol and available for transport because of the physical stress created by the accident scenario. For TRU waste facilities, DOE-STD-5506 [DOE 2007] provides guidance on acceptable bounding ARFs for various phenomena and is used where applicable. Guidance in DOE-HDBK-3010-94 [DOE 2000a] is used for tritium releases.

The key elements associated with determining respirable ARFs include:
- The form of the material (e.g., solid liquid, powder, or combustible waste) affected by the event;
- The physical processes involved in the event (e.g., mechanical shock, vibrations, fire, explosion); and
- When applicable, the approximate quantity of kinetic and thermal energy involved in the physical process.

The RF is the fraction of airborne particles that can be inhaled into the human respiratory system and is commonly assumed to include particles of 10-µm Aerodynamic Equivalent Diameter and smaller.

An ARF/RF for each postulated DBA is selected based on the data and recommendations from DOE-STD-5506-2007 [DOE 2007] and DOE-HDBK-3010-94 [DOE 2000a]. Table 3-23 lists the appropriate ARF × RF from the DOE guidance for the material forms and accident characteristics of the various accident scenarios postulated. The ARF × RF values are bounding values. The individual accident scenario descriptions identify the specific ARF × RF used.

**Table 3-23. Release Fraction Data for Area G Accidents**

<table>
<thead>
<tr>
<th>Material Form</th>
<th>Release Mechanism</th>
<th>DOE-HDBK-3010 Basis</th>
<th>Bounding ARF/RF</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible Dispersible</td>
<td>Drum impacted (low-energy impact); contents spilled</td>
<td>Contaminated, combustible solids packaged in a robust container that is spilled and subjected to shock and impact (vibration) during the spill [DOE 2007, pg 5-4]</td>
<td>1E-3/0.1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Combustible Dispersible</td>
<td>Drum impacted (high-energy impact, &gt; 35 mph); contents spilled</td>
<td>Contaminated, combustible solids packaged in a robust container that is spilled and subjected to shock and high-energy impact during the spill [DOE 2007, pg 4-87]</td>
<td>1E-2/0.2</td>
<td>Large vehicles traveling at &gt; 35 mph will cause significant damage at Area G</td>
</tr>
<tr>
<td>Combustible Dispersible</td>
<td>Waste material spills or is ejected from drum and burns (uncontained)</td>
<td>Contaminated, combustible solids, uncontained cellulosics or largely cellulosic mixed waste (burning of unpackaged, loosely strewn cellulosic materials, such as paper, cardboard, rags, and wood shavings) and plastic</td>
<td>1E-2/1.0</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
</tbody>
</table>
### Table 3-23. Release Fraction Data for Area G Accidents

<table>
<thead>
<tr>
<th>Material Form</th>
<th>Release Mechanism</th>
<th>DOE-HDBK-3010 Basis</th>
<th>Bounding ARF/RF</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible Dispersible</td>
<td>Fire causes drum lid seal failure; waste material burns in drum (contained)</td>
<td>Contaminated, combustible solids; packaged mixed waste heated/ burned in packages with largely non-contaminated exterior surfaces (e.g., packaged in bags, compact piles, drums) [DOE 2007, pg 5-1]</td>
<td>5E-4/1.0</td>
<td>The recommended ARF for burning uncontained plastics is 5E-2 based on tests of powder piles on burning plastic material. A more representative configuration is listed in DOE-HDBK-3010, Tables A.51 and A.53 [DOE 2000a], using air-dried liquid on a plastic substrate (max. ARF of 0.006). The recommended bounding ARF for uncontained cellulosics bounds these results and will be used for both cellulosics and plastics.</td>
</tr>
<tr>
<td>Combustible Dispersible</td>
<td>Drum bursts lid in fire and expels contents</td>
<td>Release for the event is split into 3 components: 2/3 of the contents burn in the drum 1/3 of the contents is subject to shock/impact during the ejection Remaining ejected waste burns outside the drum</td>
<td>5E-4/1.0</td>
<td>These values are consistent with DOE-STD-5506-2007. Same as waste burning in drum (above) Same as impact/spill (above) Same as uncontained material fire (above)</td>
</tr>
<tr>
<td>Combustible Dispersible</td>
<td>Deflagration of drum</td>
<td>Release for the event is split into 3 components: 60% of the contents burn in the drum 40% of the contents ejected from the drum 5% of the ejected contents burns</td>
<td>5E-4/1.0</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Drum impacted (low energy impact); contents spilled</td>
<td>Contaminated, noncombustible solids.</td>
<td>1E-3/0.1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
</tbody>
</table>
### Table 3-23. Release Fraction Data for Area G Accidents

<table>
<thead>
<tr>
<th>Material Form</th>
<th>Release Mechanism</th>
<th>DOE-HDBK-3010 Basis</th>
<th>Bounding ARF/RF</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncombustible Dispersible</td>
<td>Drum impacted (low-energy impact); contents spilled</td>
<td>Contaminated, noncombustible dispersible material such as soil/ gravel, powder, and granules</td>
<td>6E-4/1</td>
<td>These values were taken from DOE-STD-5506-2007 and represent sand-like materials</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Drum impacted (high-energy impact, &gt; 35 mph); contents spilled</td>
<td>Contaminated, noncombustible dispersible material such as soil/ gravel, powder, and granules</td>
<td>1E-3/1</td>
<td>These values were taken from DOE-STD-5506-2007 and represent sand-like materials</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Waste material spills or is ejected from drum and burns (uncontained)</td>
<td>Contaminated, noncombustible solids [DOE 2007, pg 5-5]</td>
<td>6E-3/1E-02</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Fire causes drum lid seal failure; waste material burns in drum (contained)</td>
<td>Contaminated, noncombustible solids [DOE 2007, pg 5-5]</td>
<td>6E-3/1E-02</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Drum bursts lid in fire and expels contents</td>
<td>Release for the event is split into 3 components:</td>
<td></td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Dispersible</td>
<td>Deflagration of drum</td>
<td>Release for the event is split into 3 components:</td>
<td></td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Drum impacted (low-energy); contents spilled</td>
<td>Contaminated, noncombustible solids, nondispersible</td>
<td>7.0E-05/1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
</tbody>
</table>
Table 3-23. Release Fraction Data for Area G Accidents

<table>
<thead>
<tr>
<th>Material Form</th>
<th>Release Mechanism</th>
<th>DOE-HDBK-3010 Basis</th>
<th>Bounding ARF/RF</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Drum impacted (high-energy &gt; 35 mph); contents spilled</td>
<td>Contaminated, noncombustible solids, nondispersible</td>
<td>7.0E-04/1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Waste material spills or is ejected from drum and burns (uncontained)</td>
<td>Contaminated, noncombustible solids nondispersible</td>
<td>1.0E-06/1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Fire causes drum lid seal failure; waste material burns in drum (contained)</td>
<td>Contaminated, noncombustible solids nondispersible</td>
<td>1.0E-06/1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Drum bursts lid in fire and expels contents</td>
<td>Release for the event is split into 3 components:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2/3 of the contents burn in the drum (pg 5-1)</td>
<td>1.0E-06/1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/3 of the contents is subject to shock/impact during ejection</td>
<td>7.0E-05/1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remaining ejected waste burns outside the drum</td>
<td>1.0E-06/1</td>
<td></td>
</tr>
<tr>
<td>Noncombustible Nondispersible</td>
<td>Deflagration of drum</td>
<td>Release for the event is split into 3 components:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60% of the contents burn in the drum</td>
<td>1.0E-06/1</td>
<td>These values are consistent with DOE-STD-5506-2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% of the contents ejected from the drum</td>
<td>7.0E-05/1</td>
<td>Same as waste burning in drum (above)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5% of the ejected contents burns</td>
<td>1.0E-06/1</td>
<td>Same as impact/spill (above)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remaining ejected waste burns outside the drum</td>
<td>1.0E-06/1</td>
<td>Same as uncontained material fire (above)</td>
</tr>
</tbody>
</table>

LPF

The LPF defines the efficiency with which airborne contaminants that are generated as a consequence of a postulated accident are transported to the environment. It represents the fraction of the airborne contaminants that are transported out of the confinement (e.g., building) to the environment. Because of the nature of most Area G operations, and the lack of confinement provided by the fabric dome design of most Area G facilities, no deposition, no plate-out within a facility, and no HEPA filtration are assumed for these operations. Thus the LPF is assumed to be 1.0 for all accident scenarios.
3.4.1.3 Dispersion and Consequence Calculations

The dose consequence is the product of the ST multiplied by the dose-to-source term (DST) scaling factor (DSF).

\[
\text{Dose (rem)} = \text{ST (PE-Ci)} \times \text{DSF (rem/PE-Ci)}
\]

The doses for a 1 PE-Ci release (DSF) are determined according to the following equation:

\[
\text{DSF} = (\text{DCF}) \times (\text{breathing rate}) \times (\chi/Q_{95\%})
\]

Where:

\[
\text{DSF} = \quad \text{DST scaling factor; the DSF is normalized to } ^{239}\text{Pu}
\]

\[
\text{DCF} = \quad \text{Dose conversion factor} = 5.0 \times 10^{-5} \text{ Sv/Bq for } ^{239}\text{Pu} = 5.0 \times 10^{-5} \text{ Sv/Bq} \times 3.7 \times 10^{10} \text{ Bq/Ci} \times 100 \text{ rem/Sv} = 1.85 \times 10^{8} \text{ rem/PE-Ci (Type M). For tritium releases (tritium oxides as}} \\
\text{water vapor), the DCF is } 1.8 \times 10^{-11} \text{ Sv/Bq} \times 3.7 \times 10^{10} \text{ Bq/Ci} \times 100 \text{ rem/Sv} = 6.66 \times 10^{1} \text{ rem/Ci}
\]

\[
\text{BR} = \quad \text{Breathing rate (m}^3/\text{sec)} = 3.33 \times 10^{-4} \text{ m}^3/\text{s (recommended value from DOE-STD-5506-2007 [DOE 2007])}
\]

\[
\chi/Q_{95\%} = \quad \text{Plume-centerline dilution factor (sec}/m^3). \text{ Several factors are calculated in SB-DO:CALC-08-060, } \text{Atmospheric Dispersion Analysis for TA-54, Area G and RANT [LANL 2009c]}
\]

Four release points were evaluated for the Area G AA to provide conservative results with respect to the site boundary while keeping the number of required MACCS2 runs within reason. The release locations were selected to define a single release point for accidents involving one or more structures or outdoor locations in the same general area. Releases from an accident at (or further from the site boundary than) TA-54-412, the trenches, and the tritium sheds (e.g., SSSR, Storage, Retrieval, or Tritium Area) are analyzed using \(\chi/Q_{95\%}\) and DSF values calculated specifically for those locations. Dome 54-33 is specified as the default release location for accidents that could occur elsewhere, as it bounds all the other locations (minimum distance to site boundary). The analysis worksheets in Appendix 3C identify the specific DSF values and associated release locations for each DBA. Collocated worker doses are also calculated and use DSF values from \(\chi/Q_{95\%}\) values for points 100 m away from a release point.

DOE-STD-5506-2007 is prescriptive on the use of a 3-cm surface roughness parameter in the dispersion analysis. However, the standard allows for the use of an alternate surface roughness parameter if approved by the DOE Approval Authority. For the LANL environs, a 38-cm surface roughness parameter has been approved for use by the Los Alamos Site Office [NNSA 2010]. Therefore, unmitigated consequence analysis in the AA uses \(\chi/Q_{95\%}\) values derived from a 38-cm surface roughness parameter. Control selection is based on the dose consequences using the 38-cm surface roughness \(\chi/Q_{95\%}\) values.

The dispersion analysis in SB-DO:CALC-08-060 presents a parametric study to investigate \(\chi/Q_{95\%}\) values from the variation in dispersion parameters (plume meander, wake effects, and building height). From the parametric study, the bounding applicable \(\chi/Q_{95\%}\) values were used to calculate DSF values. The bounding DSF values used in the AA are shown in Tables 3-24 and 3-25. Table 3-24 shows the DSF with plume meander effects based on a 20-min release duration. Table 3-25 gives the DSF for spills, which assumes a
3-min release duration and does not include plume meander. The DSF values for tritium include a factor of 1.5 applied to the inhalation DCF to account for the dose from skin absorption.

**Table 3-24. Fire Release Dose to Source Term Factor (DSF; rem/PE-Ci)***

<table>
<thead>
<tr>
<th>MACCS Release Point</th>
<th>Public With Deposition</th>
<th>Collocated Worker With Deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>χ/Q95%</td>
<td>DSF</td>
</tr>
<tr>
<td>TA-54-033 TRU Releases</td>
<td>5.93E-04</td>
<td>36.5</td>
</tr>
<tr>
<td>TA-54-412 TRU Releases</td>
<td>5.14E-04</td>
<td>31.7</td>
</tr>
<tr>
<td>TA-54 Tritium Sheds Tritium Releases</td>
<td>4.36E-04</td>
<td>1.45E-05</td>
</tr>
<tr>
<td>TA-54-Trench TRU Release</td>
<td>1.56E-04</td>
<td>9.61</td>
</tr>
</tbody>
</table>

*Tritium units in rem/H3 Ci. Tritium dispersion is without deposition.

**Table 3-25. Spill Release Dose to Source Term Factor (DSF; rem/PE-Ci)**

<table>
<thead>
<tr>
<th>MACCS2 Release Point</th>
<th>Public With Deposition</th>
<th>Collocated Worker With Deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>χ/Q95%</td>
<td>DSF</td>
</tr>
<tr>
<td>TA-54-033 Releases</td>
<td>8.66E-04</td>
<td>53.3</td>
</tr>
<tr>
<td>TA-54-412 Releases</td>
<td>7.51E-04</td>
<td>46.3</td>
</tr>
<tr>
<td>TA-54- Trench Releases</td>
<td>2.28E-04</td>
<td>14.0</td>
</tr>
<tr>
<td>TA-54-033 High Wind (30 m/s) Releases</td>
<td>2.84E-05</td>
<td>1.75</td>
</tr>
</tbody>
</table>

3.4.1.4 Control Selection

**Control Selection in the AA**

A principal objective of the AA is to identify the requirement for safety-class designation of the controls selected in the CHA, identify the conditions to which the controls will be exposed, and define the functional requirements for safety-class-level control for protection of the public. The AA (along with the HA) also defines a safe operating envelope for the facility against which new facility operations or modifications can be assessed via the USQ process.
Safety-class SSCs or SACs are identified by determining the consequences of unmitigated accidents and determining if the results challenge or exceed the EG. For accidents that challenge or exceed the EG, credit is then taken for SSCs and SACs to either reduce the frequency of the accident or mitigate the consequence (dose) of the event. These SSCs or SACs are then designated as safety-class, requiring them to be addressed by corresponding TSRs.

The controls selected in the AA are from those controls identified in the CHA and are those that either provide full bin reduction in the frequency or consequence of the analyzed accident, or protect the initial conditions or assumptions of the analysis.

In the discussion of controls in the DBAs, prevention or frequency reduction of a hazard by an engineered control is always the preferred option. However, the implementation and maintenance of a TSR engineered control, balanced against the limited lifetime of Area G, has resulted in the selection of SACs or a combination of SMPs to eliminate a hazard. While these are not engineered controls, a SAC or SMP that eliminates the hazard is considered an effective control (i.e., it prevents the event). SMPs are not credited for risk reduction for accidents with high unmitigated consequences to the public. When a single AC has been selected in lieu of an SSC, or when an SSC is not available, guidance in DOE-STD-1186-2004, *Specific Administrative Controls* [DOE 2004], is used to identify if an AC should be treated as an SAC.

A summary of the safety-class SSCs, SACs, and TSR controls identified for each DBA is included in Section 3.4.2.X.5 of each DBA.

### 3.4.1.5 Assumptions and Sensitivities

Input data and assumptions for the TA-54, Area G facility used in this BIO were obtained from the TA-54, Area G Safety Basis Group, facility personnel, and BIO team members. The following assumptions form the basis for the analyses and conclusions of accident analyses. Assumptions that can be controlled by the facility include those that have the potential to significantly affect the consequence or frequency values determined by the AA (e.g., inventories, process variables). Where applicable, the justification and/or sensitivity of the assumptions is discussed.

The following general assumptions were used in the hazard analysis and AA to form the basis for the analyses and resulting controls. Assumptions specific to the type of accidents and release mechanisms are provided below, and also identified as necessary in their respective DBAs in Section 3.4.2.

#### 3.4.1.5.1 MAR Assumptions

**Full Facility Inventory MAR**

- The MAR for Area G is as follows:
  - 57,000 PE-Ci (above-ground TRU waste inventory) distributed as follows:
    - 53,500 PE-Ci (compliant [metal] containers)
    - 2,000 PE-Ci (non-metal above-ground TRU)
    - 1,500 PE-Ci (non-metal retrieved below-ground containers)
    - 100 PE-Ci (LLW)
    - 4,000,000 Ci (tritium)
This is reasonably conservative, as it bounds the current inventory at Area G. The analysis is not overly sensitive to this inventory distribution, because the inventory is so large that changing the distribution does not result in significant changes to the total dose.

**Waste Distribution for Large-Scale Events**

During the analysis of the DBAs for TA-54, Area G, one of the assumptions made is that for large-scale events (e.g., events involving storage arrays or larger), the MAR is equally distributed amongst the containers involved. An example is that, for a storage array stacked 3 tiers high, one-third of the MAR is located on the top tier. This assumption allows the analysis to be simplified by essentially equating some percentage of the MAR to be equivalent to the same percentage of containers (i.e., 25% of the MAR is equal to 25% of the containers). This assumption is judged to be reasonably conservative due to the nature of the process and the random arrangement of the containers. It should be noted that some high–FGE containers are required by Nuclear Criticality Program representatives to be isolated and stored in one location. However, the required spacing between the high-FGE containers and their isolation limit their involvement in accident scenarios. Therefore, the storage of these particular containers does not invalidate the statistical analysis.

**Truck MAR**

The large transport vehicle contains a stake bed upon which TRU waste containers are placed. The configuration of the stake bed precludes the ability to stack TRU waste containers during their transport, thus limiting the total number of drums that can be carried on the truck to 48. The analysis is not very sensitive to this assumption. Because of the methodology prescribed for MAR determination given in DOE-STD-5506-2007 [DOE 2007], any metal container past the fourth container only adds 4.84 PE-Ci to the total MAR. Therefore, the analysis of additional containers will result in an almost negligible increase in consequences.

The transport truck can also carry up to 2 FRPs. Based on the AGTRU MAR statistics for non-compliant (metal and non-metal) containers (Table 3-16), and the methodology outlined in Table 3-18 for the bounding MAR limits for two containers, the truck can carry up to 615 PE-Ci in non-metal containers. This value is used to establish the Transport MAR limit for non-metal containers, and applies to any non-metal container (Above-Ground TRU or Pit 9).

**Maximum Compliant (Metal) Container MAR on Single Transportation Vehicle**

The MAR of 1,100 PE-Ci in compliant (metal) containers is consistent with the limit in the currently approved Area G Safety Basis, and is the current maximum for a single vehicle on-site transportation activity.

**TA-54, Area G Domes**

The domes at TA-54, Area G are assumed to offer no protection to the TRU waste stored in Area G. The Area G domes have been in place longer than their life expectancy and have experienced some degradation (e.g., torn panels). Due to this degradation and utilization well beyond the design life expectancy, it is assumed that the domes will offer no protection from flying debris during high-wind events. In addition, it is assumed that these domes will collapse during the analyzed seismic event. Since the Area G domes are classified as structures of light construction, this collapse will have no impact on compliant (metal) containers; however, FRPs are susceptible to damage from debris from the collapse of the domes. Any protection or resistance to collapse that the domes do offer will reduce the consequences of the event.
Single-Container Event MAR

For single-container event scenarios, the highest MAR container is assumed to be involved in the facility activities (Characterization). This is in accordance with DOE-STD-5506-2007 [DOE 2007] guidance. The consequences of the event would then provide conservative release values.

Remote-Handled Shafts MAR

Remote-Handled shafts contain less than or equal to 150 PE-Ci. Based on Area G Material Inventory records, this is the MAR value for the worst-case remote handled shaft. Based on this MAR value, the only unique events for the remote-handled waste are direct radiation exposure events.

Non-certified Sealed Sources

Releases from non-certified sealed sources packaged in a POC are bound by the worst-case TRU waste container. The POCs provide robust containment of non-certified sealed sources (i.e., laboratory–made radiological sources) as packaged in specifically designed waste drums. In accordance with DOE-STD-5506-2007, a POC provides substantial confinement compared to a standard waste container. The PE-Ci values for the sealed sources contained in this configuration are bound by the highest MAR TRU waste container. Therefore, there are no event scenarios that specifically identify sealed sources in POCs. For conservatism, all sealed sources that are not packaged in a POC will be tracked and counted against the site MAR limits for TRU waste.

Release of Tritium

The only method to release tritium from a matrix requires extended exposure to high heat. Release mechanisms other than fire do not release tritium from the matrix. Potential mechanisms to release tritium mechanically from a binding matrix do not exist within Area G. Therefore, only the fire event scenarios that postulated the releases of tritium were considered.

Process Areas

Closed TRU waste container activities, such as NDA/NDE, may be performed in the process areas. These areas include the characterization trailers and the HE-RTR. The characterization trailers are of light construction and would impart a low impact to containers given a collapse, as from a seismic event. However, the HE-RTR is housed in a vault and a seismic collapse would be expected to impart a high impact to containers within the vault or in the immediate vicinity. Consequently, for the HE-RTR the process area MAR limit applies to the vault and to an area within 20 ft of the vault.

3.4.1.5.2 Fire Event Assumptions and Sensitivities

Many of the DBAs selected for AA could involve either non-metal containers (e.g., FRPs) or compliant (metal) containers (drums). A different set of MARs and DRs apply to non-metal containers versus compliant (metal) containers. In addition, non-metal containers have different waste compositions that affect the ST calculation through application of the appropriate ARF × RF values to the various waste-composition components (i.e., combustible, dispersible noncombustible, and non-dispersible noncombustible). To assist in the determination of which type of container and waste composition would yield bounding results, a sensitivity study was performed for various accident types as shown in Table 3-26. Dose results are based on 1 PE-Ci MAR, allowing scale-up for varying MAR values, and on the public DSF that corresponds to a 38-cm surface roughness specific to the LANL environs.
### Table 3-26. Consequence Sensitivity Study on Container Type and Waste Composition

<table>
<thead>
<tr>
<th>Accident Type</th>
<th>Compliant- (metal) Container</th>
<th>Non-metal Container</th>
<th>All-Container Composition³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compliant- (metal) Container Composition</td>
<td>BGTRU Pit 9 Container Composition</td>
<td>100% BGTRU Composition</td>
</tr>
<tr>
<td>Compressible Fire¹</td>
<td>5.89E-04</td>
<td>5.08E-03</td>
<td>2.21E-03</td>
</tr>
<tr>
<td>Fuel Fire²</td>
<td>8.46E-04</td>
<td>6.33E-03</td>
<td>2.21E-03</td>
</tr>
<tr>
<td>Moderate Impact</td>
<td>3.34E-04</td>
<td>4.85E-04</td>
<td>5.33E-03</td>
</tr>
<tr>
<td>Comb. Fire w/Moderate Impact</td>
<td>1.85E-03</td>
<td>1.32E-02</td>
<td>7.88E-03</td>
</tr>
<tr>
<td>Fuel Fire w/Moderate Impact</td>
<td>2.16E-03</td>
<td>1.92E-02</td>
<td>7.88E-03</td>
</tr>
<tr>
<td>High Impact</td>
<td>3.48E-02</td>
<td>6.02E-02</td>
<td>5.34E-02</td>
</tr>
<tr>
<td>Comb Fire w/High Impact</td>
<td>4.46E-02</td>
<td>1.42E-01</td>
<td>5.59E-02</td>
</tr>
<tr>
<td>Fuel Fire w/High Impact</td>
<td>4.46E-02</td>
<td>1.42E-01</td>
<td>5.59E-02</td>
</tr>
</tbody>
</table>

1 For combustible fire, a DR = 1.0 is assumed based on <10 drums. A DR = 0.5 may be applied for > 10 drums (compliant [metal] containers) that would half the values shown here.

2 For fuel fire, compliant (metal) drums assumed to be stacked three high and MAR equally distributed among three tiers. Stacking is not a factor for other cases as long as stacks are not more than three high.

3 Results shown for all container composition are based on DRs applicable for compliant (metal) containers, including those associated with drums being stacked three high in the fuel fire analysis.

Some general observations are made:

- For the same MAR, the consequences are higher with non-metal containers than with compliant (metal) containers.
- The consequences are highest with the below-ground waste composition when only moderate-impact stresses are involved, and highest with above-ground waste composition in the other events.
- For combustible and fuel fire events (that do not involve impact stresses), consequences are similar (within a factor of two) between compliant (metal) and non-metal containers.

### Waste Composition Effect on Bounding Consequence Calculation

For most events, the MAR is different depending upon whether compliant (metal) or non-metal containers are involved, and must be considered in determining which combination of MAR, type of container, and waste composition will yield bounding results.

- The transport truck can carry up to 48 drums (up to 864 PE-Ci, which includes the four statistically high drums) or two FRPs (up to 475 PE-Ci, which includes the two statistically high FRPs) from above grade. The transport vehicle MAR limits are 1,100 PE-Ci for metal containers and 615 PE-Ci for non-metal containers.
For moderate-impact events (not including those accompanied with a combustible fire or fuel fire), the consequences with the non-metal containers (FRPs) bound those with compliant (metal) containers. For these events, the higher consequence per unit MAR with the non-metal containers has a larger effect than the increased MAR with the compliant (metal) containers.

The opposite holds true for all other events. For all other events (including those accompanied with a combustible fire or fuel fire), the consequences with compliant (metal) containers (drums) bound those with non-metal containers. For these events, the increased MAR with the compliant (metal) containers has a larger effect than the higher consequences per unit MAR with the non-metal containers.

Other impact events involve a vehicle collision with either 48 drums in the storage array (up to 864 PE-Ci that includes the four statistically high drums) or equivalently six FRPs (up to 855 PE-Ci, which includes the two statistically high FRPs). The consequences are higher with those involving the non-metal containers (FRPs) for moderate-impact events (including those with a combustible fire), and combustible fire events. All fuel pool events and high-impact events (including those accompanied with a combustible fire or fuel fire) have higher consequences when the compliant (metal) containers (drums) are involved.

### Fire in Non-metal Storage Area

Any fire in a non-metal container storage area will spread to involve all containers in a non-metal storage array (2,000 PE-Ci).

### Drums Stacked Three High

The normal configuration for compliant (metal) containers at TA-54, Area G is storage arrays stacked three tiers high. For pool fire accident scenarios that involve compliant (metal) containers in storage arrays, this configuration is expected and utilized in the model for containers that have not been impacted. Only top-tier waste containers can experience lid loss and ejection of waste, and all lower-tier containers will experience seal failure and confined burning of TRU waste. Increasing the number of tiers reduces the number of containers that can experience lid loss and ejection of waste, which is the major dose contributor for pool fire events. The analysis is sensitive to this assumption.

### Non-metal Container Stacking

Non-metal containers (FRPs, crates) in a storage array involved in the pool fire are assumed to be in a three-high stacked array, except in Pit 9, where they may be stacked five high or higher.

### Fuel Pool Fire, 100-Gal Fuel Spill

A fuel pool fire from a 100-gal fuel spill involves several hundred drums. The number of drums is based on a model using aisle spacing that is conservative with respect to RCRA requirements. The consequences of such a fire bound a fuel pool fire in a non-metal storage area.

### Unmitigated Fuel Pool Fire Events

For unmitigated fuel pool fire analyses, it is assumed that there is enough fuel spilled to engulf the entire waste storage array in the pool fire. This is conservative in that it analyzes the maximum possible MAR for the unmitigated event. The unmitigated analysis is sensitive to this assumption. Decreasing the MAR
impacted by the fuel pool will reduce the unmitigated consequences. The mitigated MAR and associated controls are not sensitive to this unmitigated assumption.

**Fuel Pool Fire Size**

The mitigated analysis assumes that the fuel pool occurs on a smooth, flat surface that allows the pool to spread out so that it has the largest pool area possible. The reality of Area G is that most of the roads are gravel and the storage areas are asphalt. This assumption is conservative in that it allows for the largest pool area, and thus the largest number of containers engulfed by the pool fire. The analysis is sensitive to this assumption in that a thicker liquid layer and the absorbent nature of the grounds at Area G will minimize the area of the pool, and thus the number of containers that are engulfed by the pool fire.

**Fuel Pool Fire Thickness**

A fuel pool thickness of 0.15 in. was used to determine the fuel pool size (SB-DO:CALC-12-001, Rev. 0 [LANL 2012b]). The 0.15-in. thickness allows for the pool fire to burn a minimum of 70 sec to initiate fires and/or lid ejection in involved drums. A lower pool thickness would result in a larger pool size and higher MAR; however, the shorter duration of the pool fire would then not cause lid ejection for the upper tier (DOE-STD-5506-2007 [DOE 2007]) and would therefore result in lower consequences. Conversely, increasing the fuel pool thickness will reduce the MAR involved. The analysis is sensitive to the fuel pool thickness.

**Small Quantities of Flammable Liquids**

Small amounts of flammable or combustible liquids may be stored and used within a defined area. A total of up to seven gal of combustible or flammable liquids is considered to be a necessary working volume within a single defined area. The basis for a 7-gal *de minimus* limit for flammable and combustible liquids is discussed in Section 3.3 and is less than NFPA 5000 [NFPA 2009] requirements for maximum allowable quantities of hazardous materials. The maximum allowable quantity permitted by NFPA 5000 for a Class IA flammable liquid in an open container for a storage occupancy is 10 gal. A 7-gal limit is conservative. Small spills of flammable or combustible liquids (7 gal or less) are not expected to produce the steady-state burning conditions required to initiate confined burning of enough MAR to exceed offsite dose consequences, Section 3.3.

**Fire Propagation Across Closed Drums**

Fires will not propagate across non-flammable, closed TRU waste containers. Non-flammable TRU waste containers involved in fire events do not burn, nor do they support propagation to other non-flammable closed containers. A reduction in unmitigated frequency is credited, since closed non-flammable TRU waste containers reduce the likelihood for the propagation of small fires to large fires within a TRU waste compliant (metal) container storage array

**Liquid Fuel Spills – Surface Grading Around Storage Areas**

Liquid fuel spills flow away from waste storage areas. The RCRA permit (Chapter 2) requires that TRU waste be stored on elevated or bermed surfaces (i.e., asphalt, densely packed soil/ gravel pads) so that rainwater does not flow into them. This existing configuration may help to limit the consequences from pool fire events by directing flammable/ combustible liquid spills external to the storage areas away from stored TRU waste, but is not credited unless the berm or slope is qualified as a liquid impediment. RCRA-permitted waste storage areas are discussed further in Chapter 2 of the BIO.
Refueling Vehicle

The large refueling vehicle contains 2,000 gal of diesel fuel (in addition to 1,000 gal of unleaded gasoline). The GFE refueling vehicles that are used at the Laboratory could contain up to 5,000 gal; therefore, the CHA team concluded that 5,000 gal would be the maximum amount of fuel available for release for postulated event scenarios involving a large refueling vehicle.

Wildland Fire and Post-Seismic Fire Involving Full Facility Inventory

One of the events analyzed in the BIO is a wildland fire propagating to Area G. It was qualitatively determined that assuming that the entire facility inventory is involved in the accident would be conservative based on the physical layout and characteristics of Area G (spacing between domes, dirt and gravel surface), and the non-combustible metal containers and pallets. Conversely, it would be non-conservative to discount all of the metal containers. However, the accident analysis assumes that all of the MAR is involved in the fire.

3.4.1.5.3 Deflagration Event Assumptions and Sensitivities

Unvented Containers

In general, above-ground drums are compliant (metal) and passively vented. Unvented containers can be retrieved from underground burial or may be found within the above-ground storage area for legacy containers. Unvented drums are isolated from the general population and are sampled during or after venting.

Deflagration of Unvented Drums

Normal handling of an unvented drum does not cause a spontaneous deflagration unless a spark is introduced into the flammable gas mixture within the drum. This assumption is based on studies cited in DOE-STD-5506-2007 [DOE 2007] that indicate that a spark is required for a deflagration to occur within a flammable gas headspace. DOE-STD-5506-2007 cites the results of Idaho National Lab (INL) drum deflagration tests, which involved a drum with a flammable gas mixture that fell from 12 ft, rotated a complete 180° upon impact with a hard unyielding surface, and did not deflagrate. Another test drum was impacted with a drill bit and did not deflagrate. The test drums that deflagrated required a soft or hard spark (20 mJ or 5 J).

MAR in Single Drum Deflagration

For deflagration events that involve a single container, the MAR is assumed to be 553 PE-Ci, which is the maximum single container inventory. Also, all above-ground (AGTRU) waste has been sufficiently characterized so that an additional 20% uncertainty is not required. For below-ground (BGTRU) waste, an extra 20% is added to the maximum container MAR, per DOE-STD-5506-2007 [DOE 2007]. This assumption is bounding and extremely conservative. The maximum largely combustible container is 621 PE-Ci from Trenches A-D.

For deflagration events that involve a single container, the material within the container is assumed to be 100% combustible. This assumption is bounding because the ARF × RF values of combustibles for all three release mechanisms in a deflagration (flexing in air, unconfined burn, and confined burn) are always equal to or greater than those of non-combustible/ dispersible and non-combustible/ non-dispersible waste forms.
MAR in Multiple Drum Deflagrations

For deflagration events that involve more than one container, the waste composition is represented by the waste matrix of the compliant (metal) type. The rationale for this assumption is based on the fact that the non-metal containers are not leak-tight, so they cannot accumulate enough flammable gases for deflagration.

Frequency of Deflagration of a Vented Container During Intrusive Sampling

DOE-STD-5506-2007 [DOE 2007] does not require the evaluation of vented drums being processed to meet the WIPP WAC for potential deflagrations (assumed to be Beyond Extremely Unlikely unless evidence indicates otherwise); however, this definition carries some conditions. If the condition of vented legacy containers is questionable (i.e., there is some evidence or suspicion of plugging), a deflagration frequency of Unlikely or even Anticipated would be appropriate. However, just because a vented container is legacy, that does not mean that it has a high deflagration potential; rather, that deflagration becomes more credible if there is obvious or suspected degradation or the potential for plugging because of the container’s origin.

Legacy drums that have not yet been evaluated for WIPP WAC certification compliance (e.g., determined to be free of liquids and other prohibited items via RTR), and with no obvious indication that they are suspect drums (e.g., plugged filters, bulging), are analyzed using the following accident frequencies, due to the possibility of vent plugging allowing buildup of hydrogen or VOCs:

- Deflagration during intrusive sampling of vented drums – Unlikely
- Deflagration during handling/transport of vented drums – Unlikely
- Deflagration of vented drums while in storage – Extremely Unlikely

Sympathetic Drum Deflagration

The effect of a sympathetic drum deflagration is vertical. DOE-STD-5506-2007 [DOE 2007] defines a sympathetic deflagration as affecting a drum on top (vertically) of the initial deflagration. A horizontal sympathetic deflagration has not been observed.

Hydrogen Accumulation in Non-Metal Containers

The FRPs, cargo containers (SeaLand), and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs. The FRPs and SeaLand containers are constructed such that hydrogen or VOCs cannot accumulate, as these containers or structures are not sealed units. Either the concentration of any accumulated flammable gases is insufficient to sustain a fire or deflagration, or the influx of air dilutes any potential buildup.

MAR Characterization of TRU Waste Containers in Trenches A-D

In Trenches A-D, the TRU waste containers are placed in casks. Each of these casks contains two stacked waste containers. There is no statistical analysis for this waste. Also the material is not considered to be fully characterized, and a maximum MAR of 750 PE-Ci (which includes a 20% uncertainty) per container is assumed. In addition, the composition of the waste is conservatively assumed to be 100% combustible for deflagration events.
3.4.1.5.4 Loss of Confinement, Natural Phenomena, and External Event Assumptions

Low-Speed Vehicle Accident

Low-speed ($\leq 10$ mph) vehicle event scenarios with fire are considered Unlikely. This frequency assignment is based on DOT accident statistics [USDOT 2010]. A vehicle fire requires two separate events: (1) an accident, and (2) ignition of combustible materials.

Moderate-Speed Vehicle Accident with Pool Fire

Moderate-speed ($> 10$ mph, $< 35$ mph) vehicle event scenarios with pool fire are considered Extremely Unlikely. This frequency assignment was based on DOT accident statistics [USDOT 2010]. A vehicle accident with pool fire requires three separate events: (1) an accident, (2) rupture of the fuel tank, and (3) ignition of the fuel.

Storage Array Behavior during High-Energy Events

During events where there is a large mechanical insult to a storage array (e.g., high-energy impact, seismic event), it is assumed that all of the stacked containers will topple. This assumption maximizes the MAR that is available for release due to seismic events. In addition, this assumption maximizes the number of containers that are able to undergo lid loss and ejection of waste during a pool fire following high-energy impact events. A reduction in the number of stacked containers that collapse will reduce the consequences of the events.

MAR Impacted by Debris during High-Wind Events

During the high-wind event, it is assumed that twelve compliant (metal) containers, two current above-ground non-metal containers, two retrieved Pit 9 non-metal containers, and all exposed MAR in LLW Areas are impacted by wind-generated missiles. This is judged to be reasonably conservative based on the number of containers that are present at TA-54, Area G, the limited number of potential missiles, and the shielding that the impacted containers will provide for other containers. The LLW is primarily in Pits and Shafts that limit the exposure to high winds. The analysis is sensitive to this assumption, as increasing the MAR impacted by wind-generated missiles will proportionally increase the consequences.

Aircraft Accident

Frequencies of airplane crashes are based on actual airport flight patterns for airports within a 20-mile radius, based on DOE-STD-3014-2006 [DOE 2006b] and documented in Appendix 3E of this BIO. Based on the information in this calculation, the frequency of a large aircraft impact is less than 1E−06/yr. Therefore, the bounding analysis is based on a general aviation aircraft with a frequency slightly larger than 5E-06/yr.

The aircraft impact event assumes that a small single-engine aircraft impacts a single storage array of compliant (metal) containers. Compliant (metal) containers were determined to be the bounding container type due to the quantity of MAR impacted by the aircraft. With the fraction of MAR that undergoes a high-energy impact with catastrophic container failure during the aircraft accident, and the waste composition of compliant (metal) containers, the dose from the compliant (metal) container is over twice as high as the dose from either the total of non-metal containers currently in above-ground storage or retrieved from Pit 9. Due to the small size of the aircraft assumed to impact the storage arrays, it is not expected to impact multiple storage arrays. The control selection is not sensitive to this assumption.
The number of containers that are involved in the accident will be determined based on an inelastic collision between the airplane and the containers. The plane will lose speed as it penetrates the array and transfers energy and momentum to the impacted containers. The aircraft is assumed to directly impact the drum array, with the momentum of the aircraft being used to determine the number of drums that are impacted. This analysis assumes that the aircraft is fully fueled, at full takeoff weight, and impacts the storage array at maximum cruising speed. These assumptions provide a reasonably conservative estimate of the number of containers that are impacted.

Characteristics of small single-engine aircraft span a wide range of weight, airspeed, and fuel capacity. To align with the aircraft crash frequency estimate, the aircraft selection was based on the abundance of particular models. Of all the single-engine light aircraft registered in the U.S., the two most common are the low-wing Piper PA-28 Cherokee and the high-wing Cessna 172 Skyhawk, with tens of thousands of registered planes of each of these models. Both of these aircraft have been manufactured for more than 50 years, with later versions being slightly heavier, faster, and having larger fuel capacity than earlier models. Maximum cruising speed for later models of both aircraft is 142 mph (63 m/s). The specifications for a Cessna 172R will be used in the determination of impact energy and fuel pool fire size, due to its slightly greater maximum takeoff weight (1111 kg) and fuel capacity (56 gal). Based on the information in DOE-STD-5506-2007 [DOE 2007], the energy required to breach the drum can be determined. The energy requirements can be broken down into three impact levels, with different damage ratios and ARF × RFs for each level. Impact energies were determined based on fall heights of 13.67 ft and 4 ft. These energies were converted into their corresponding velocities just before impact. For a fall height greater than 13.67 ft, a high-energy impact is appropriate; and for a fall height between 4 ft and 13.67 ft, a low-energy impact is appropriate. No damage will result from a container that is dropped less than 4 ft. The equation below was used to convert the potential energy from a drop height into its corresponding velocity just before impact. This equation was based on conservation of energy that kinetic energy equals potential energy.

\[
\nu_{\text{impact}} = \sqrt{2gh}
\]

where,

\[
\nu_{\text{impact}} = \text{velocity just before impact (m/s)}
\]

\[
g = \text{acceleration of gravity} = 9.8 \text{ m/s}^2
\]

\[
h = \text{fall height}
\]

Solving the above equation for the drop heights of 13.67 ft and 4 ft yields velocities just before impact of 9.04 m/s and 4.89 m/s, respectively. Appendix C of DOE-STD-5506-2007 shows that for impacts greater than 35 mph (15.64 m/s), the container experiences catastrophic stress, DR = 1.0, and an ARF × RF for a high-energy impact. Therefore, the three impact velocities of concern are 15.64 m/s, 9.04 m/s, and 4.89 m/s.

An aircraft impacting into the drum array is considered to be an inelastic collision because, upon impact, the aircraft is expected to deform, break apart, and press into the array, as opposed to the aircraft bouncing off the array like a rubber ball. As such, conservation of momentum requires that the initial momentum of the aircraft equal the final momentum of the aircraft plus that of the impacted drums. This is expressed as:

\[
m \times \nu_i = (m + M) \times \nu_f
\]

where,

\[
m = \text{mass of aircraft and drums already impacted}
\]
\(v_i = \text{initial velocity before impact}\)
\(M = \text{mass of drums impacted}\)
\(v_f = \text{velocity of aircraft plus drums after impact}\)

An airspeed of 63 m/s will be assumed for the available impact energy. It is assumed that the average mass for a 55-gal container is 127 kg. For this analysis, an initial aircraft mass of 1111 kg will be used. Using an initial mass of 1111 kg, an initial velocity of 63 m/s, and a final velocity of 15.64 m/s, the above equation was solved for the mass of containers, \(M\). This is the required mass of containers needed to slow the airplane to 15.64 m/s. This value was equal to 3365 kg. Dividing by the mass of a container of 127 kg and rounding up gives 27 containers. Next, using an initial mass of 5115 kg \([= 1111\text{kg} + 3365\text{kg}]\), an initial velocity of 15.64 m/s and a final velocity of 9.04 m/s, the above equation was once again solved for the mass of containers, \(M\). This is the required mass of containers needed to slow the airplane to 9.04 m/s. This value was equal to 3268 kg. Dividing by the mass of a container of 127 kg and rounding up gives 26 containers. Next, using an initial mass of 7742 kg \([= 1111\text{kg} + 3365\text{kg} + 3268\text{kg}]\), an initial velocity of 9.04 m/s and a final velocity of 4.89 m/s, the above equation was once again solved for the mass of containers, \(M\). This is the required mass of containers needed to slow the airplane to 4.89 m/s. This value was equal to 6571 kg. Dividing by the mass of a container of 127 kg and rounding up gives 52 containers. Therefore, from the impact of the airplane, 27 containers will experience a high-energy impact with a DR = 1.0; 26 containers will experience a high-energy impact with a DR = 0.1; and 52 containers will experience a low-energy impact with a DR = 0.01. Additional containers that cause the airplane to slow from 4.89 m/s to zero result in a DR = 0.0.

**Effect of Seismic Event in Process Areas**

Process areas are defined areas where activities involving closed containers may be performed. The process areas include the characterization trailers and the HE-RTR where NDA/NDE activities are conducted. The characterization trailers are light construction and seismic collapse would result in low impact to the containers. However, seismic collapse of the HE-RTR would result in a high energy impact to waste within the HE-RTR vault and staged immediately outside of the building. The process is such that only a few containers are expected to be at risk. A building collapse onto a small number of containers as a result of a seismic event has a DR of 1.0 for a substantially constructed (reinforced concrete) building per Section 4.5.3.2 in DOE-STD-5506-2007. Table 4.5-1 of DOE Standard 5506-2007 recommends a bounding ARF x RF for high impact events of 2.0E-03. However, an alternative ARFxRF is also endorsed in Section 4.5.3.2 of DOE-STD-5506-2007 which states:

“It is recognized that the new approach for evaluating severe seismic stresses produces similar results to the traditional approach in DOE-HDBK-3010-94. Accordingly, use of the original DOE-HDBK-3010-94 basis for an ARF*RF of 1E-4 coupled with a damage ratio of 1.0 is also acceptable. This approach may also be extended to drums that will clearly be buried under a significant amount of debris as discussed in DOE-HDBK-3010-94, or drums stored outside of facilities.”

The paragraph cited above acknowledges that an ARFxRF of 1.0E-04 with a 1.0 DR produces a similar release as applying an ARFxRF of 2.0E-03, but with a 0.1 DR from DOE-STD-5506-2007 Table 4.4.5-1 for collapse of a substantial construction structure, i.e., 2.0E-04 for the ARF*RF*DR. Based on the HE-RTR construction, which would generate substantial debris, the above recommendation is applicable to the HE-RTR vault.

Review of DOE-HDBK-3010-94 proves justification for the use of an ARF x RF of 1.0E-4 for seismic collapse of the HE-RTR affecting a single or couple of waste containers.
The bounding ARF x RF value of 2.0E-3 found in Table 4.5-1 of DOE-STD-5506-2007 is based on DOE-HDBK-3010-94 (Vol. 1), Section 4.4.3.3.2 for Large Falling Object Impact or Induced Air Turbulence. The value of 2.0E-3 is from experiments in which rocks were dropped on various types of particles, including sand, Al₂O₃ and nickel. The conservatism in this recommendation is noted as follows: *this value is a factor of 5 greater than the largest measured value and a factor of 25 greater than the median.* Of the six cited experiments, four involved loose powders that had no containment. The discussion acknowledges that the experiment may not be representative of seismic collapse that may generate larger amounts of debris and in which debris may be dropped from a greater height. However, as noted, as the debris size increases, the impact effect is less likely to be fully concentrated in one area, and debris will provide cover for material that could limit releases.

Additional analysis is provided in section 4.4.3.3.2 of DOE-HDBK-3010-94 that focuses on the experimental data from the two experiments that used sand aggregates contained in steel quart cans without lids. The containment was observed to provide a significant reduction in the respirable release fraction. Section 4.4.3.3.2 of the Standard recommends an ARF of 1.0E-3 and an RF of 0.1 based on the highest ARF from the data set along with the largest RF. Section 4.4.3.3.2 concludes: *Accordingly, for powder held in cans failed by debris, an ARF of 1E-3 with an RF of 0.1 is assessed to be bounding.* The contained powders are more representative of the MAR for HE-RTR than uncontained powders. Example 7.3.10, Seismic Release, also considers powder and notes that the bounding ARF and RF values assessed for shock-impact on powder confinement are 1.0E-3 and 0.1, even if the confinement ultimately fails.

The DOE-HDBK-3010-94 Section 5.2.3.2 (page 5-20) recommends an ARF of 1.0E-3 with a RF of 0.1 for waste containers where combustible material is packaged in a reasonably robust container (e.g., drum) that fails due to impact*, and its summary recommendation on page 5-4 includes impaction by falling debris (shock-vibration induced by impact).

The bounding value for waste subject to brittle fracture, such as grout, given in Table 4.5-1 of DOE-STD-5506-2007 is greater than 1.0E-4 (i.e., 7.0E-4.) However, this value is recommended as a conservative value to be used in lieu of the calculation method provided in DOE-HDBK-3010-94, Section 4.3.3 for free-fall spill and impaction stress of brittle materials. The calculation method applies the following formula:

\[
ARF \times RF = (A)(P)(g)(h)
\]

where:

\[
ARF \times RF = (\text{Airborne Release Fraction})(\text{Respirable Fraction})
\]

\[
A = \text{empirical correlation, } 2E-11 \text{ cm}^3\text{per g-cm}^2/s^2
\]

\[
P = \text{specimen density, g/cm}^3
\]

\[
g = \text{gravitational acceleration, } 980 \text{ cm/s}^2 \text{ at sea level}
\]

\[
h = \text{fall height, cm.}
\]

This formula is applied to the conditions at the RTR. A bounding density for the concrete used in the roof of the HE-RTR is 2.40g/cm³, which corresponds to a strength of 6000 psi. This value is conservative because the estimated strength of the concrete in the HE-RTR ceiling is 2000 to 3000 psi. (VJ Technologies, 2010). The height of the HE-RTR vault is approximately 10 ft 8 in (325 cm). Application of these values to the recommended formula yields:
2E-11 cm³ per g-cm²/s x 2.40 gm/cm³ x 980 cm/s x 3257 cm = 1.5E-5

The calculation method is based on experiments that involved dropping uncontainerized brittle material upon an unyielding surface rather than impacting stationary material with debris. However, the experimental value clearly represents a bounding situation compared to the building collapse upon containerized material, because, according to the second law of thermodynamics, the kinetic energy of the falling debris will not be transferred to the impacted object with 100% efficiency. Also, the debris itself provides some containment and the container would absorb some of the energy of the falling debris. The Standard [DOE 2007] notes that use of this correlation to estimate the ARF x RF value is considered very conservative, and may be excessively so if large debris from substantial heights is considered.

Application of the calculation method recommended by DOE-HDBK-3010-94 [DOE 2000a] confirms that the use of an ARF x RF of 1.0E-4 bounds the value for waste subject to brittle fracture.

Effect of Seismic Event on FRPs

The seismic event analysis does not consider the toppling of FRPs as a release mechanism. This assumption is based on the information discussed in Appendix C of DOE-STD-5506-2007 [DOE 2007], where it is stated that SWBs, TDOPs, and TRUPACT II payloads are not expected to topple. Due to their similarity in size and shape to SWBs, FRP boxes are assumed to behave in a similar manner (i.e., not topple). Because the FRP boxes are not assumed to topple, the only release mechanism during the seismic event for the FRP boxes is the impact of debris. Since the domes are a structure of light construction, the compliant (metal) containers have a DR = 0.0, as stated in DOE-STD-5506-2007. Unlike compliant (metal) containers, the FRP boxes are susceptible to falling debris impact, and conservatively assumed to have a DR = 0.1 from falling debris. This assumed DR is consistent with the DR for compliant (metal) containers impacted by debris during a collapse earthquake of a building of substantial construction; this is the bounding DR for compliant (metal) containers, and is judged to be reasonably conservative when applied to FRP boxes. The analysis is not very sensitive to this assumption, since the dose is dominated by the contribution from compliant (metal) containers.

CMPs

Releases from CMPs are excluded from accident scenarios due to the nature of the CMP. The CMPs are 20–ft-long corrugated metal pipes filled with cemented TRU waste. Both ends of the CMP are sealed with a ~0.3 m-thick clean concrete cap. Because of the arduous path associated with any release from the CMPs, the physical characteristics of the CMPs, the curie content, and the low ARF x RF associated with grout, the CMPs are excluded from AA, as the consequences from accidents involving CMPs are negligible.

Natural Phenomena Event Frequency

The frequency of natural phenomena events is based on the return periods and magnitudes (e.g., ground acceleration, wind speed, etc.) defined by DOE-STD-1020 through -1023 [DOE 2002c, DOE 2002d, DOE 2002e, and DOE 2002f] or by site-specific evaluations [DOE 2002d].

3.4.1.5.5 General Assumptions

Vehicle Barriers

Safety-class vehicle barriers installed at high-risk locations are credited for preventing vehicles from impacting defined areas and the associated thermal separation distance at TA-54, Area G. The vehicle
barriers are designed to stop the heaviest vehicle found at Area G, a water truck weighing 150,000 lb and traveling 15 mph. The truck’s speed is limited by the escort required for a vehicle with greater than 100 gal flammable liquid fuel. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location. In addition to the safety-class vehicle barriers, other defense-in-depth vehicle barriers are installed along roadways running next to defined areas to reduce the potential for vehicle impacts.

**RCRA Spacing**

Since Area G is a TRU waste storage facility, it has to follow applicable regulations with regard to the storage of TRU waste. One of these regulations has to do with the way that the TRU waste containers are spaced, as prescribed by RCRA. The RCRA-required aisle spacing is 36 in., but the number of containers in the fuel pool fire is based on 28 in aisle spacing. Less spacing between the aisles will result in a larger number of containers within the fuel pool, and a higher dose.

**MACCS2 Assumptions**

For the TA-54, Area G BIO, several assumptions were incorporated into the MACCS2 DSF calculations. One of these assumptions is that all releases occur at ground level and are non-buoyant. This is due to the uncertainty associated with the condition and the behavior of the dome skin, as well as the uncertainties associated with fire sizes and sensible heats.

Even though the initiating pool fire theoretically lasts only 70 sec, MACCS2 analysis models the release as occurring within 20 min. Once ignited by the pool fire, the waste in the containers is assumed to burn, releasing the available MAR. Contained burns and large FRP fires could last multiple hours. The assumption of a 20-min release duration is conservative.

In addition to conservatism in using fire DSF values with no plume buoyancy, the methodology for the dispersion analysis in and of itself is conservative by a factor-of-4 minimum [DOE 2000a]. The factor-of-4 minimum is based on only one of several conservatisms in the methodology. The dispersion analysis uses a Gaussian plume modeling that assumes an ideal flat terrain, and does not consider a complex terrain such as that at LANL [LANL 2010c]. This results in a factor-of-2-to-10 increase in the standard deviations of the dispersion (σ_y and σ_z, with y representing the crosswind and z vertical) considered in the dispersion analysis, which is based on 1/(σ_y × σ_z). Other conservatisms in the methodology for the dispersion analysis result in additional conservatism in the dose consequences [LANL 2010c].

### 3.4.2 DESIGN BASIS ACCIDENTS

This section presents the analysis and control selection for each of the DBAs.

**3.4.2.1 DBA No 1A – AGTRU-1-025, Vehicle Accident with Fuel Pool Fire**

**3.4.2.1.1 Scenario Development**

This DBA involves a vehicle transporting multiple compliant (metal) TRU waste containers at > 10 mph and < 35 mph that impacts an SSSR Area. Staged TRU waste in closed containers is located in proximity to the open SSSR container that is in process. Fuel is leaked and ignited, resulting in a fuel pool fire encircling the transported and staged waste containers, and igniting the unconfined, in process, SSSR waste, and resulting in a release of radiological material. Waste containers in separate Storage Areas are
not impacted by the vehicle or affected by the pool fire. The CHA identified the unmitigated frequency of this DBA as Extremely Unlikely.

The SSSR area may include one or more staged containers, awaiting SSSR processing, but may not be collocated with a defined Storage Area.

The causes that could potentially result in this accident are:

- Inadequate road condition (e.g., erosion or potholes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering or brakes)

Assumptions

- ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis for containers on the transport vehicle and are considered bounding.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93%
- The SSSR activity involves a MAR of 18 PE-Ci (Equivalent Combustible) in process, unconfined, and up to that amount staged, in one or more closed containers, awaiting processing or removal of packaged waste from the SSSR processing area.
- MAR limits prohibit TRU waste Storage Areas within a dome or building that houses an SSSR Area.
- The SSSR MAR is 100% combustible.
- The truck MAR is the 1,100 PE-Ci limit, which is greater than the 48 compliant (metal) containers, including the four statistically high containers, based on the physical dimensions of the transport vehicles.
- The containers on the truck and those staged containers, awaiting SSSR processing, experience moderate to severe stress (DR = 0.1) from the impact, consistent with Table 4.4.4-1 of DOE-STD-5506-2007 [DOE 2007] for compliant (metal) containers.
- The truck releases 100 gal of fuel, which results in a fuel pool of 1,069.5 ft² (SB-DO:CALC-12-001, Rev. 0 [LANL 2012b]), engulfing all containers from the truck plus those staged or in-process in the SSSR area.
- Once the spilled fuel is consumed by the pool fire, the waste continues burning for the remainder of the 20-min duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.
3.4.2.1.2 Source Term Analysis

MAR

The unmitigated MAR for the event is determined as follows:

- Transport truck = 1,100PE-Ci
- SSSR MAR staged (closed containers) = 18 PE-Ci Equivalent Combustible
- SSSR MAR in process (unconfined) = 18 PE-Ci Equivalent Combustible

The total unmitigated MAR used in this analysis is 1,136 PE-Ci.

DR

DRs are considered for the MAR that is on the truck, and staged or in process in the SSSR area.

Truck:

- Spill from the initial impact, DR = 0.1
- Fire terms: spilled material burns unconfined, DR = 0.1
- Containers on the truck not breached by initial impact:
  Of the 90% of containers that did not expel waste due to initial impact.
  25% of the containers experiences lid ejection:
    1/3 of the contents experiences ejection
    - Flexing in air, DR = 0.25 × 0.33 × 0.9 = 0.07
    - Unconfined burning, DR = 0.25 × 0.33 × 0.9 = 0.07
      o Remaining waste burns confined, DR = 0.9 – 0.07 = 0.83

MAR staged in the SSSR area in closed containers, spilled by impact, DR = 1.0

MAR (staged and in-process) in the SSSR area which experiences unconfined burning, DR = 1.0

ARF × RF

The ARF × RF values for spill/flexing in air, confined burning, and unconfined burning for each of the waste types are shown in Table 3-28.
Table 3-28. DBA No. 1A – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 1.56E-02 PE-Ci
- Fires = 4.36E-01 PE-Ci

3.4.2.1.3 Consequence Analysis

Table 3-29 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The public DSF values for spills resulting from the initial impact and flexing in air is 4.63E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem/PE-Ci. These DSF values are based upon $\chi/Q_{95\%}$ values for a release from a location no closer to the site boundary than TA-54-412 (the nearest SSSR Area to the public). The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

Table 3-29. DBA No. 1A – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.56E-02</td>
<td>4.63E+01</td>
<td>7.23E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>4.36E-01</td>
<td>3.17E+01</td>
<td>1.38E+01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>1.45E+01</td>
<td>Total Collocated Worker Dose</td>
<td>1.42E+02</td>
</tr>
</tbody>
</table>

3.4.2.1.4 Comparison to the Evaluation Guideline

The unmitigated 1.45E+01 rem dose to the public is High and exceeds the EG. In addition, the unmitigated dose of 1.42E+02 rem to the collocated workers is High.
Analysis

Event Frequency/ Risk Rank

The unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Extremely Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required. The unmitigated Extremely Unlikely frequency for the event is based on DOT accident statistics, limited vehicle activity within TA-54, Area G, and the moderate (> 10 mph, < 35 mph) speeds typical for waste transport vehicles within TA-54, Area G. A vehicle pool fire requires the following three separate contributors: (1) an accident, (2) rupture of the fuel tank, and (3) ignition of the fuel.

Control Selection

The unmitigated dose contribution of 1.38E+01 rem from the fire dominates the total dose to the public (1.45E+01 rem). Of this fire dose, 2.41E+00 rem is from MAR on the transport vehicle, 5.7E+00 rem is from the staged containers awaiting SSSR processing, and 5.7E+00 rem is from unconfined MAR in process in the SSSR area. The dose from the spill term is 7.23E-01 rem. Thus, the control selection is focused on reducing the event frequency and the consequences of the fire STs related to the MAR on the vehicle and in the SSSR area.

Vehicle barriers protect against impact. Fuel pool fire protection is provided by the thermal separation distance. Therefore, the following controls were derived:

- The safety-class SSC, Vehicle Barriers—High Risk Location, ensuring that barriers capable of stopping a vehicle (moving at a velocity of ≤ 15 mph) with a gross weight of ≤ 150,000 lb and a ground clearance of < 40 inches are installed at high-risk locations and ensuring the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location, is credited for preventing vehicles from impacting defined areas at TA-54, Area G, thereby reducing the consequences to only the MAR in transport.

- A complementary control is an SMP element through the Vehicle Safety Program requiring the installation of vehicle barriers along the roadways running next to the defined areas. These barriers work in conjunction with the safety-class SSC Vehicle Barriers to prevent vehicles from impacting waste in defined areas adjacent to the roadway. These barriers provide (uncredited) defense-in-depth because significant dose consequences are postulated to not occur if a defined area next to a roadway is subject to a glancing impact from a vehicle accident.

With vehicle barriers at high-risk locations, the source term associated with impacted TRU waste containers in the SSSR area is removed. Therefore, dose consequences are reduced. The assurance that any fuel pool fire resulting from leaking fuel from a stopped or deflected vehicle does not impact defined areas is accomplished by the following control:

The safety-class SAC, Thermal Separation Distance, is credited for creating a thermal distance that limits heat flux from the leading edge of the fuel spill to radiological waste containers, thereby reducing the likelihood that MAR involved in the accident is greater than the MAR in transport. Vehicle barriers at high-risk locations and along the roadway are positioned so that the vehicle stopping or deflection point does not allow spilled fuel up to 100 gal to intrude upon the thermal separation distance.
Another control limits the amount of MAR that is on a transportation vehicle; it is equivalent to the MAR limit on transportation vehicles used historically at Area G, and is comparable to the MAR limit on LANL Transportation Safety Document [LANL 2010a] vehicles. The selection of an Area G TRU transport vehicle MAR limit that is different from the LANL Transportation Safety Document MAR limit for compliant metal TRU waste containers could result in confusion over two different limits. The transportation MAR limit is as follows:

- The total MAR inventory on a vehicle transporting TRU waste with only compliant, metal containers does not exceed 1,100 PE-Ci,

The implementation of the vehicle barriers and the thermal separation distance (preventing involvement of the SSSR MAR in the accident) mitigate the dose consequences to the public to $2.41 \times 10^0$ rem (fire) and $6.39 \times 10^{-1}$ rem (spill). This dose is from the initial vehicle accident. The Moderate mitigated consequence of $3.05 \times 10^0$ rem and the Extremely Unlikely frequency for the initial transport vehicle accident results in a risk rank III, as shown in Table 3-30. Table 3-30 shows that collocated worker dose consequences are also Moderate.

Table 3-30. DBA No. 1A – Mitigated Consequence Analysis; Effect of Vehicle Barrier and MAR Limit

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.38E-02</td>
<td>4.63E+01</td>
<td>6.39E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>7.62E-02</td>
<td>3.17E+01</td>
<td>2.41E+00</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>3.05E+00</td>
<td>Total Collocated Worker Dose</td>
<td>2.99E+01</td>
</tr>
</tbody>
</table>

As indicated, the dose consequences in Table 3-30 involve compliant metal containers. If only non-compliant metal or non-metal containers are involved in the accident, a MAR limit of 615 PE-Ci applies to achieve comparable dose consequences. Therefore, the following safety-class SAC is also required

- The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.

The selection of additional controls for the protection of the public and the collocated workers is required to further mitigate the consequences of or frequency of the vehicle accident. Thus, additional control selection is focused on further reducing the consequence and frequency of the vehicle crash.

A safety-significant-SAC requires a rolling roadblock, based on the MAR on the transport vehicle:

- Transports with $> 800$ PE-Ci in compliant metal containers, or $> 450$ PE-Ci in non-compliant metal or non-metal containers, require a rolling roadblock

If the transport vehicle is transporting $\leq 800$ PE-Ci, the maximum metal container inventory that can be transported without a rolling roadblock, the dose consequences to the public from a vehicle accident are reduced to $2.22 \times 10^0$ rem, as indicated in Table 3-31. If the transport vehicle contains only non-compliant metal or non-metal TRU waste containers, a MAR of $\leq 450$ PE-Ci provides a comparable dose consequence; therefore, TRU transports with non-compliant containers with a MAR $> 450$ PE-Ci require a rolling roadblock.
Table 3-31. DBA No. 1A – Mitigated Consequence Analysis; Maximum Inventory without Rolling Roadblock (800 PE-Ci)

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Dose (rem)</th>
<th>Collocated Worker</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spill</td>
<td>1.00E-02</td>
<td>4.63E+01</td>
<td>4.65E-01</td>
<td>4.50E+02</td>
<td>4.52E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>5.54E-02</td>
<td>3.17E+01</td>
<td>1.76E+00</td>
<td>3.10E+02</td>
<td>1.72E+01</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>2.22E+00</td>
<td>Total Collocated Worker Dose</td>
<td>2.17E+01</td>
<td></td>
</tr>
</tbody>
</table>

The rolling roadblock for transports with MAR > 800 and ≤ 1,100 PE-Ci in compliant metal containers, or with MAR > 450 PE-Ci and ≤ 615 PE-Ci in non-compliant metal and non-metal containers, reduces the frequency of the vehicle accident to Beyond Extremely Unlikely. This frequency with dose consequences as shown in Table 3-31 results in a mitigated risk rank IV, based on mitigated (moderate) consequences and (Beyond Extremely Unlikely) frequency.

For accident scenarios which involve vehicle transports of MAR between RANT and Area G, the following control is credited to reduce the likelihood of vehicle accidents:

- Vehicle Escort Control—Escort of Transportation Vehicle between TA-54, Area G and TA-54 RANT.

This credited safety-class SAC is required because the posted speed limit between RANT and Area G is 35 mph. The escort controls the speed of the transport vehicle; therefore, the presumptions of the analysis are protected.

For some bounded vehicle accident scenarios that occur at a waste face or Pit 9, the following unique safety-class SAC is credited to mitigate the consequences of the pool fire:

- Defined areas containing only metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal containers shall be attended, and limited to a total of 100 gal.

For bounded vehicle accident scenarios involving refueling trucks, the following unique safety-class SAC is credited to prevent fuel spillage and fire from involving MAR:

- Transportation vehicles are not to be refueled while they are transporting MAR.

Additional defense-in-depth for overall facility safety is afforded by SMPs and/or Programmatic ACs:

- The Maintenance Program SMP requires periodic inspection and maintenance of LANL vehicles/equipment (e.g., forklift, transport truck). This control reduces the frequency of equipment malfunction, which could lead to the initiating vehicle accident and subsequent fuel pool fire.

- The SMP, Training and Qualification Program, requires that personnel maintain applicable LANL qualifications for vehicle and equipment operation to reduce the frequency for vehicle accidents.
The CHA identified the following ICs that protect the assumptions of the AA:

- SSSR Area equivalent combustible MAR is limited to \( \leq 18 \) PE-Ci Equivalent Combustible in process, unconfined, and an additional 18 PE-Ci Equivalent Combustible staged in one or more closed containers.
- No Storage Area is collocated in a dome or building that houses an SSSR Area.
- Radiological waste is packaged, reducing the radiological consequences as waste is agglomerated and burns as packaged.
- Metal TRU waste containers have sound integrity, as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effect to contained waste.

It is noted that the CHA identified an additional control, the SAC requiring doublepacking of compliant metal TRU waste drums \( \geq 200 \) PE-Ci, which provides a reduction in consequences. The reduction is not quantifiable because it is not known at any one time how many containers may be doublepacked.

**Conclusion**

**Overall mitigation for DBA No. 1A**

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting vehicle barriers at high-risk locations, rolling roadblocks, and thermal separation distances, and limiting the MAR on the transport vehicle reduces the dose to the public from 1.45E+01 rem (unmitigated) to 3.05E+00 rem (mitigated) and the dose to the collocated workers is reduced from 1.42E+02 rem (unmitigated) to 2.99E+01 rem (mitigated), and reduces the frequency to below Beyond Extremely Unlikely. Therefore, the final mitigated risk ranking for this event is IV for the public and collocated workers.

**Applicability of selected control set for DBA No. 1A to bounded events**

Table 3-32 lists the mitigative and preventive controls in DBA No. 1A. Table 3-32 also lists the HA events that are bounded by DBA No. 1A, based on event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class by the results of this analysis, though these controls may not be applicable to the DBA No. 1A event scenario.

**3.4.2.1.5 Summary of the Safety SSCs, SACs, and TSR Controls**

The credited controls listed in Table 3-32 are those that are discussed in the AA and indicated as providing protection to the public and collocated workers through significant reduction in consequences or frequency. Other ACs that protect the initial conditions of the analysis and provide defense-in-depth are also shown.
<table>
<thead>
<tr>
<th>Control / Applicable or Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Barriers—High-Risk Location</td>
<td>Vehicle barrier systems installed at high-risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>Safety-class (SC)-SSC</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers. Mitigate consequences by limiting MAR to MAR in transit.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance (with or without a liquid impediment)</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers. A reduction in thermal separation distance is permitted when a liquid impediment is used to restrict the spread of potential liquid fuel sources.</td>
<td>SAC (SC Function)</td>
<td>Reduces likelihood of fire progression between defined areas.</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>
#### Table 3-32. DBA No. 1A – Summary of TSR Safety Controls for Vehicle Accidents with Subsequent Fuel Pool Spills

<table>
<thead>
<tr>
<th>Control / Applicable or Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Transportation vehicle - Compliant Metal Containers Only - Vehicle MAR Limit</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>SAC (SC Function)</td>
<td>Reduces radiological consequences by limiting MAR involved</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-1-025 AGTRU-1-072</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Transportation vehicle with non-compliant metal or nonmetal containers - MAR Limit</td>
<td>The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.</td>
<td>SAC (SC Function)</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>AGTRU-1-025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle/ Equipment Safety Control – Escort of High MAR TRU Waste Transport Within TA-54, Area G Compliant Containers, Non-Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt; 800 PE-Ci, or with non-compliant metal and non-metal containers and &gt; 450 PE-Ci, will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>SAC (SS Function)</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-1-025 AGTRU-1-072</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3-32. DBA No. 1A – Summary of TSR Safety Controls for Vehicle Accidents with Subsequent Fuel Pool Spills

<table>
<thead>
<tr>
<th>Control / Applicable or Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escort of Transportation Vehicle between TA-54, Area G and TA-54 RANT</td>
<td>Transportation vehicle is escorted when traveling between TA-54, Area G and RANT with MAR onboard.</td>
<td>SAC (SC Function)</td>
<td>Reduces the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
<td>The AA bounds the unmitigated consequences and frequency of the listed bounded HA events. This control is specific to the bounded (unmitigated EU) HA events, and is SC, reducing the frequency to BEU, for a mitigated risk rank III.</td>
</tr>
<tr>
<td>RANTTOG-1-001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RANTTOG-1-002</td>
<td></td>
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<tr>
<td>RANTTOG-1-003</td>
<td></td>
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<tr>
<td>RANTTOG-1-004</td>
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<tr>
<td>RANTTOG-1-005</td>
<td></td>
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<tr>
<td>RANTTOG-1-006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustible/ Flammable Liquids Control</td>
<td>Defined areas with only compliant metal containers are permitted up to 7 gal of unattended flammable/ combustible liquids and up to a total of 100 gal of attended liquid/ flammable combustibles. All flammable/ combustible liquids in defined areas with non-metal containers shall be attended and limited to a total of 100 gal.</td>
<td>SAC (SC Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>The AA bounds the unmitigated consequences and frequency of the listed bounded HA events. This control is specific to the bounded (unmitigated EU) HA events, and is SC, reducing the frequency to BEU, for a mitigated risk rank IV.</td>
</tr>
<tr>
<td>BGTRUPIT-1-002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for the listed bounded HA events.</td>
</tr>
<tr>
<td>AGTRU-1-025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-1-072</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BGTRUPIT-1-002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control / Applicable or Bounded HA Events</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control – SSSR AGTRU-1-025</td>
<td>Limit a SSSR Area equivalent combustible MAR, uncontained, to ( \leq 18 ) PE-Ci, and another ( \leq 18 ) PE-Ci staged, contained.</td>
<td>IC (SC Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – TRU waste shall not be stored in a Building or Dome containing a SSSR area AGTRU-1-025</td>
<td>Limit MAR near an SSSR Area</td>
<td>IC (SC Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control AGTRU-1-025 AGTRU-1-072 BGTRUPIT-1-002</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management - TRU Waste Container Integrity AGTRU-1-025 AGTRU-1-072</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effect to contained waste</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
</tbody>
</table>
Table 3-32. **DBA No. 1A – Summary of TSR Safety Controls for Vehicle Accidents with Subsequent Fuel Pool Spills**

<table>
<thead>
<tr>
<th>Control / Applicable or Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle/ Equipment Safety Control – Refueling Prohibition AGTRU-1-052</td>
<td>Transportation vehicles transporting MAR are not to be refueled</td>
<td>SAC (SC Function)</td>
<td>Reduce likelihood for involvement of MAR in event</td>
<td>The AA bounds the unmitigated consequences and frequency of the listed bounded HA event. This control is specific to the bounded (unmitigated EU) HA event, and is SC, reducing the frequency to BEU, for a mitigated risk rank III.</td>
</tr>
</tbody>
</table>
3.4.2.2 DBA No. 1B – AGTRU-1-044, Fuel Pool Fire from Container Leak

3.4.2.2.1 Scenario Development

This DBA involves a spill of combustible/flammable liquid (e.g., gasoline, diesel fuel, transient combustible liquids) present within a stored TRU waste array. The spilled liquid is ignited, resulting in a pool fire engulfing the stored waste with a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- Equipment malfunction
- Ignition source
- Operator error

Assumptions

- The 22,000 PE-Ci in the storage array is in compliant (metal) containers.
- The percentage composition of each waste type in the compliant (metal) container used in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible non-combustible: 3.9%
  - Non-dispersible non-combustible: 93.0%
- Compliant (metal) containers in the storage array involved in the fire are stacked three high.
- The 22,000 PE-Ci in compliant (metal) containers is uniformly distributed among the three tiers.
- Once the spilled combustible/flammable liquid is consumed by the pool fire, the waste continues burning for the remainder of the 20-min duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.

3.4.2.2.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 22,000 PE-Ci.

DR

Compliant (metal) containers in storage array, 1/3 are in top tier:

- 25% of the top tier containers experience lid ejection:
  - 1/3 of the waste contents from these drums experiences ejection
    - Flexing in air of waste ejected from drum following lid loss, DR = (1/3) × 0.25 × 0.33 = 0.03
    - All ejected material burns unconfined, DR = (1/3) × 0.25 × 0.33 = 0.03
Material not ejected burns confined, \( DR = \frac{1}{3} \times 0.25 \times (1 - 0.33) = 0.06 \)

- 75% of the top tier containers do not lose lids and experience confined burning, \( DR = \frac{1}{3} \times 0.75 = 0.25 \)

Compliant (metal) containers in storage array; 2/3 are in bottom two tiers and experience confined burning, \( DR = \frac{2}{3} = 0.67 \)

**ARF \times RF**

The ARF \times RF values for spill/flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-33.

### Table 3-33. DBA No. 1B – ARF \times RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 4.36E-02 PE-Ci
- Fires = 5.85E-01 PE-Ci

### 3.4.2.2.3 Consequence Analysis

Table 3-34 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The public DSF value for the spills resulting from the flexing in air is 4.63E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem/PE-Ci. These DSF values are based on the \( \chi/Q_{95\%} \) values for a spill and fire release from TA-54-412, which is closer to the site boundary than the defined Storage Areas. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).
### Table 3-34. DBA No. 1B – Unmitigated Consequence Analysis

| Component | ST (PE-Ci) | Public | | Collocated Worker | |
|-----------|------------|--------|| | |
| | | DSF (rem/PE-Ci) | Dose (rem) | DSF (rem/PE-Ci) | Dose (rem) | |
| Spill | 4.36E-02 | 4.63E+01 | 2.02E+00 | 4.50E+02 | 1.96E+01 | |
| Fire | 5.85E-01 | 3.17E+01 | 1.85E+01 | 3.10E+02 | 1.81E+02 | |
| | | | Total Public Dose | 2.05E+01 | Total Collocated Worker Dose | 2.01E+02 | |

#### 3.4.2.2.4 Comparison to the Evaluation Guideline

The unmitigated 2.05E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 2.01E+02 rem to the collocated workers is High.

#### Analysis

**Event Frequency/Risk Rank**

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

#### Control Selection

The unmitigated dose contribution of 1.85E+01 rem from the fire dominates the total dose to the public (2.05E+01 rem). The dose from the spill term is 2.02E+00 rem. Thus, the initial control selection is focused on reducing the consequences of the fire STs related to the MAR in the storage array.

The bounding fuel pool fire scenario involves spills of combustible/flammable liquids present within a stored TRU waste array. A safety-class SAC is credited for limiting the amount of combustible/flammable liquids within a defined area and thereby reducing the consequences of a pool fire. The defined areas are permitted up to 100 gal of flammable/combustible liquids through the following safety-class SAC on Combustible/Flammable Liquid limits within TRU waste storage areas:

- Defined areas are limited to a total of 100 gal of combustible/flammable liquids.

The implementation of this control limits the size of the combustible/flammable liquid pool analyzed for this event to a 100-gal spill. The mitigated analysis requires assumptions to redefine the MAR based on a 100-gal spill of combustible/flammable liquid.

A spill of 100 gal translates to a pool area of 1,069.5 ft² (SB-DO:CALC-12-001, Rev. 0 [LANL 2012b]). RCRA required aisle spacing is 36 in, but the number of containers in the combustible/flammable pool fire is conservatively based on 28 in. aisle spacing, as shown in Table 3-35.
### Table 3-35. DBA No. 1B – Number of Containers Affected by 100-gal Combustible/ Flammable Liquid Spill

<table>
<thead>
<tr>
<th>Area of Pool Fire</th>
<th>Containers engulfed by pool fire</th>
<th>Containers in the first row along the edge of the pool fire</th>
<th>Containers in the second row outside the pool fire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top Tier</td>
<td>Bottom two tiers</td>
<td>Top Tier</td>
</tr>
<tr>
<td>1,069.5 ft²</td>
<td>176</td>
<td>352</td>
<td>42</td>
</tr>
</tbody>
</table>

The MAR associated with these containers is based on the four statistically high containers (651 PE-Ci from Table 3-19 [Section 3.4]) being in the top tier of containers engulfed by the pool fire, and the remainder at the statistical mean MAR of 4.84 PE-Ci.

Containers engulfed by pool fire:
- Top tier: 305 PE-Ci + (176 – 4) × 4.84 PE-Ci = 1138 PE-Ci
- Bottom tiers: 352 × 4.84 PE-Ci = 1704 PE-Ci

Containers in the first row along the edge of the pool fire:
- Top tier: 42 × 4.84 PE-Ci = 203 PE-Ci
- Bottom tiers: 84 × 4.84 PE-Ci = 407 PE-Ci

Containers in the second row outside the pool fire:
- Top tier: 47 × 4.84 PE-Ci = 227 PE-Ci
- Bottom tiers: Not impacted by fire

Compliant (metal) containers in storage array on edge (no engulfment) of fuel pool fire:
- 25% of the top tier in the first row experiences lid ejection:
  - 2/3 of the contents experience confined burning, DR = 0.25 × 0.67 = 0.17
  - 1/3 of the contents experience ejection
    - Flexing in air, DR = 0.25 × 0.33 = 0.08
    - Unconfined burning, DR = 0.25 × 0.33 = 0.08
- 75% of the top tier in the first row experiences confined burning, DR = 0.75
- 100% of the bottom two tiers of the first row and the top tier in the second row experience confined burning, DR = 1

Compliant (metal) containers in storage array inside pool area:
- 25% of the top tier containers experience lid ejection
  - 2/3 of the contents experience confined burning, DR = 0.25 × 0.67 = 0.17
  - 1/3 of the contents experience ejection
    - Flexing in air, DR = 0.25 × 0.33 = 0.08
Unconfined burning, $DR = 0.25 \times 0.33 = 0.08$

- 75% of the top tier containers experience confined burning, $DR = 0.75$
- 100% of bottom two tiers experience confined burning, $DR = 1.0$

The implementation of the Combustible/ Flammable Liquid Controls SAC reduces the ST in the accident, thereby mitigating the dose consequences to the public to 3.55 rem. The Moderate mitigated consequence of 3.55 rem to the public and 34.8 rem to the collocated worker, and the Unlikely frequency of the accident, still results in a risk rank II as shown in Table 3-36.

**Table 3-36. DBA No. 1B – Mitigated Consequence Analysis; Effect of 100-gal Combustible/ Flammable Liquid Limit**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>7.98E-03</td>
<td>4.63E+01</td>
<td>93.69E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>1.01E-01</td>
<td>3.17E+01</td>
<td>3.18E+00</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>3.55E+00</td>
<td>Total Collocated Worker Dose</td>
<td>3.48E+01</td>
</tr>
</tbody>
</table>

The selection of additional controls for the protection of the public and the collocated workers are required to mitigate the consequences of the accident. The CHA identified the doublepacking of TRU waste drums containing $MAR \geq 200$ PE-Ci. This control will reduce the radiological consequences by limiting the amount of MAR involved. However, given the number of drums that have $MAR > 200$ PE-Ci and the random placement of these containers within a defined area, the mitigation in dose consequences is not quantifiable. Additional safety-significant SACs further reduce the consequences of the fuel pool fire as analyzed by requiring combustible/ flammable liquids to be attended:

- Defined areas with only TRU metal waste containers are permitted up to 7 gal liquid combustibles *unattended*, and greater than 7 gal up to 100 gal liquid combustibles *attended* (for a total maximum of 100 gal). (The allowance for 7 gal of liquid combustibles unattended is discussed in Section 3.3.2.3.2.2, C.)
- All volumes of liquid flammable/ combustibles up to 100 gal in defined areas containing non-metal containers are required to be *attended*.

This control reduces radiological consequences by limiting amount of MAR involved.

With these controls, when flammable/combustible liquid up to 100 gal is within a defined area, the required *attendant* is credited to limit the spillage of all 100 gal of liquid fuel. When equipment spills, the spill is rarely catastrophic, where all volume is spilled at one time. Therefore, as a leak occurs, the attendant will be able to respond and take action to stop or minimize the leak. In this case, even a 7-gal spill (approximately 75 ft$^2$ area) will be evident to the attendant for a response. The dose consequence associated with a 7-gal spill is around 1 rem to the public and 11 rem to the collocated worker, if it is assumed that the high-MAR drum (with 553 PE-Ci) is in a doublepack (the public dose consequence does not account for the 7-gal spill burning within 10 sec – see Section 3.3.2.3.2.2, C). Table 3-37 shows the mitigated result with the required *attendant*. 
Table 3-37. DBA No. 1B – Mitigated Consequence Analysis; 7-gal Combustible/Flammable Liquid Spill

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>2.42E-03</td>
<td>4.63E+01</td>
<td>1.12E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>3.15E-02</td>
<td>3.17E+01</td>
<td>9.96E-01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>1.11E+00</td>
<td>Total Collocated Worker Dose</td>
<td>1.08E+01</td>
</tr>
</tbody>
</table>

Some of the bounded scenarios involving a fuel spill while refueling equipment require the unique safety-class SAC to mitigate the consequences from a refueling truck fuel leak and pool fire:

- Refueling location will be separated from MAR in defined areas by the thermal separation distance.

The following preventative safety-significant SAC prevents the ignition of a flammable/combustible fuel pool fire as analyzed:

- Hot work is prohibited without a stationary fire watch in TRU waste container storage areas.

With this control, the probability of an ignition source for a fuel pool fire is reduced to Extremely Unlikely. This mitigated frequency, along with Moderate public and Low collocated worker mitigated consequences, results in a risk rank III for the public and risk rank IV for the collocated worker.

Some of the bounded scenarios involving fuel spills from equipment/vehicles require the unique safety-class SAC to prevent a vehicle with over 100 gal of fuel from entering a defined area:

- Vehicles/equipment with greater than the total of 100 gal of flammable liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel, except for emergency response vehicles.

Some of the bounded scenarios include an impact from a vehicle/equipment that results in a fuel spill. These require a unique safety-class SAC to prevent the spill from entering a defined area:

- The safety-class SSC, Vehicle Barriers—High Risk Location, ensuring that barriers capable of stopping a vehicle moving at a velocity of ≤15 mph with a gross weight of ≤150,000 lb and a ground clearance of <40 in. are installed at high-risk locations, is credited for preventing vehicles from impacting defined areas at TA-54, Area G, thereby reducing the consequences to only the MAR in transport. The final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

- A complementary control is an SMP element through the Vehicle Safety Program requiring the installation of vehicle barriers along the roadways running next to the defined areas. These barriers work in conjunction with the safety-class SSC Vehicle Barriers to prevent vehicles from impacting waste in defined areas adjacent to the roadway. These barriers provide (uncredited) defense-in-depth because significant dose consequences are postulated to not occur if a defined area next to a roadway is subject to a glancing impact from a vehicle accident.
In addition to the above SACs, overall facility safety afforded by defense-in-depth Safety Management Programs and/or Programmatic ACs may further reduce the probability of the fuel pool fire:

- The Fire Protection Programmatic AC requiring ignition source control within defined areas is credited with reducing the frequency of the ignition of flammable liquids.
- The Maintenance Program SMP is credited in some scenarios for requiring periodic inspection and maintenance of LANL vehicles/ equipment (e.g., forklift, transport truck). This control reduces the frequency of equipment malfunction, which could lead to the initiating fuel leak and subsequent fuel pool fire.
- The SMP, Training and Qualification Program, requires that personnel are trained to a job hazard analysis process.

The implementation of the SACs on hot work and attendance of flammable/ combustible fuels within defined areas, combined with the SMP/ Programmatic AC preventative controls, are judged to significantly reduce the frequency of an ignition source causing a fuel spill to become a fuel pool fire. A fuel spill may occur, but without an ignition source, because of spill minimization and overall facility safety, the fuel pool fire is prevented or results in minimal consequence, or has a mitigated occurrence frequency of Beyond Extremely Unlikely.

The CHA identified the following ICs that protect the assumptions of the AA:

- Radiological waste is packaged, reducing the radiological consequences, as waste is agglomerated and burns as packaged.
- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effects on contained waste.

**Conclusion**

**Overall mitigation for DBA No. 1B**

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting limits on combustible/ flammable liquid volumes allowed in the defined area reduces the dose to the public from 20.6 rem (unmitigated) to 3.55 rem (mitigated), and the dose to the collocated workers is reduced from 202 rem (unmitigated) to 34.8 rem (mitigated). With the safety-significant SAC requirement for an attendant when fuel is present in defined areas, consequences are mitigated to Moderate level – (less than 2 rem) to the public, and Low level (less than 20 rem) to the collocated worker. The combination of the preventative safety-significant SAC for stationary fire watch during hot work with SMPs reduces the frequency to Beyond Extremely Unlikely, for a final mitigated risk rank IV for both the public and collocated worker receptors.

Although sufficient mitigative controls result in a mitigated Moderate public consequence, residual consequences are considered to be conservative. This is because several conservatisms are built into the parameters used in the unmitigated analysis. The methodology in the dispersion analysis provides several layers of conservatism, one of which stems from the use of a Gaussian plume model that is conservative for the LANL terrain, resulting in a factor-of-4 conservatism in the dose-to-source-term factor. Also, the fuel pool fire and burning waste contribute energy to plume buoyancy, thereby potentially reducing dose consequences, though this is not credited in the consequence analysis.
Applicability of selected control set for DBA No. 1B to bounded events

Table 3-38 lists the mitigative and preventive controls in DBA No. 1B. Table 3-38 also lists the HA events that are bounded by DBA No. 1B, based on the event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class from the results of this analysis, though they may not be applicable to the event scenario in DBA No. 1B.

3.4.2.2.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-38 are those that are discussed in the AA as providing protection to the public and collocated workers by preventing or mitigating the consequences of a radiological release, or contributing to defense-in-depth.
### Table 3-38. DBA No. 1B – Summary of TSR Safety Controls for Combustible/ Flammable Liquid Pool Fire from Container Leak

<table>
<thead>
<tr>
<th>Control / Applicable / Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible / Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas which contain non-metal containers shall be attended, and limited to a total of 100 gal.</td>
<td>SAC   (SS Function)</td>
<td>Reduces the frequency of fire by identifying fire initiators and incipient fires and eliciting an appropriate response. Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>AGTRU-1-044</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationary Fire Watch during Hot Work</td>
<td>Hot work is prohibited without a stationary fire watch within TRU storage areas.</td>
<td>SAC   (SS Function)</td>
<td>Reduces likelihood for ignition of flammables/combustibles</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>AGTRU-1-044</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>IC    (Safety-significant [SS] Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-1-044</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-1-081</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-1-083</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste have sound integrity</td>
<td>IC    (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effect to contained waste</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-1-044</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-1-081</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-1-083</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3-38. DBA No. 1B – Summary of TSR Safety Controls for Combustible/ Flammable Liquid Pool Fire from Container Leak

<table>
<thead>
<tr>
<th>Control / Applicable / Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-1-044 AGTRU-1-081 Escort of &gt;100 gallons Flammable Liquid Inventory Vehicles within TA-54, Area G. AGTRU-1-046 BGTRUPIT-1-040 BGTRUCSK-1-008 Vehicle Barriers–High-Risk Locations</td>
<td>Vehicles/ equipment with greater than the total of 100 gal of flammable liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td>SAC (SC Function)</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td>The AA bounds consequences of listed HA events. This control is specific to the bounded (unmitigated EU) HA events, and is deemed SC, reducing frequency to BEU, for a mitigated risk rank III.</td>
</tr>
<tr>
<td></td>
<td>Vehicle barrier systems installed at high-risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/ movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>SC-SSC</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers</td>
<td>The AA bounds the scenario and consequences of listed HA event. This control is specific to the bounded HA event and is deemed a SC-SSC, so consequences of the HA event are mitigated to zero.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers.</td>
<td>SAC (SC Function)</td>
<td>Reduce likelihood of fire progression between defined areas.</td>
<td>The AA bounds the scenario and consequences of listed HA event. This control can work in combination with the vehicle barriers. The vehicle barriers stop or deflect the vehicle, and</td>
</tr>
</tbody>
</table>
### Table 3-38. DBA No. 1B – Summary of TSR Safety Controls for Combustible/Flammable Liquid Pool Fire from Container Leak

<table>
<thead>
<tr>
<th>Control / Applicable / Bounded HA Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGTRU-1-081 BGTRUCSK-1-008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle/ Equipment Safety Control – Refueling Location AGTRU-1-076 BGTRUCSK-1-011</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
<td>SAC (SC Function)</td>
<td>Reduces frequency of a refueling accident involving a fuel pool fire impacting TRU waste</td>
<td>The AA bounds the scenario and consequences of listed HA event. This control is specific to the bounded HA events and is deemed a SC-SAC, so consequences of the HA event are mitigated to zero.</td>
</tr>
</tbody>
</table>

the thermal separation distance is between any leaking fuel from the vehicle and the boundary of a defined area. The boundary of the leaking fuel may be designated by a berm, curb, slope, and/or ditch to control liquid-run-on.
3.4.2.3 DBA No. 1C - AGTRU-1-048, Refueling Vehicle Accident with Fuel Pool Fire

3.4.2.3.1 Scenario Development

This DBA involves a refueling vehicle at > 10 mph and < 35 mph impacting stored TRU waste containers. Fuel is spilled and ignited. The fuel pool fire engulfs the stored waste, resulting in a release of radiological material. It is assumed that quantity of fuel on the large refueling vehicle is < 5,000 gal. The CHA identified the unmitigated frequency of this DBA as Extremely Unlikely.

The causes that could potentially result in this accident are as follows:

- Degraded road condition (e.g., erosion, potholes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle equipment mechanical failure (e.g., steering, brakes)

Assumptions

- ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%
- The MAR involved is 22,000 PE-Ci in a compliant (metal) storage array.
- The storage array contains all compliant (metal) containers.
- Compliant (metal) containers in the storage array involved in the fire are stacked three high.
- The 22,000 PE-Ci in compliant (metal) containers is uniformly distributed among the three tiers.
- Forty-eight of the compliant (metal) storage array containers are impacted by the vehicle (statistically calculated MAR equal to 864 PE-Ci, including the four statistically high MAR drums).
- The 48 storage array containers experience moderate stress (DR = 0.1) from the impact, consistent with Table 4.4.4-1, Item 5, of DOE-STD-5506-2007 [DOE 2007] for vehicles traveling > 10 mph and < 35 mph.
- Once the spilled fuel is consumed by the pool fire, the waste continues burning for the remainder of the 20-minute duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.
3.4.2.3.2 Source Term Analysis

MAR

The unmitigated MAR is 22,000 PE-Ci.

- Impacted by vehicle, then exposed to fuel pool fire = 864 PE-Ci
- Exposed to fuel pool fire only = 22,000 PE-Ci - 864 PE-Ci = 21,136 PE-Ci

The total unmitigated MAR used in this analysis is 22,000 PE-Ci.

DR

DRs are considered for the MAR in the storage array.

Compliant (metal) containers involved in vehicle impact:

- Spill from the initial impact, DR = 0.1
- Fire terms:
  - The spilled material that burns unconfined, DR = 0.1
  - Of the containers the 90% unaffected by the initial impact, 25% expel 33% of the waste contents; waste contents experience flexing in air and unconfined burning, DR = 0.9 × 0.25 × 0.33 = 0.07
  - The remaining material burns confined, DR = 1 - (0.1 + 0.07) = 0.83

Compliant (metal) containers in storage array, 1/3 are in top tier:

- 25% of the top tier container experience lid ejection
  - 1/3 of the waste contents from these drums experiences ejection
    - Flexing in air of waste ejected from drum following lid loss, DR = (1/3) × 0.25 × 0.33 = 0.03
    - All ejected material burns unconfined, DR = (1/3) × 0.25 × 0.33 = 0.03
  - Material not ejected burns confined, DR = (1/3) × 0.25 × (1 - 0.33) = 0.06
- 75% of the top tier containers do not lose lids and experience confined burning, DR = (1/3) × 0.75 = 0.25

Compliant (metal) containers in storage array, 2/3 are in bottom two tiers and experience confined burning, DR = (2/3) = 0.67

ARF × RF

The ARF × RF values for spill/flexing in air, confined burning, and unconfined burning for each of the waste types are shown in Table 3-39.
Table 3-39. DBA No. 1C – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 5.28E-02 PE-Ci
- Fires = 6.22E-01 PE-Ci

3.4.2.3.3 Consequence Analysis

Table 3-40 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The public DSF value for the spills resulting from the initial impact and flexing in air is 4.63E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem/PE-Ci. These DSF values are based on the χ/Q_{95%} values for a spill and fire release from TA-54-412, which is closer to the site boundary than the defined Storage Areas. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

Table 3-40. DBA No. 1C – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>5.28E-02</td>
<td>4.63E+01</td>
<td>2.44E+00</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Fire</td>
<td>6.22E-01</td>
<td>3.17E+01</td>
<td>1.97E+01</td>
<td>3.10E+02</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>2.21E+01</td>
<td>Total Collocated Worker Dose</td>
<td>2.17E+02</td>
</tr>
</tbody>
</table>

3.4.2.3.4 Comparison to the Evaluation Guideline

The unmitigated 2.21E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 2.17E+02 rem to the collocated workers is High.
Analysis

Event Frequency/ Risk Rank

This unmitigated event has High consequences to the public and collocated workers, and an unmitigated frequency of Extremely Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event. The unmitigated Extremely Unlikely frequency for the event is based on DOT accident statistics, limited vehicle activity within TA-54, Area G, and the moderate (> 10 mph, < 35 mph) speeds typical for waste transport vehicles within TA-54, Area G. A vehicle pool fire requires the following three separate contributors: (1) an accident, (2) rupture of the fuel tank, and (3) ignition of the fuel.

Control Selection

The vehicle impact and spilled fuel from the vehicle can be prevented from reaching the storage array at high-risk locations by stopping vehicles from impacting defined areas, preventing spilled fuel in the vehicle accident from reaching the defined areas, and preventing the resulting fire from affecting the stored waste. Safety-class SSC Vehicle Barriers at high-risk locations are designed so that they could easily stop the vehicle from impacting the storage array. However, if the refueling vehicle leaks fuel, the TRU waste containers must be protected from a subsequent fuel pool fire, resulting in dose consequences shown in Table 3-40. Vehicle barriers at high-risk locations and along the roadway are positioned so that the vehicle’s stopping or deflection point does not allow spilled fuel up to 100 gal to intrude upon the thermal separation distance. Vehicles containing more than 100 gal flammable liquid (such as the water truck, which is the design basis vehicle for the barrier design) are under escort, and their speed and path of travel are established by the escorting vehicle traveling along designated routes.

The storage array would be protected from fuel pool spills from a vehicle accident by an established thermal separation distance from the leading edge of a fuel pool spill to the defined area. As discussed in DBA No. 1A, the leading edge of the fuel pool fire can be provided by a liquid impediment.

The following safety-class SAC is selected to lower the frequency of the event:

- Vehicles/ equipment with greater than a total of 100 gal of flammable liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel, except for emergency response vehicles.

The escort vehicles keep the refueling vehicle at a speed that would make a vehicle accident improbable, and the designated route of travel is selected to minimize the number of TRU waste defined areas that the refueling vehicle must drive past. By crediting this control, the probability of the event is mitigated to Beyond Extremely Unlikely. Data available through the U.S. Department of Transportation, Traffic Safety Facts (2005-2009) [USDOT 2010] indicates a probability of 1.6E-4/yr, averaged over 5 yr, that a large truck in an accident will result in a fire when compared to all vehicle accidents with fire occurrence on public roads. Because Area G is a controlled area, and there is a control for vehicle escorts to ensure low speeds, the probability of a large truck vehicle accident with fire is Beyond Extremely Unlikely.

On the Beyond Extremely Unlikely presumption that, during the escort, a vehicle accident does occur, it is improbable that the accident will involve a fuel spill because the low speed of the refueling vehicle is ensured by the escort, and the accident will only involve an impact to a defined area. In this case, the vehicle barriers stop the refueling vehicle from impacting the defined area, and no spill source term is incurred. The vehicle barriers will provide a safety-significant function to prevent the Moderate spill term, as shown in Table 3-40.
The following unique control was credited in one bounded scenario to prevent a spill from a refueling vehicle accident near Pit 9:

- Refueling location will be separated from MAR in defined areas by the thermal separation distance.

Conclusion

Overall mitigation for DBA No. 1C

With the vehicle escort, the probability of the event is Beyond Extremely Unlikely, so a mitigated risk rank III is achieved. Vehicle barriers at high-risk locations will prevent a refueling vehicle from directly impacting storage locations. However, the storage location will not be protected from a 5,000-gal fuel pool spill. Therefore, the vehicle barriers can only protect the storage array from an impact. In the accident scenario without a fuel pool spill, crediting the vehicle barriers will result in zero consequences. In this case, the vehicle barriers are safety-significant because of the unmitigated Moderate dose consequences from the spill source term.

Applicability of selected control set for DBA No. 1C to bounded events

Table 3-41 lists the mitigative and preventive controls in DBA No. 1C. Table 3-41 also lists a HA event that is bounded by DBA No. 1C, based on the event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class by the results of this analysis, though they may not be applicable to the event scenario in DBA No. 1C.

3.4.2.3.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-41 are those that are discussed in the AA as providing protection to the public and collocated workers by preventing a radiological release, or contributing to defense-in-depth.
### Table 3-41. DBA No. 1C – Summary of TSR Safety Controls for Fuel Pool Fire from Refueling Vehicle Accident

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escort of &gt;100 gallons Flammable Liquid Inventory Vehicles within TA-54, Area G. AGTRU-1-048</td>
<td>Vehicles/ equipment with greater than the total of 100 gal of flammable liquid on board (i.e., fuel tanks, fuel cans) must be escorted along designated routes of travel, except for emergency response vehicles.</td>
<td>SAC (SC Function)</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Vehicle Barriers—High-Risk Locations AGTRU-1-048</td>
<td>Vehicle barrier systems installed at high-risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/ movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>SS-SSC</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Vehicle/ Equipment Safety Control – Refueling Location BGTRUPIT-1-033</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
<td>SAC (SC Function)</td>
<td>Reduces frequency of a refueling accident involving a fuel pool fire impacting TRU waste</td>
<td>The AA bounds the scenario and consequences of the listed HA event. This control is specific to the bounded HA event and is designated a SC-SAC, preventing the occurrence of the HA event.</td>
</tr>
</tbody>
</table>
3.4.2.4 DBA No. 1D - BGTRUPIT-1-016, Fuel Pool Fire in Pit 9

3.4.2.4.1 Scenario Development

This DBA involves a leak of combustible/flammable liquid (e.g., gasoline, diesel fuel) adjacent to Pit 9 after an excavation of a Pit 9 cell. The spilled liquid is ignited, resulting in a pool fire engulfing the exposed waste in the pit cell, with a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- Disposal of pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Fuel spills/ leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering or brakes)

Assumptions

- DOE-STD-5506 [DOE 2007] indicates that the use of damage ratios specified in the Standard is based on containers with sound integrity (i.e., DR < 1). Application of the criteria assumes that container integrity can be verified through an inspection program or process knowledge. Where this cannot be accomplished (e.g., TRU waste retrieval from a burial ground), a DR of < 1 requires explicit justification. Additionally, in cases where a criterion in Table 4.4.4.1-1 is met, the legacy container cannot be assumed to be of sound integrity.

Several years ago, the TWISP activity involved the retrieval of TRU drums that were buried in the 1970s through 1980s. The method of burial and the waste compositions of Pit 9 drums are comparable to those that were retrieved during the TWISP activity. The drums that were retrieved during the TWISP activity were found to be of a condition that met the WIPP inspection criteria. On a few occasions, retrieved unvented drums showed signs of bulging and underwent emergency venting. Based on the TWISP process experience on the condition of retrieved drums, and because drums buried at Pit 9 and TWISP are comparable, it is believed that the Pit 9 drums are of sound integrity. Therefore, the source term factors provided by DOE-STD-5506 for containers of sound integrity are used in the Pit 9 accident analysis involving drums.

- The percentage composition of each waste type in the statistical Pit 9 metal container used in the analysis is taken from Table 3-21:
  - Combustible: 22.0%
  - Dispersible, non-combustible: 48.1%
  - Non-dispersible, non-combustible: 29.9%

- The percentage composition of each waste type in the statistical Pit 9 non-metal container used in the analysis is taken from Table 3-22:
Combustible: 0.1%

Dispersible, non-combustible: 99.9%

Non-dispersible, non-combustible: 0.0%

- Metal drums are stacked five high or higher in a pit cell
- Pit 9 is divided into 3 cells with a total of 197 FRP Boxes and 3880 metal containers
  - Pool fire event only affects one cell of Pit 9, corresponding to 66 FRP boxes and 1294 compliant (metal) containers
  - MAR for compliant (metal) containers is 2260 PE-Ci = (196.13 + 20.06 + 9.27 + 9.27 + (1290 × 1.57))
  - MAR in non-metal containers (FRPs) involved in this accident is 430 PE-Ci (The total Pit 9 inventory of FRPs).
  - Based on 5-high stacking, there are 259 top-tier containers (1294 / 5) = 258.8
  - The MAR for compliant (metal) containers in the top tier is: 636 PE-Ci = (196.13 + 20.06 + 9.27 + 9.27 + (255 × 1.57))
  - The remaining MAR in lower tiered rows contains 1624 PE-Ci = (2260 - 636).
- The fuel pool fire size is not considered in this analysis. However, in comparison to the 659 drums in a 3-high stacked array in a 100-gal fuel pool area, 3880 metal containers in a close-packed, 5-high stacked array correspond to a minimum 263-gal fuel pool spill.
- Once the spilled fuel is consumed by the pool fire, the waste continues burning for the remainder of the 20-min duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.

3.4.2.4.2 Source Term Analysis

MAR

The unmitigated MAR for the event is determined as follows:

- FRPs = 430 PE-Ci
- Drums, top tier = 636 PE-Ci
- Drums, bottom tiers = 1,624 PE-Ci

The total unmitigated MAR used in this analysis is 2,690 PE-Ci.

DR

Drums:

- 25% of the top tier experiences lid ejection:
  - 1/3 of the contents experience ejection
    - Flexing in air, DR = 0.25 × 0.33 = 0.08
    - Unconfined burning, DR = 0.25 × 0.33 = 0.08
The remainder of the contents experience confined burning, DR = 0.25 × (1 - 0.33) = 0.17
- 75% of the top tier in the first row experiences confined burning, DR = 0.75
- 100% of the bottom two tiers of the first row and the top tier in the second row experience confined burning, DR = 1.0

The MAR in the FRPs experience confined burning, DR = 1.0.

**ARF × RF**

The ARF × RF values for spill/ flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-42.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 4.78E-03 PE-Ci
- Fires = 4.50E-01 PE-Ci

**3.4.2.4.3 Consequence Analysis**

Table 3-43 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spill resulting from the waste ejection and flexing in air is 4.63E+01 rem PE/Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem PE/Ci. These DSF values are based on the χ/Q<sub>95%</sub> values for a spill and fire release from TA-54-412, which is closer to the site boundary than Pit 9. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE/Ci (fire).
Table 3-43. DBA No. 1D – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>4.78E-03</td>
<td>4.63E+01</td>
<td>2.21E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>4.50E-01</td>
<td>3.17E+01</td>
<td>1.43E+01</td>
</tr>
</tbody>
</table>

3.4.2.4.4 Comparison to the Evaluation Guideline

The unmitigated 1.45E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 1.42E+02 rem to the collocated workers is High.

Analysis

Event Frequency/ Risk Rank

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

Control Selection

The unmitigated dose contribution of 1.43E+01 rem from the fire dominates the total dose to the public (1.45E+01 rem). The dose from the spill term is 2.21E-01 rem. Since the two components are the result of the same event and cannot be separated, control selection is focused on reducing the frequency and consequences of the event.

Reviewing the available controls, it is not possible to select a single engineered control to prevent the initiating fuel spill, spread, or ignition, so a suite of SACs is selected.

- A safety-class SAC is credited for requiring a thermal separation distance to reduce the likelihood of the propagation of fire between defined areas.

This control reduces the frequency of the event to Extremely Unlikely, corresponding to a mitigated risk rank II. Additional reduction in frequency of this DBA can be accomplished with prevention of liquid run-on. Therefore, the following control is credited:

- A safety-class SAC requiring a liquid impediment to prevent liquid run on into a retrieval area is credited for containing or diverting the maximum fuel capacity of the retrieval equipment so that spilled fuel will not flow into the pit or trench.

The implementation of the listed controls reduces the mitigated frequency to Beyond Extremely Unlikely, mitigated risk rank III.
Additional controls are selected to reduce consequences:

- The SAC, Retrieval Area MAR Limit, limits the MAR in defined areas. This is credited for limiting the exposed MAR in Pit 9 to 1,500 PE-Ci.

Using the statistical MAR methodology, it can be determined that a MAR of 1500 PE-Ci corresponds to 810 Pit 9 metal containers \((196.13 + 20.06 + 9.27 + 9.27 + (806 \times 1.57)) = 1500.15\). Because of the small amount of MAR contained in FRPs and the low percentage of the waste matrix that is combustible, the compliant (metal) containers are the container of concern. This assumption maximizes the consequences of the event.

- Assuming the containers are stacked 5 tiers, the top tier containers 162 containers \((810 / 5)\)
- The top-tier MAR is: \(196.13 + 20.06 + 9.27 + 9.27 + (158 \times 1.57)\)
- The lower-tier MAR experiences confined burning: \((1500 \text{ PE-Ci} - 483 \text{ PE-Ci}) = 1017 \text{ PE-Ci}\)

The mitigated dose consequences that result from limiting the exposed MAR to 1,500 PE-Ci are presented in Table 3-44.

### Table 3-44. DBA No. 1D – Mitigated Consequence Analysis; Effect of MAR Limit

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>3.63E-03</td>
<td>4.63E+01</td>
<td>1.68E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>2.92E-01</td>
<td>3.17E+01</td>
<td>9.25E+00</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>9.41E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

The implementation of the exposed MAR control reduces the consequences to the public and collocated workers to Moderate. Given the mitigated Beyond Extremely Unlikely frequency, a mitigated risk rank IV is achieved for the public and for the collocated worker.

The 1,500 PE-Ci MAR limit is chosen because it provides the necessary “buffer” between a working operational limit and what is actually retrieved. At Pit 9, the total MAR within pit markers is known, as well as the identification of the containers within the pit markers. However, the actual geographical location of a TRU waste container within the pit markers is not known. Therefore, the 1,500 PE-Ci MAR value is judged to provide an operational buffer to account for the uncertainty about exact container location.

The CHA identified the following IC that protects the assumption of the AA:

- TRU Waste Packaging Control: TRU waste is packaged.
Conclusion

Overall mitigation for DBA No. 1D

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting the MAR limit for pit cells reduces the dose to the public from 1.45E+01 rem (unmitigated) to 9.41E+00 rem (mitigated), and reduces the dose to the collocated workers from 1.42E+02 rem (unmitigated) to 9.22E+01 rem (mitigated). Crediting a safety-class SAC on hot work reduces the frequency from Unlikely to Extremely Unlikely. Crediting control of liquid run on reduces the frequency from Extremely Unlikely to Beyond Extremely Unlikely. Therefore, the final mitigated risk ranking for this event is IV to the public and to the collocated workers and is judged to be acceptable due to the following considerations:

The 1,500 PE-Ci MAR limit corresponds to about three-quarters of a Pit 9 cell, and under normal conditions it is not expected that such a large fraction of the cell will be exposed at any given time. Additionally, the mitigated analysis assumes that the four statistically bounding containers are in the top tier of the material in Pit 9, which maximizes the MAR available for ejection and unconfined burning.

Several conservatisms are built into the parameters used in the unmitigated analysis. The methodology in the dispersion analysis provides several layers of conservatism, one of which stems from the use of a Gaussian plume model that is conservative for the LANL terrain. This results in a minimum factor-of-4 conservatism in the dose-to-source-term factor. Also, the fuel pool fire and burning waste contribute energy to plume buoyancy, thereby potentially reducing dose consequences, though this is not credited in the consequence analysis.

Applicability of selected control set for DBA No. 1D, to bounded events

None

3.4.2.4.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-45 are those discussed in the AA as providing protection to the public and collocated workers through significant reduction in consequences or frequency.
Table 3-45.  DBA No. 1D – Summary of TSR Safety Controls for Fuel Pool Fire in Pit 9

<table>
<thead>
<tr>
<th>Control / Applicable Scenario</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control of Liquid Run-On BGTRUPIT-1-016</td>
<td>Liquid impediments established between liquid-fueled retrieval equipment and the edge of Pit 9/ Trenches A through D during operation and warm standby, except during relocation of the retrieval equipment.</td>
<td>SAC (SC Function)</td>
<td>Prevent fuel spills from the liquid-fueled retrieval equipment from entering the pit or trench.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers.</td>
<td>SAC (SC Function)</td>
<td>Reduces likelihood of propagation of fire between defined areas.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Retrieval Area MAR Limit BGTRUPIT-1-016</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci</td>
<td>SAC (SC Function)</td>
<td>Reduces radiological consequences by limiting the MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control BGTRUPIT-1-016</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>

3.4.2.5  DBA No. 2A – AGTRU-1-031, Vehicle Accident with Combustible Fire

3.4.2.5.1  Scenario Development

This DBA involves a vehicle transporting multiple non-metal above-ground TRU waste containers at > 10 mph and < 35 mph that impacts an SSSR activity and closed containers staged nearby that are awaiting SSSR processing, or remediated components that are pending disposal. The collision event initiates a combustible fire that involves the unconfined SSSR waste, the waste containers in transport, and the staged waste containers affected by the impact, resulting in a release of radiological material. The accident consequence is evaluated at TA-54-412, the SSSR location that is closest to the site boundary. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- Inadequate road condition (e.g., erosion, potholes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Assumptions

- The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.7%
  - Dispersible, non-combustible: 95.3%
  - Non-dispersible, non-combustible: 0%
- The SSSR activity involves a MAR of 18 PE-Ci, in-process and unconfined.
- The SSSR staging area also includes an additional 18 PE-Ci, confined in one or more closed metal or non-metal containers, awaiting processing or removal of remediated waste.
- The SSSR MAR is 100% combustible.
- Storage Areas are not collocated in defined areas in which SSSR Areas are located.
- The truck MAR is 615 PE-Ci (non-metal containers).
- The non-metal containers on the truck experience high stress (DR=1.0) from the impact.
- The MAR in metal or non-metal containers staged and awaiting SSSR processing or removal of remediated waste experiences moderate stress (DR=0.1)
- The spilled waste is assumed to burn for 20 minutes. Buoyancy is not modeled in for the releases for conservatism.

3.4.2.5.2 Source Term Analysis

MAR

The unmitigated MAR for the event is determined as follows:

- Transport truck = 615 PE-Ci in non-metal containers
- Staged SSSR area, metal or non-metal containers = 18 PE-Ci
- In-process in SSSR area, unconfined = 18 PE-Ci

The total unmitigated MAR used in this analysis is 651 PE-Ci.

DR

DRs are considered for the MAR that is on the truck, in the SSSR staging area, and in the SSSR process area.
Truck with non-metal containers:

- Spill from the initial impact, DR = 1.0
- Spilled waste burns unconfined, DR = 1.0

Impacted metal or non-metal containers in SSSR staging area:

- Spill from the initial impact, DR = 1.0
- Spilled waste burns unconfined, DR = 1.0

MAR in SSSR process area which experience unconfined burning, DR = 1.0

ARF × RF

The ARF × RF values for spill/ flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-46.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 6.33E-02 PE-Ci
- Fires = 6.83E-01 PE-Ci

3.4.2.5.3 Consequence Analysis

Table 3-47 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 4.63E+01 rem PE-Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem PE-Ci. These DSF values are based on the $\chi/Q_{95\%}$ values for a spill and fire release from TA-54-412, the closest SSSR Area to the site boundary. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE-Ci (fire).
Table 3-47.  DBA No. 2A – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th></th>
<th>Collocated Worker</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spill</td>
<td>6.33E-02</td>
<td>4.63E+01</td>
<td>2.93E+00</td>
<td>4.50E+02</td>
<td>2.85E+01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>6.83E-01</td>
<td>3.17E+01</td>
<td>2.16E+01</td>
<td>3.10E+02</td>
<td>2.12E+02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.4.2.5.4 Comparison to the Evaluation Guideline

The unmitigated 2.46E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 2.40E+02 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

This unmitigated event has High consequences to the public and collocated workers, and an unmitigated frequency of Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required. The unmitigated Unlikely frequency for the event is based on DOT accident statistics, limited vehicle activity within TA-54, Area G, and the moderate (> 10 mph, < 35 mph) speeds typical for waste transport vehicles within TA-54, Area G. A vehicle fire requires the following two separate contributors: (1) an accident, and (2) ignition of combustible materials.

Control Selection

The unmitigated dose contribution of 2.16E+01 rem from the fire dominates the total dose to the public (2.46E+01 rem). Of this fire dose, 1.02E+00 rem is from MAR on the transport vehicle, 5.7E+00 rem is from the staging area, and 5.7E+00 rem is from the SSSR processing area. The dose from the spill term is 2.93E+00 rem. Thus, the control selection is focused on reducing the consequences and frequency of the fire STs related to the MAR on the vehicle and in the SSSR process and staging areas.

The transport vehicle can be prevented from reaching the SSSR area at high-risk locations by stopping the vehicle from impacting the defined area and preventing the resulting fire from affecting the SSSR area waste. Therefore, the following controls were derived:

- The safety-class SSC, Vehicle Barriers—High Risk Locations, ensuring that barriers capable of stopping a vehicle (moving at a velocity of ≤ 15 mph) with a gross weight of ≤ 150,000 lb and a ground clearance of < 40 in. are installed at high-risk locations, is credited for preventing vehicles from impacting defined areas at TA-54, Area G, thereby reducing the consequences to only the MAR in transport. The final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location. A complementary control is an SMP requiring the installation of defense-in-depth vehicle barriers along the roadways running next to the defined areas. This works in conjunction
with the safety-class SSC Vehicle Barriers to prevent vehicles from impacting waste in defined areas adjacent to the roadway.

With this control, the source term associated with impacted TRU waste containers is removed. Therefore, dose consequences are reduced. The following control reduces the likelihood that leaked fuel from an unescorted vehicle will impact a defined area:

- The safety-class SAC, Thermal Separation Distance, is credited for creating a thermal distance that limits heat flux from a fire to radiological waste containers, thereby reducing the likelihood that the fire would involve MAR not in transport.

The implementation of the vehicle barriers and thermal separation distance removes the SSSR area STs in the accident, thereby mitigating the dose consequences to the public to 1.02E+01 rem (fire) and 2.85E+00 rem (spill). This dose is from the ST for the initial vehicle accident. The High mitigated consequence of 1.31+01 rem and the Extremely Unlikely frequency for the initial transport vehicle accident still result in a risk rank II as shown in Table 3-48. Table 3-47 also shows that collocated worker dose consequences are also High.

**Table 3-48. DBA No. 2A – Mitigated Consequence Analysis; Effect of Vehicle Barrier**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>4.50E-02</td>
<td>4.63E+01</td>
<td>2.85E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>1.02E+01</td>
<td>3.17E+01</td>
<td>1.02E+01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>1.31E+01</td>
<td>Total Collocated Worker Dose</td>
<td>1.28E+02</td>
</tr>
</tbody>
</table>

The selection of additional controls for the protection of the public and the collocated workers is required to mitigate the consequences of the transport vehicle accident. However, reviewing the available controls, it is not possible to select a single engineered control to prevent the initiating transport vehicle accident (thus preventing the combustible fire). Thus, additional control selection is based on further reducing the frequency and consequences of the vehicle crash.

An additional control is selected to reduce the probability of the event which involves only the transport vehicle with non-compliant, metal or non-metal TRU waste containers:

- Escort of High MAR TRU Waste Transport Within TA-54, Area G – non-Compliant Containers requires that transportation vehicles with > 450 PE-Ci in non-compliant metal or non-metal containers be escorted by a rolling roadblock.

For the bounded scenarios that involve transport vehicles with compliant metal containers, the following unique control is credited to reduce the probability of the event:

- Transportation vehicles with compliant metal containers and > 800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).

Also, for the bounded scenarios involving a transport vehicle in route between Area G and RANT, the following unique control is credited to reduce the probability of the event:
• Transportation vehicle requires escort when traveling between TA-54, Area G and RANT with MAR onboard.

Up to 450 PE-Ci, dose consequences are Moderate, Table 3-49, and a rolling roadblock is not required. With the Extremely Unlikely frequency, this results in a mitigated risk rank III. For transports involving greater than 450 PE-Ci up to 615 PE-Ci, dose consequences are High, Table 3-48. The safety-class SAC control to require a rolling roadblock for these transports further reduces the frequency of the event to Beyond Extremely Unlikely, thus also resulting in a risk rank III.

Table 3-49. DBA No. 2A – Mitigated Consequence Analysis; Maximum Inventory without Rolling Roadblock (450 PE-Ci)

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>4.50E-02</td>
<td>4.63E+01</td>
<td>2.08E+00</td>
<td>4.50E+02</td>
<td>2.02E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>2.36E-01</td>
<td>3.17E+01</td>
<td>7.48E+00</td>
<td>3.10E+02</td>
<td>7.32E+01</td>
</tr>
</tbody>
</table>

For bounded scenarios that involve a vehicular fire near MAR, the following unique control is credited to reduce the consequences of the event:

• Defined areas containing only TRU metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas with non-metal containers shall be attended, and limited to a total of 100 gal.

The CHA identified the following ICs that protect the assumptions of the AA:

• TRU Waste Packaging: TRU waste is packaged.
• An SSSR Area equivalent combustible MAR is limited to \( \leq 18 \) PE-Ci in-process, unconfined, and 18 PE-Ci staged, in closed container(s), awaiting processing or removal.
• The SAC, Defined Area MAR Control, limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, LAA, and Transports). The Storage Area MAR limit prohibits storage of TRU waste in a building or dome that has an SSSR Area.
• Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effects on contained waste.

It is noted that the CHA identified the following additional controls for this accident:

• The SAC, TRU Waste Packaging Control—Doublepack, requires doublepacking of radiological waste drums \( \geq 200 \) PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.

Implementation of this control may provide additional reduction in risk. However, this risk reduction cannot be quantified in this DBA.
Conclusion

Overall mitigation for DBA No. 2A

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting vehicle barriers at high-risk locations and thermal separation reduces the dose to the public from 2.46E+01 rem (unmitigated) to 1.31E+01 rem (mitigated), and the dose to the collocated worker is reduced from 2.40E+02 rem (unmitigated) to 1.28E+01 rem (mitigated) and reduces the frequency from Unlikely to Extremely Unlikely. For vehicle transports with up to 450 PE-Ci in non-compliant metal or non-metal containers, the dose consequences are Moderate, and a risk rank III is achieved. For transports involving non-compliant containers with more than 450 PE-Ci up to 615 PE-Ci, High doses are still incurred. However, the safety-class SAC requirement for a rolling roadblock when transporting non-compliant containers with MAR > 450 PE-Ci reduces the frequency of the event to Beyond Extremely Unlikely. In this case, a mitigated risk rank III is also achieved.

The requirement for a rolling roadblock during high-MAR transports effectively prevents those accidents that result in the listed High consequences. Also, it should be noted that the majority of waste transportation involves compliant (metal) waste containers, which have lower consequences for normal combustible fires.

Several conservatisms are built into the parameters used in the unmitigated analysis. The methodology in the dispersion analysis provides several layers of conservatism, one of which stems from the use of a Gaussian plume model that is conservative for the LANL terrain. This results in a minimum factor-of-4 conservatism in the dose-to-source-term factor. Also, the fuel pool fire and burning waste contribute energy to plume buoyancy, thereby potentially reducing dose consequences, though this is not credited in the consequence analysis.

Based on the credited controls, as well as the conservatisms discussed above, the residual risk from this event is significantly lower than analyzed. Given that Area G is a limited lifetime facility, and the mitigated frequency of this event is Beyond Extremely Unlikely, the residual risk is judged to be acceptable.

Applicability of selected control set for DBA No. 2A to bounded events

Table 3-50 lists the mitigative and preventive controls in DBA No. 2A. Table 3-50 also lists HA events that are bounded by DBA No. 2A, based on event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class by the results of this analysis, though they may not be applicable to the event scenario in DBA No. 2A.

3.4.2.5.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-50 are those that are discussed in the AA as providing protection to the public and collocated workers through significant reduction in consequences or frequency.
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Barriers–High-Risk Locations AGTRU-1-031</td>
<td>Vehicle barrier systems installed at high-risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>SC-SSC</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers. Mitigates the consequences by preventing loaded transportation vehicles from impacting stored waste.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Vehicle/ Equipment Safety Controls – Vehicle Barriers - Non-high-risk AGTRU-1-031</td>
<td>Vehicle crash barrier placement around areas that are non-high-risk locations where TRU waste is stored</td>
<td>AC-SMP</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers</td>
<td>This contributes to defense-in-depth but is not a credited control for this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance AGTRU-1-031</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC (SC Function)</td>
<td>Reduce likelihood of fire progression between defined areas. Reduce radiological consequences by limiting the amount of MAR involved.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – non-Compliant Containers AGTRU-1-031</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>SAC (SC Function)</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>
### Table 3-50. DBA No. 2A – Summary of TSR Safety Controls for Vehicle Accidents with Subsequent Combustible Fire

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Material and Waste Management - TRU Waste Container Integrity</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effect to contained waste</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Storage, Process, within Bldg 54-412, LAA, and Transports). TRU Storage Areas not collocated with SSSR Areas.</td>
<td>IC (SC-Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management - Defined Area MAR Control – SSSR</td>
<td>Limit a SSSR Area equivalent combustible MAR, contained or uncontained, to ≤ 18 PE-Ci in process and ≤ 18 PE-Ci staged.</td>
<td>IC (SS Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Control / Applicable Event</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------</td>
<td>-------</td>
<td>-------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Combustible/ Flammable Liquids Control AGTRU-1-029</td>
<td>Defined areas with TRU metal containers are permitted up to 7 gal of unattended flammable/combustible liquids and up to a total of 100 gal of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas with non-metal containers shall be attended, and limited to a total of 100 gal.</td>
<td>SAC (SC Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>The AA bounds the scenario and consequences of the listed HA event. This control is specific to the bounded HA event and is designated a SC-SAC.</td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers AGTRU-1-027 AGTRU-1-028 AGTRU-1-030 AGTRU-1-073 AGTRU-1-080 BGTRUCMP-1-002 TRU LLW-1-002</td>
<td>Transportation vehicles with compliant metal containers and &gt; 800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>SAC (SC Function)</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>The AA bounds the scenario and consequences of the listed HA events. This control is specific to the bounded HA events and is designated a SC-SAC.</td>
</tr>
</tbody>
</table>
### Table 3-50. DBA No. 2A – Summary of TSR Safety Controls for Vehicle Accidents with Subsequent Combustible Fire

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escort of Transportation Vehicle between TA-54, Area G and TA-54 RANT RANTTOG-1-007 RANTTOG-1-008 RANTTOG-1-009 RANTTOG-1-010 RANTTOG-1-011 RANTTOG-1-012</td>
<td>Transportation vehicle is escorted when traveling between TA-54, Area G and RANT with MAR onboard.</td>
<td>SAC (SC Function)</td>
<td>Reduces the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
<td>The AA bounds the scenario and consequences of the listed HA events. This control is specific to the bounded HA events and is designated a SC-SAC.</td>
</tr>
</tbody>
</table>
3.4.2.6 DBA No. 2B - BGTRUCSK-1-003, Combustible Fire in Trenches

3.4.2.6.1 Scenario Development

This DBA involves a fire near TRU waste drums retrieved from the trenches (Trenches A through D). The fire results in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Equipment malfunction
- Ignition source
- Lightning
- Seismic event

Assumptions

- The total MAR is 7,500 PE-Ci (ten Trench A-D drums at 750 PE-Ci each)
- The waste is 100% combustible.

3.4.2.6.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 7,500 PE-Ci.

DR

The MAR in the drums experiences confined burning, DR = 1.0.

ARF × RF

The ARF × RF value for confined burning of combustible waste is shown in Table 3-51.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined burning</td>
<td>5E-04</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:
- Fires = 3.75E+00 PE-Ci

### 3.4.2.6.3 Consequence Analysis

Table 3-52 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for calculating public doses for the fire in the trenches with no buoyancy is 9.6E+00 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from the DSF value of 3.10E+02 rem/PE-Ci.

| Component | ST (PE-Ci) | Public | | Collocated Worker | |
|-----------|------------|--------|-----------------|------------------|
| Fire      | 3.75E+00   | 9.60E+00 | 3.60E+01        | 3.10E+02         |
|           |            | Dose (rem) | 1.16E+03        |
|           |            | DSF (rem/PE-Ci) | Dose (rem) | Dose (rem) |
| Total Public Dose | 3.60E+01 | 1.16E+03 |
| Total Collocated Worker Dose | 1.16E+03 |

#### Table 3-52. DBA No. 2B – Unmitigated Consequence Analysis

### 3.4.2.6.4 Comparison to the Evaluation Guideline

The unmitigated 3.60E+01 rem dose to the public is High and exceeds the EG. In addition, the unmitigated dose of 1.16E+03 rem to the collocated workers is High.

**Analysis**

**Event Frequency/Risk Rank**

This unmitigated event has High consequences to the public and collocated worker receptors and an unmitigated frequency of Anticipated. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

**Control Selection**

The unmitigated dose of 3.60E+01 rem from the fire is High to the public. Thus, the control selection is focused on reducing the frequency and consequences of the fire.

Reviewing the available controls, it is not possible to select an engineered control to prevent the initiating combustible fire. To reduce the frequency of this event, the CHA has identified the following controls:

- Fire Protection Program SAC – Control of Transient Combustibles, reduces the likelihood of fire progression within a defined area.
- Fire Protection Program SAC – Thermal Separation Distance, reduces the likelihood of fire propagation between defined areas

Additional controls are credited to reduce the frequency of some of the bounded events:
The SMP, Maintenance Program, is credited for requiring periodic inspection and maintenance of LANL vehicles/equipment (e.g., forklift, transport truck). This control reduces the frequency of equipment malfunction, which could trigger a fire.

The SMP, Fire Protection Program, transient combustible controls (e.g., housekeeping, vegetation control, and periodic inspections) reduces the frequency of initiation and the fire size.

The SMP, Training and Qualification Program, is credited for requiring that personnel performing activities are trained to a job hazards analysis to reduce the frequency of ignition of flammables/combustibles.

The implementation of the SACs reduces the mitigated event frequency to Extremely Unlikely, for an (initial) mitigated risk rank II. An additional control reduces the consequences of the event:

- The SAC limiting the Retrieval Area exposed MAR to 1,500 PE-Ci is credited for reducing the mitigated consequences to 7.2 rem for the public.

The mitigated dose consequences that result from limiting the MAR to 1,500 PE-Ci are presented in Table 3-53.

**Table 3-53. DBA No. 2B – Mitigated Consequence Analysis; Effect of MAR Limit**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.60E+00</td>
<td>7.20E+00</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>7.20E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

The implementation of this MAR control reduces the calculated doses. The consequences to the public are reduced to Moderate; however, the consequences to the collocated workers are still High. Given the mitigated Extremely Unlikely frequency, the mitigated risk rank is III for the public and risk rank II for the collocated workers.

Another control to further reduce consequences is a SAC that reduces the damage ratio of drums involved in a fire.

- The safety-significant SAC, TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.

With this control to reduce the source terms, the mitigated dose for the public is Low (less than one rem) and the dose to the collocated worker is Moderate (23.3 rem). The final mitigated risk rank is IV for the public and III for the collocated workers.

The CHA identified the following IC that protects the assumption in the AA:

- TRU waste is packaged, reducing the radiological consequences as waste is agglomerated and burns as packaged.

**Conclusion**
Overall mitigation for DBA No. 2B

Based on the credited controls selected and the ICs identified, reductions in consequences and frequency are achieved. Crediting a Fire Protection SAC requiring a thermal separation distance and another Fire Protection SAC for control of transient combustibles reduces the frequency from Anticipated to Extremely Unlikely. The MAR limit for the retrieval area reduces the dose to the public from 4.95E+01 rem (unmitigated) to 7.21E-01 rem (mitigated).

Applicability of selected control set for DBA No. 2B to bounded events

Table 3-54 lists the mitigative and preventive controls in DBA No. 2B. Table 3-43 also lists HA events that are bounded by DBA No. 2B, based on the event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed, though they may not be applicable to the event scenario in DBA No. 2B.

3.4.2.6.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-54 are those that are discussed in the AA as providing protection to the public and collocated workers through significant reduction in consequences or frequency, or contributing to defense-in-depth.
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Protection Program – Good Housekeeping and Inspections BGTRUCSK-1-003 BGTRUPIT-1-017</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections) to include inspection by LANL FPE</td>
<td>AC-SMP</td>
<td>Reduces the likelihood of fire progression</td>
<td>This is credited for a bounded HA event.</td>
</tr>
<tr>
<td>Training and Qualification Program – Hazards Recognition BGTRUCSK-1-003 BGTRUPIT-1-017</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>AC-SMP</td>
<td>Reduces likelihood and/or consequence for job-hazard-related accidents, including those related to building/facility operations, process operations, and ignition of flammables/combustibles</td>
<td>This is credited for a bounded HA event.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Retrieval Area MAR Limit BGTRUCSK-1-003 BGTRUCSK-1-007</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>SAC (SC Function)</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>Fire Protection – Control of Transient Combustibles – Fuel Package Limit BGTRUCSK-1-003 BGTRUPIT-1-017</td>
<td>Transient combustible controls within defined areas. Transient fuel packages &gt; 100 lb are attended. Unattended transient combustible fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft from metal containers by a minimum of 3 ft in order to reduce fire progression</td>
<td>SAC (SS Function)</td>
<td>Reduces the likelihood of fire progression within a defined area</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>Control / Applicable Event</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------</td>
<td>-------</td>
<td>--------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC</td>
<td>Reduces the likelihood of fire propagation between defined areas by limiting heat flux to radiological waste containers.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>BGTRUCSK-1-003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DoublePacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches A-D Retrieval Activities</td>
<td>Doublepack radiological waste drums &gt; 200 PE-Ci</td>
<td>SAC</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>BGTRUCSK-1-016</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>IC</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA and the listed bounded HA events.</td>
</tr>
<tr>
<td>BGTRUCSK-1-003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BGTRUPIT-1-017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BGTRUCSK-1-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.7 DBA No. 3 - AGTRU-1-041, Large Combustible Fire

3.4.2.7.1 Scenario Development

This DBA involves a small fire within a stored TRU waste array of non-compliant, non-metal containers (e.g., FRPs) that propagates to an additional array of non-metal Pit 9 containers in addition to a storage array of compliant (metal) containers (e.g., drums) within a Storage Area. The fire involves waste in FRPs and drums with a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The cause is the propagation of a small combustible fire event.

Assumptions

- The fire spreads to affect all drums in all containers.
- The MAR involved in this event is as follows:
  - 22,000 PE-Ci (compliant [metal] TRU waste containers)
  - 2,000 PE-Ci (non-metal above-ground TRU)
  - 1,500 PE-Ci (non-metal containers retrieved from Pit 9)
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.13%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%
- The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.7%
  - Dispersible, non-combustible: 95.3%
  - Non-dispersible, non-combustible: 0%
- The percentage composition of each waste type in the statistical Pit 9 non-metal container used in the analysis is taken from Table 3-22 (Section 3.4):
  - Combustible: 0.1%
  - Dispersible, non-combustible: 99.9%
  - Non-dispersible, non-combustible: 0.0%
- Non-metal container waste burns agglomerated.
- The waste is assumed to burn for 20 min. Buoyancy is not modeled for the releases for conservatism.

3.4.2.7.2 Source Term Analysis

MAR
The unmitigated MAR for the event is as follows:

- AGTRU compliant (metal) containers (e.g., drums) = 22,000 PE-Ci
- AGTRU non-metal containers (e.g., FRP boxes) = 2,000 PE-Ci
- BGTRU Pit 9 non-metal containers (e.g., FRP boxes) = 1,500 PE-Ci

The total unmitigated MAR used in this analysis is 25,500 PE-Ci.

**DR**

- The MAR in the drums (compliant [metal] containers) experiences confined burning, DR = 0.5
- The MAR in the FRPs (non-metal containers) experiences confined burning, DR = 1.0

**ARF × RF**

The ARF × RF values for confined burning for each of the waste types are shown in Table 3-55.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Fires = 4.56E-01 PE-Ci

### 3.4.2.7.3 Consequence Analysis

Table 3-56 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the fire with no buoyancy is 3.17E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF value of 3.10E+02 rem/PE-Ci.
Table 3-56. DBA No. 3 – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>4.56E-01</td>
<td>3.17E+01</td>
<td>1.44E+01</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>1.44E+01</td>
<td></td>
</tr>
</tbody>
</table>

3.4.2.7.4 Comparison to the Evaluation Guideline

The unmitigated 1.44E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 1.41E+02 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

The unmitigated frequency of a small fire is Anticipated. It is conservatively assumed that the frequency of the small fire propagating into a large fire is Unlikely, due to the limited combustibles in a defined area. The unmitigated event has High consequences to the public and collocated workers. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

Control Selection

The unmitigated dose of 1.44E+01 rem from the fire is High to the public. Thus the control selection is focused on reducing the consequences of the fire STs related to the MAR involved in the accident and on reducing the frequency of the fire event.

Reviewing the available controls, it is not possible to select an engineered control to prevent the initiating combustible fire event. The feasibility of a fire suppression system is discussed in Section 3.3.2.3.2.9(4). To reduce the frequency of this event, the CHA has identified the following controls:

- The safety-class SAC requiring that hot work is prohibited without a stationary fire watch in TRU waste container storage areas.
- The safety-significant SAC, Thermal Separation Distance, will reduce the likelihood of fire progression between defined areas.

These controls reduce the frequency of the event to Extremely Unlikely. Given the High consequences, a mitigated risk rank II is achieved.

To reduce the consequences of a fire, these additional controls are credited:

- The safety-class SAC for MAR limits in Storage Areas. For a non-compliant metal or non-metal waste container Storage Area, the MAR limit is 2,000 PE-Ci. If only metal waste containers are
present in a Storage Area, the MAR limit is 22,000 PE-Ci. If a Storage Area contains both metal and non-metal waste containers, the more restrictive non-metal Storage Area MAR limit applies.

- The safety-significant SAC, Control of Transient Combustibles, limits fire progression within a defined area so that MAR involvement is limited.

The implementation of the Storage Area inventory controls reduces the ST in the accident, thereby mitigating the dose consequences to the public to 5.10E+00 rem based on a MAR limit of 2,000 PE-Ci in the non-compliant (metal and/or non-metal) waste container Storage Area, or 6.47E+00 rem if the fire occurred in a Storage Area with 22,000 PE-Ci in metal waste containers. The mitigated consequences to the public and collocated workers are Moderate, as shown in Table 3-57. Given the Extremely Unlikely mitigated frequency, a risk rank III is achieved.

**Table 3-57. DBA No. 3 – Mitigated Consequence Analysis; Effect of Non-Metal Container TRU Storage Area MAR Limit (2,000 PE-Ci)**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>1.61E-01</td>
<td>3.17E+01</td>
<td>5.10E+00</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>5.10E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>2.04E-01</td>
<td>3.17E+01</td>
<td>6.47E+00</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>6.47E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

The CHA identified the following ICs that protect the assumptions of the AA:

- Radiological waste is packaged reducing the radiological consequences as waste is agglomerated and burns as packaged.
- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effect to contained waste.

**Conclusion**

**Overall mitigation for DBA No. 3**

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting the thermal separation and MAR limit controls reduces the dose to the public from
1.44E+01 rem (unmitigated) to 5.10E+00 rem or 6.47E+00 rem (mitigated, for a non-metal or metal storage area fire, respectively), and reduces the dose to the collocated workers from 1.41E+02 rem (unmitigated) to 5.00E+01 rem or 6.32E+01 rem (mitigated). Crediting the SACs on thermal separation distances and hot work prohibitions without a stationary fire watch reduces the frequency from Unlikely to Extremely Unlikely for a mitigated risk rank III.

Applicability of selected control set for DBA No. 3 to bounded events

DBA No. 3 bounds several HA events, as indicated in the hazard evaluation. The controls designated as safety-class are also safety-class for the bounded HA events.

3.4.2.7.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-58 are those that are discussed in the AA as providing protection to the public and collocated workers through significant reduction in consequences or frequency. Other controls that provide defense-in-depth are also listed.
### Table 3-59. DBA No. 3 – Summary of TSR Safety Controls for Large Combustible Fire

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary Fire Watch during Hot Work</td>
<td>Hot work is prohibited without a stationary fire watch within TRU waste storage areas</td>
<td>SAC (SC Function)</td>
<td>Reduce likelihood for ignition of flammables/combustibles</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduce likelihood of fire progression between defined areas.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Control of Transient Combustibles – Fuel Package Limit</td>
<td>Transient combustible controls within defined areas. Transient fuel packages &gt; 100 lb are attended. Unattended transient combustible fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal containers by a minimum of 3 ft in order to reduce fire progression</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences of a fire by limiting fire progression within a defined area and the amount of MAR involved.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Storage, Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC (SC Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>Control / Applicable Event</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste container in have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.8 DBA No. 4A – AGTRU-2-028, Single Container Deflagration Caused by Shock

3.4.2.8.1 Scenario Development

This DBA involves a single unvented TRU waste drum which is violently shaken during handling, resulting in a deflagration and a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Container mishandling
- Container toppling
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock-sensitive material
- Vehicle impact

Assumptions

- The MAR is 553 PE-Ci (one maximum compliant [metal] TRU waste container) – This is a conservative assumption for this accident, though the value is used to be consistent with the statistical method in DOE-STD-5506 [DOE 2007] in determining MAR. The container with 553 PE-Ci is a non-dispersible, non-combustible waste form within an 85-gal overpack; however, in this analysis, the 553 PE-Ci is considered as the MAR within an unvented drum.
- The MAR is 100% combustible

3.4.2.8.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 553 PE-Ci.

DR

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 × 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6
ARF × RF

The ARF × RF values for spill/flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-59.

Table 3-60. DBA No. 4A – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 2.21E-02 PE-Ci
- Fires = 2.77E-01 PE-Ci

3.4.2.8.3 Consequence Analysis

Table 3-60 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the deflagration and flexing in air is 5.33E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

Table 3-61. DBA No. 4A – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>2.21E-02</td>
<td>5.33E+01</td>
<td>1.18E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>2.77E-01</td>
<td>3.65E+01</td>
<td>1.01E+01</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>1.13E+01</td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>
3.4.2.8.4 Comparison to the Evaluation Guideline

The unmitigated 1.13E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 9.57E+01 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

Control Selection

The unmitigated dose contribution of 1.01E+01 rem from the fire dominates the total dose to the public (1.13E+01 rem). The dose from the spill term is 1.18E+00 rem. Since the two components are the result of the same event and cannot be separated, control section is focused on reducing the consequences and frequency of the deflagration.

To reduce the consequences of the event, the following is credited:

- The safety-class SAC requires doublepacking of radiological waste drums > 200 PE-Ci, to reduce the radiological consequences by limiting the amount of MAR involved.

DOE-STD-5506 indicates that unvented containers that are double-packed can be modeled as a confined burn with a DR=0.1 because there is no lid loss and ejection of contents. Therefore, the 553 PE Ci deflagration is mitigated to approximately 1 rem. The Trenches A through D drum with a 100% combustible waste matrix has a MAR content of 621 PE-Ci. If this drum is retrieved and stored in the above-ground storage array, and deflagrates within the doublepack, the dose consequence is approximately 1.1 rem to the public and 9.6 rem to the collocated worker. The control of a doublepack reduces consequences to Moderate to the public and Low to the collocated worker. The deflagration of an unvented drum with MAR at 199 PE–Ci and not within a doublepack is 4.1 rem to the public and 34.4 rem to the collocated worker; also Moderate consequences, risk rank II.

The Moderate dose consequences and risk rank II require the selection of safety-significant controls for protection of the collocated worker and public receptors. The reduction in frequency of this DBA can be accomplished through the isolation of unvented containers and the requirement of not stacking unvented containers:

- The safety-significant SAC requires isolation of unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container, and thus reduces the frequency of deflagration.

- The safety-significant SAC, Hazardous Material and Waste Management Program, requires that unvented TRU waste drums are not stacked, reducing the frequency of inadvertent container toppling or consequences from a sympathetic deflagration.

Additional preventative controls further reduce the frequency of the event:
The safety-significant SAC requires that a spotter support forklift and crane operations during elevated lifts (> 4 to < 12 feet) placement/ removal (e.g., stacking/ unstacking, loading/ unloading) of TRU waste containers, which reduces the frequency of container puncture, topple, and impacts.

The safety significant SAC requires a critical lift plan for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface.

These controls reduce the frequency to Extremely Unlikely, and a risk rank III is achieved.

Some of the bounded HA scenarios credit additional controls for reduction of event frequency:

- The SMP, Training and Qualification Program, requires that personnel maintain applicable LANL qualifications for vehicle and equipment operation to reduce the frequency of improper vehicle operation.
- The SMP, Maintenance Program, requires periodic inspection and maintenance of LANL vehicles/ equipment (e.g., forklift, transport truck). This control reduces the frequency of equipment malfunction that may result in dropping or toppling the containers.

Some of the bounded scenarios involve impact by a missile generated by a gas cylinder and rely on the additional control to further reduce the frequency of the event:

- The SAC, Acetylene Cylinders Control, prohibits the storage or use of acetylene cylinders inside or within 50-feet of defined areas where MAR is present.

It is noted that the CHA identified an additional control for this accident (mainly for the protection of the worker, and providing a major contribution to defense-in-depth for the collocated worker and public receptors):

- The safety-significant SAC requires that unvented TRU waste drums are handled and/or transported using lid restraints and either blast shields or safe standoff distances to reduce the physical consequences by limiting debris dispersion.

The CHA identified no ICs for this event.

Conclusion

Overall mitigation for DBA No. 4A

Based on the credited controls selected and discussed, reductions in consequences and frequency are achieved. Crediting the safety-class SAC requirement for doublepacking drums with > 200 PE-Ci mitigates the High dose consequences from the 553 PE-Ci deflagrating drum to Moderate consequences. A postulated unvented drum with MAR = 199 PE-Ci, not required to be within a doublepack, can deflagrate with mishandling, also leading to Moderate consequences. Reduction in frequency is achieved by crediting safety-significant SACs on isolating and not stacking unvented containers, requiring a spotter for lifts between 4 and 12 ft and a critical lift plan for lifts greater than 12 ft, for an overall mitigated risk rank III.

Applicability of selected control set for DBA No. 4A to bounded events

DBA No. 4A bounds several HA events, as indicated in the hazard evaluation and in Table 3-61. The controls designated as safety-class are also safety-class for the bounded HA events.
3.4.2.8.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-61 are those that are discussed in the AA as providing protection to the public and collocated worker, and reduction in frequency. Other ACs that protect the assumptions of the analysis are provided in the hazard evaluation and summarized in Section 3.3. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
### Table 3-62. DBA No. 4A - Summary of TSR Safety Controls for Single Container Deflagration Caused by Shock

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SC Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood of deflagration</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste drums are not stacked</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood of inadvertent container toppling.</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/ crane operations during elevated lifts (&gt; 4 to ≤ 12 ft) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for container puncture, topple, and impacts</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
</tbody>
</table>
### Table 3-62. DBA No. 4A - Summary of TSR Safety Controls for Single Container Deflagration Caused by Shock

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene Cylinder Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
<td>SAC</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste.</td>
<td>The AA bounds the scenario and consequences of the listed HA event.</td>
</tr>
<tr>
<td>AGTRU-2-012</td>
<td>AGTRU-2-034</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-2-034a</td>
<td>BGTRUPIT-2-001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-2-004</td>
<td>BGTRUPIT-2-013</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRU Waste Container Management – Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and either blast shields, or safe standoff distance of ≥ 30 ft between the unvented TRU waste container and the worker</td>
<td>SAC</td>
<td>Reduces radiological consequences by ensuring contained burning and reduces physical consequences by limiting debris dispersion</td>
<td>This is a credited control for this DBA and the listed bounded HA event, and is predominantly a worker protection control, though it provides a major contribution to defense-in-depth for the public and collocated worker receptors.</td>
</tr>
<tr>
<td>AGTRU-2-028</td>
<td>AGTRU-2-028a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.9 DBA No. 4B – DELETED

Table 3-63. Deleted

Table 3-64. Deleted

3.4.2.10 DBA No. 4C – AGTRU-2-015, Single Container Deflagration Caused by Puncture

3.4.2.10.1 Scenario Development

This DBA involves a single unvented above-ground TRU waste container that is penetrated during drum venting, resulting in a deflagration and a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Chemical reaction
- Electrical discharge
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Metal-to-metal contact
- Static electricity
- Operator error

Assumptions

- The hazard analysis considered a MAR value of up to 1,100 PE-Ci, the Drum Venting Process Area MAR limit. This MAR value is conservative when compared to 553 PE-Ci, the highest MAR in a single, above-ground, TRU waste container, as specified for the statistical method in DOE-STD-5506 [DOE 2007] in determining MAR for a single container event. The range of MAR values in the accident analysis is selected based on cut-off MAR values leading to low, moderate, or high receptor consequences, and the current above-ground and below-ground inventory of waste containers.

- The MAR is 100% combustible. Because the analysis assumes a 100% combustible waste matrix, the units for this DBA are in Equivalent Combustible PE-Ci, though this unit designation is not repeated in the analysis for brevity.

3.4.2.10.2 Source Term Analysis

MAR

The range of MAR values used is:

\[ \leq 45 \text{ PE-Ci} \]
> 45 PE-Ci and < 480 PE-Ci

> 480 PE-Ci and < 1,100 PE-Ci

**DR**

- Flexing in air of waste ejected from drum following lid loss, \( DR = 0.4 \) (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, \( DR = 0.4 \times 0.05 = 0.02 \)
  - All the waste remaining in the drum burns confined, \( DR = 0.6 \)

**ARF \times RF**

The ARF \times RF values for spill/flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-65.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The public maximum unmitigated STs for each MAR range are as follows:

<table>
<thead>
<tr>
<th>MAR</th>
<th>Fire</th>
<th>Spill</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 45 \text{ PE-Ci} )</td>
<td>2.25E-02</td>
<td>1.80E-03</td>
</tr>
<tr>
<td>&gt; 45 PE-Ci and ( \leq 480 \text{ PE-Ci} )</td>
<td>2.40E-01</td>
<td>1.92E-02</td>
</tr>
<tr>
<td>&gt; 480 PE-Ci and ( \leq 1,100 \text{ PE-Ci} )</td>
<td>5.50E-01</td>
<td>4.40E-02</td>
</tr>
</tbody>
</table>

### 3.4.2.10.3 Consequence Analysis

Table 3-66 is a summary of the unmitigated public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the deflagration and flexing in air is 5.33E+01 rem PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE-Ci (fire).
### Table 3-66. DBA No. 4C – Maximum Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.80E-03</td>
<td>5.33E+01</td>
<td>9.59E-02</td>
</tr>
<tr>
<td>Fire</td>
<td>2.25E-02</td>
<td>3.65E+01</td>
<td>8.21E-01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>9.17E-01</td>
<td>Total Collocated Worker Dose</td>
<td>7.79E+00</td>
</tr>
<tr>
<td>Spill</td>
<td>1.92E-02</td>
<td>5.33E+01</td>
<td>1.02E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>2.40E-01</td>
<td>3.65E+01</td>
<td>8.76E+00</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>9.78E+00</td>
<td>Total Collocated Worker Dose</td>
<td>8.30E+01</td>
</tr>
<tr>
<td>Spill</td>
<td>4.40E-02</td>
<td>5.33E+01</td>
<td>2.35E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>5.50E-01</td>
<td>3.65E+01</td>
<td>2.10E+01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>2.24E+01</td>
<td>Total Collocated Worker Dose</td>
<td>1.90E+02</td>
</tr>
</tbody>
</table>

### 3.4.2.10.4 Comparison to the Evaluation Guideline

**MAR < 45 PE-Ci**

The maximum unmitigated 9.17E-01 rem dose to the public is Low. In addition, the maximum unmitigated dose of 7.79E+00 rem to the collocated workers is Low.

**MAR > 45 PE-Ci and < 480 PE-Ci**

The maximum unmitigated 9.78E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the maximum unmitigated dose of 8.30E+01 rem to the collocated workers is Moderate.

**MAR > 480 PE-Ci and < 1,100 PE-Ci**

The maximum unmitigated 2.24E+01 rem dose to the public is High and challenges the EG. In addition, the maximum unmitigated dose of 1.90E+02 rem to the collocated workers is High.

**Analysis**

**Event Frequency/Risk Rank**

**MAR ≤ 45 PE-Ci**
This unmitigated event has low consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank III binning for the unmitigated event. Control selection for all receptors is discussed further below when venting drums with a maximum MAR value of 45 PE-Ci.

**MAR > 45 PE-Ci and ≤ 480 PE-Ci**

This unmitigated event has Moderate consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event. Control selection for all receptors is discussed further below when venting drums with MAR within this range.

**MAR > 480 PE-Ci and ≤ 1,100 PE-Ci**

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Control selection for all receptors is discussed further below when venting drums with MAR within this range.

**Control Selection**

The control selection is focused on reducing the frequency or mitigating the consequences of the deflagration. However, reviewing the available controls, it is not possible to select a single engineered control that will reduce the frequency or mitigate the consequences for all postulated initiators.

To mitigate the radiological consequence of a drum deflagration, controls for the protection of the collocated worker and public are selected as a function of the MAR content in the waste container undergoing venting. There are no physical hazards to the collocated worker or public receptor as a result of deflagration fragments or overpressure.

Worker protection controls are summarized in Section 3.3. Appendix 3I provides additional information on their use.

**Venting Drums with MAR ≤ 45 PE-Ci**

When venting drums with MAR ≤ 45 PE-Ci and a 100% combustible waste matrix, the unmitigated consequence analysis shows low consequences for the public and collocated worker, as summarized in Table 3-67. Unmitigated risk ranks are also shown in Table 3-67, given the unmitigated Anticipated frequency.
Table 3-67. Maximum Unmitigated Collocated Worker and Public Dose/Risk Rank; Venting Drums with MAR ≤ 45 PE-Ci

<table>
<thead>
<tr>
<th>MAR (PE-Ci) (combustible equivalent waste)</th>
<th>Collocated Worker Dose (rem)/Risk-Rank</th>
<th>Public Dose (rem)/Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 45*</td>
<td>7.79E+00/III</td>
<td>9.17E-01/III</td>
</tr>
</tbody>
</table>

* The dose consequence associated with 45 PE-Ci in a 100% combustible waste matrix is comparable to those of 265 PE-Ci in a 100% non-combustible, dispersible waste matrix, and 610 PE-Ci in a 100% non-combustible, non-dispersible waste matrix. The corresponding ARF × RF values for these waste matrices can be found in other DBAs that consider all waste matrices, such as Table 3-28.

In this case, no safety-class or safety-significant controls are required to protect public or collocated worker receptors from the radiological hazard.

**Venting Drums with MAR > 45 PE-Ci and ≤ 480 PE-Ci**

When venting drums with MAR > 45 PE-Ci and ≤ 480 PE-Ci, the unmitigated consequence analysis shows Moderate consequences to both the public and collocated worker, summarized in Table 3-68. Unmitigated risk ranks are also shown in Table 3-68, given the unmitigated Anticipated frequency.

Table 3-68. Collocated Worker and Public Dose/ Risk Rank; Unmitigated Consequences and Frequency

<table>
<thead>
<tr>
<th>MAR (PE-Ci) (combustible equivalent waste)</th>
<th>Collocated Worker Dose (rem)/Risk-Rank</th>
<th>Public Dose (rem)/Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 480 PE-Ci</td>
<td>8.30E+01/II</td>
<td>9.78E+00/II</td>
</tr>
</tbody>
</table>

The unmitigated analysis indicates the need for safety-significant controls for the collocated worker and public receptors.

The following control is credited for reducing the frequency of the event:

- The safety-significant SAC requires that equipment/ tools and processes used to penetrate/ breach the TRU waste container must minimize mechanically-induced sparking, thereby reducing the frequency for ignition of flammables/ combustibles or deflagration.

This control reduces the frequency of the event to Unlikely. An additional safety-significant control is required to reduce consequences. The following control is credited:

- The safety-significant SAC on venting requires that drum venting equipment provide protection from deflagration fragments (blast-mitigation device, e.g. lid restraint or doublepack). As a worker protection control, this control also requires the establishment of a safe standoff distance for workers.

The purpose of this control is to protect against lid loss in free space, thereby mitigating dose consequences. When a lid restraint is utilized, for example, the DR=1.0 as all waste burns, but in a confined manner. The lid restraint prevents ejection of material, but the lid seal failure is such that all of...
the contained waste is assumed to have sufficient air ingress to burn completely, supporting an ARF × RF value of 5E-04 and DR=1.0. Mitigated dose consequences and risk ranks are shown in Table 3-69.

**Table 3-69. Maximum Mitigated Collocated Worker and Public Dose/ Risk Rank; Venting Drums with a Lid Restraint Installed, and with MAR > 45 PE-Ci and ≤ 480 PE-Ci, DR=1, ARF × RF=5E-4**

<table>
<thead>
<tr>
<th>MAR (PE-Ci) (combustible equivalent waste)</th>
<th>Collocated Worker Dose (rem)/Risk-Rank</th>
<th>Public Dose (rem)/Risk-Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 480 PE-Ci</td>
<td>7.4E+1/II</td>
<td>8.8E+00/II</td>
</tr>
</tbody>
</table>

The following element of the Radiation Protection Program control would further reduce radiological consequences:

- The Radiation Protection Program requires that venting of unvented drums be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.

The use of a contamination-controlled environment prevents the spread of released contents by wind or the ambient atmosphere. A contamination-controlled environment may be achieved through the use of an enclosure, a hood, a drum venting chamber, or another device with air flow and filtration sufficient to fulfill the requirements of the Radiation Protection Program.

Although not quantified, fulfillment of this Radiation Protection Program requirement is expected to reduce public and worker consequences to near zero.

**Venting Drums with MAR > 480 PE-Ci and ≤ 1,100 PE-Ci**

When venting drums with MAR > 480 PE-Ci but < 1,100 PE-Ci, the maximum unmitigated consequence analysis shows High consequences for the public and collocated worker, summarized in Table 3–70. Unmitigated risk ranks are also shown in Table 3-70, given the unmitigated Anticipated frequency for the deflagration.

**Table 3-70. Maximum Unmitigated Collocated Worker and Public Dose/ Risk Rank; Venting Drums with MAR > 480 PE-Ci and ≤ 1,100 PE-Ci**

<table>
<thead>
<tr>
<th>MAR (PE-Ci) (combustible equivalent waste)</th>
<th>Collocated Worker Dose (rem)/Risk-Rank</th>
<th>Public Dose (rem)/Risk-Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1,100</td>
<td>1.90E+02/I</td>
<td>2.24E+01/I</td>
</tr>
</tbody>
</table>

The unmitigated analysis indicates the need for safety-class controls for the public, and safety-significant controls for the collocated worker. The safety-class control is selected for its ability to reduce consequences.

The following control is credited for reducing the frequency of the event:

- The safety-significant SAC requirement that equipment/ tool design controls and processes used to penetrate/ breach TRU waste container must minimize mechanically-induced sparking, reducing the frequency for ignition of flammables/ combustibles or deflagration.
This control mitigates the frequency of the event to Unlikely, and is designated as safety-significant, because the mitigated risk rank with this control (risk rank I) is the same as the unmitigated risk rank (risk rank I).

Mitigation of dose consequences is achieved through the use of a doublepack when venting drums, which is the safety-class control:

- The safety-class SAC requires that unvented drums with MAR > 480 PE-Ci will be vented through a doublepack.

When venting drums through a doublepack with MAR > 480 PE-Ci, the consequence analysis for 1,100 PE-Ci shows low consequences for the collocated worker, and moderate consequences for the public, Table 3-71.

### Table 3-71. Maximum Mitigated Collocated Worker and Public Dose/ Risk Rank; Venting Drums through a Doublepack, and with MAR > 480 PE-Ci and ≤ 1,100 PE-Ci, DR = 0.1, ARF × RF = 5E-4

<table>
<thead>
<tr>
<th>MAR (PE-Ci) (combustible equivalent waste)</th>
<th>Collocated Worker Dose (rem)/Risk-Rank</th>
<th>Public Dose (rem)/Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1,100 PE-Ci</td>
<td>1.70E+01/III</td>
<td>2.01E+00/II*</td>
</tr>
</tbody>
</table>

* A MAR=545 PE-Ci combustible waste is the threshold where Low consequences to the public result when venting through a doublepack.

The following element of the Radiation Protection program control would further reduce radiological consequences:

- The Radiation Protection Program requires that venting of unvented drums be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.

The use of a contamination-controlled environment prevents the spread of released contents by wind or the ambient atmosphere. A contamination-controlled environment may be achieved through the use of an enclosure, a hood, a drum venting chamber, or other device with airflow and filtration sufficient to fulfill the requirements of the Radiation Protection Program.

Although not quantified, fulfillment of this Radiation Protection Program requirement is expected to reduce public and worker consequences to near zero.

### Conclusion

**Overall mitigation for DBA No. 4C**

Based on the credited controls selected and discussed, i.e., the use of non-sparking processes and/or equipment during drum venting, the use of a lid restraint or doublepack when venting drums of a certain MAR value (in equivalent combustible waste), and the dependence on the contamination-controlled environment as required by the Radiation Protection Program, the hazard associated with drum venting is judged to be adequately mitigated.

The selected SAC controls are acceptable when accounting for situations where the facility encounters unvented drums with MAR > 45 PE-Ci (equivalent combustible waste).
There are no known drums in the above-ground inventory with a 100% combustible waste matrix and with MAR > 480 PE-Ci and < 1,100PE-Ci.

Most of the unvented drums retrieved from Pit 9 with a 100% combustible waste matrix contain MAR < 45 PE-Ci. There are approximately 60 unvented drums to be retrieved from Trenches A through D that contain MAR > 480 PE-Ci and are comprised of a combustible or non-combustible waste matrix.

Applicability of selected control set for DBA No. 4C to bounded events

None

3.4.2.10.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-72 are those discussed in the AA as providing protection to the public and collocated workers through reduction in frequency or consequences. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 and Appendix 3I for a discussion of the facility worker controls in the deflagration event.)
### Table 3-72. DBA No. 4C - Summary of TSR Safety Controls for Single Container Deflagration Caused by Puncture

<table>
<thead>
<tr>
<th>Control</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>The equipment or process used to penetrate the lid of an unvented TRU waste drum must be of the type that does not produce mechanically-induced sparks. A vented 55-gallon, 85-gallon, or 110-gallon TRU waste drum that contains an unvented inner drum is considered an unvented drum for the purposes of this SAC.</td>
<td>SAC (SS Function)</td>
<td>Reduces the likelihood of a deflagration by reducing the likelihood of a mechanically-induced (frictional) spark that could ignite a flammable gas mixture that may exist within the unvented TRU waste drum.</td>
<td>Credited control in DBA</td>
</tr>
<tr>
<td>AGTRU-2-015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>An established safe stand-off distance provides protection for workers.</td>
<td>SAC (SS Function)</td>
<td>Reduces consequences to workers resulting from deflagration</td>
<td>Credited control in DBA</td>
</tr>
<tr>
<td>AGTRU-2-015</td>
<td>Unvented TRU waste drum with MAR ≤ 480 PE-Ci equivalent combustible waste shall use a blast-mitigation device (e.g., doublepack or lid restraint).</td>
<td>SAC (SS Function)</td>
<td>Reduces consequences to all receptors resulting from deflagration</td>
<td>Credited control in DBA</td>
</tr>
<tr>
<td>Unvented drums with MAR &gt; 480 PE-Ci will be doublepacked prior to drum venting</td>
<td>SAC (SC Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>Credited control in DBA</td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.11  DBA No. 4D – AGTRU-2-030, Single Container Deflagration during Transportation Accident

3.4.2.11.1 Scenario Development

This DBA involves a vehicle transporting TRU waste at > 10 mph and < 35 mph that is involved in an accident. A single container deflagrates due to violent shaking experienced during the vehicle accident. The deflagration impacts other containers on the transport. The accident is assumed to occur at a location that is the closest to the site boundary. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- Container Mishandled
- Degraded road condition (e.g., erosion, potholes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle equipment mechanical failure (e.g., steering, brakes)
- Violent shaking

Assumptions

- Forty-eight compliant (metal) containers are being transported by the vehicle (the transport MAR limit is conservatively assumed, instead of the statistically calculated MAR equal to 864 PE-Ci, including the four statistically high MAR drums).
- The percentage composition of each waste type in the statistical compliant (metal) containers used for the above-ground compliant (metal) containers in the analysis, other than the drum that undergoes deflagration, is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%
- The Maximum MAR drum is the drum that deflagrates. This drum is assumed to contain 100% combustible waste.
- The remainder of the containers on the truck experience moderate stress (DR = 0.1) from the impact, consistent with Table 4.4.4-1, item 5, of DOE-STD-5506-2007 [DOE 2007] for vehicles traveling > 10 mph and < 35 mph.
3.4.2.11.2 Source Term Analysis

MAR

The unmitigated MAR for the event is determined as follows:

- Deflagrating Drum = 553 PE-Ci
- Drums experiencing moderate stress = 547 PE-Ci

The total unmitigated MAR used in this analysis is 1,100 PE-Ci.

DR

DRs are considered for the MAR that undergoes a deflagration and that experiences a Low-Energy Impact.

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 × 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6
- Spill from moderate stress, DR = 0.1

ARF × RF

The ARF × RF values for spill/ flexing in air, confined burning, and unconfined burning for each of the waste types are shown in Table 3-73.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. Based on the results of the consequence analysis, the unmitigated STs are as follows:
- Spills = 2.61E-02 PE-Ci
- Fires = 2.77E-01 PE-Ci

3.4.2.11.3 Consequence Analysis

Table 3-74 shows the public and collocated worker doses, presuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>2.61E-02</td>
<td>5.33E+01</td>
<td>1.39E+00</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Fire</td>
<td>2.77E-01</td>
<td>3.65E+01</td>
<td>1.01E+01</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>1.15E+01</td>
<td></td>
<td></td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

3.4.2.11.4 Comparison to the Evaluation Guideline

The unmitigated 1.15E+01 rem dose to the public is High and challenges the EG. In addition, the unmitigated dose of 9.74E+01 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, safety-class controls for the protection of the public and collocated workers are required.

Control Selection

The control section is focused on reducing the consequence and frequency of the deflagration.

The following control is credited for reducing the consequences of the event:

- The safety-class SAC, Hazardous Material and Waste Management Program, requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.
The safety-class SAC, Radiological Waste Inventory Controls, limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports); in this case, a MAR limit of 1,100 PE-Ci is imposed on the transport vehicle as an initial condition.

The mitigation from these controls is modeled as a doublepacked drum at 553 PE-Ci that deflagrates (highest MAR drum, with DR=0.1 and confined burning due to doublepack), and the additional 547 PE-Ci that experiences the impact. The mitigated consequences are 1.22E+00 rem to the public and 1.04E+01 rem to the collocated workers, as shown in Table 3-75. Dose consequences are still Moderate, though the collocated worker dose consequences are Low.

Table 3-75. DBA No. 4D – Mitigated Consequence Analysis; Reduced Transportation MAR and Double-Packed > 200 PE-Ci

| Component | ST (PE-Ci) | Public | | Collocated Worker |
|-----------|-----------|--------|| | |
| | | DSF (rem/PE-Ci) | Dose (rem) | DSF (rem/PE-Ci) | Dose (rem) |
| Spill | 4.00E-03 | 5.33E+01 | 2.13E-01 | 4.50E+02 | 1.80E+00 |
| Fire | 2.77E-02 | 3.65E+01 | 1.01E+00 | 3.10E+02 | 8.57E+01 |
| | Total Public Dose | 1.22E+00 | Total Collocated Worker Dose | 1.04E+01 |

To further reduce the consequences and frequency of a deflagration during transport, the following controls were credited.

- For transports with > 800 PE-Ci, the safety-significant SAC Escort of High MAR TRU Waste Transport Within TA-54, Area G, requires a rolling roadblock to further reduce the frequency of vehicle accidents and impact to stored radiological waste containers, which could trigger a deflagration.

In this case, if the transport vehicle is only transporting 800 PE-Ci, the dose consequences from a doublepacked 553 PE-Ci drum undergoing a deflagration and impacting the remaining 247 PE-Ci still result in Moderate consequences to the public, 1.11 rem, and Low consequences to the worker, 9.38 rem. However, because of the SAC requirement for a rolling roadblock, the frequency of the event involving the higher MAR transport is reduced to Extremely Unlikely for a mitigated risk rank III for the public, and risk rank IV for the collocated worker.

Conclusion

Overall mitigation for DBA No. 4D

The unmitigated consequence of DBA No. 4D is High with an unmitigated frequency of Unlikely, giving an unmitigated risk ranking of I. Based on the discussion on selected credited controls, two safety class SACs, doublepacking drums with MAR > 200 PE-Ci and transport vehicle MAR limits, mitigate dose consequences. A reduction in frequency can be achieved by crediting a safety-significant SAC on requiring a vehicle escort when transporting MAR > 800 PE-Ci, reducing the frequency of the event to Extremely Unlikely for an overall mitigated risk rank of III for the public and IV for the collocated worker.
Applicability of selected control set for DBA No. 4D, to bounded events

Table 3-77 lists the mitigative and preventive controls in DBA No. 4D. Table 3-77 also lists HA events that are bounded by DBA No. 4D, based on the event scenario or High consequences.

3.4.2.11.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-76 are those that are discussed in the AA as providing protection to the public and collocated workers through significant reduction in consequence and frequency. Other ACs protecting the assumptions of the analysis and providing DID are discussed in the hazard evaluation. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC</td>
<td>SC Function</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-2-030</td>
<td>AGTRU-2-030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGTRU-2-001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC</td>
<td>SC Function</td>
<td>This is an initial condition for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-2-030</td>
<td>AGTRU-2-030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BGTRUCSK-2-005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt; 800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>SAC</td>
<td>SS Function</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>AGTRU-2-030</td>
<td>AGTRU-2-030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RANTTOG-2-001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.12 DBA No. 4E – BGTRUCSK-2-011, Single Container Deflagration Caused by a Fire in Proximity

3.4.2.12.1 Scenario Development

This DBA involves a single unvented metal TRU waste container retrieved from Trenches A-D affected by the heat from a nearby combustible fire. The fire causes a deflagration resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Combustible material
- Equipment malfunction
- Hot work
- Ignition source
- Operator error

Assumptions

- The MAR is 750 PE-Ci, (one maximum Trenches A-D metal TRU waste container)
- The MAR is 100% combustible

3.4.2.12.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 750 PE-Ci.

DR

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 × 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6

ARF × RF

The ARF × RF values for spill/flexing in air, unconfined burning, and confined burning, for each of the waste types are shown in Table 3-77.
### Table 3-77. DBA No. 4E – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
</tr>
</tbody>
</table>

### LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

### ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 3.00E-02 PE-Ci
- Fires = 3.75E-01 PE-Ci

#### 3.4.2.12.3 Consequence Analysis

Table 3-78 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from flexing in air is 1.40E+01 rem PE-Ci; the DSF for the fire component with no buoyancy is 9.60E+00 rem PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE-Ci (fire).

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>3.00E-02</td>
<td>1.40E+01</td>
<td>4.20E-01</td>
<td>4.50E+02</td>
<td>1.35E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>3.75E-01</td>
<td>9.60E+00</td>
<td>3.60E+00</td>
<td>3.10E+02</td>
<td>1.16E+02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Public Dose</td>
<td>4.02E+00</td>
<td>Total Collocated Worker Dose</td>
<td>1.30E+02</td>
</tr>
</tbody>
</table>

#### 3.4.2.12.4 Comparison to the Evaluation Guideline

The unmitigated 4.02E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 1.30E+02 rem to the collocated workers is High.
Analysis

Event Frequency/Risk Rank

This unmitigated event has Moderate consequence to the public and High consequences to the collocated workers, with an unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], the risk rank binning for the public is II and the risk rank binning for the collocated workers is I for the unmitigated event. Thus, safety-significant controls are required for the protection of the public and collocated workers.

Control Selection

The unmitigated dose contribution of 3.60E+00 rem from the fire dominates the total dose to the public (4.02E+00 rem). The dose from the spill term is 4.20E-01 rem. Since the two components are the result of the same event and cannot be separated, control section is focused on reducing the consequences and frequency of the deflagration.

To reduce the consequences of the event, the following control is credited:

- The safety-significant SAC, TRU Waste Drums ≥ 200 PE-Ci retrieved from Trenches A through D shall be doublepacked before retrieval of an additional TRU Waste Drum in the defined area.

In this case, the deflagration within an overpacked container is modeled as contained burning and the dose consequence is mitigated to 3.60E-01 rem to the public, and 1.16E+01 rem to the collocated worker, for a mitigated risk rank III.

If a container with 199 PE-Ci is retrieved from Trenches A-D and deflagrates due to a local heat source, the dose consequence is 1.07E+00 rem to the public and 3.34E+01 rem to the collocated worker, both Moderate consequences resulting in a risk rank II. Additional controls are required to reduce risk.

To reduce the frequency of a deflagration, the following controls are credited:

- The safety-significant SAC, transient combustible controls reduces the likelihood of a fuel package being involved in a fire.
- The safety-significant SAC, Thermal Separation Distance, requires the use of thermal distance or equivalent barrier to the likelihood of fire progression between defined areas and limit heat flux to the waste containers.

The combination of all of these controls reduces the frequency of the event to Extremely Unlikely for all of the initiating events. Therefore, the overall mitigated risk rank is III for this event.

Conclusion

Overall mitigation for DBA No. 4E

Based on the credited controls selected and discussed, a reduction in consequence is achieved to 1.07E+00 rem to the public and 3.34E+01 rem to the collocated worker through the requirement for a doublepack for drums > 200 PE-Ci. Crediting SACs on hot work prohibitions and thermal separation distances, as well as a combination of SMPs, reduces the frequency from Anticipated to Extremely Unlikely, resulting in an overall mitigated risk rank of III.
Applicability of selected control set for DBA No. 4E to bounded events

Table 3-80 lists the mitigative and preventive controls in DBA No. 4E. Table 3-80 also lists HA events that are bounded by DBA No. 4E, based on the event scenario or High consequences in the hazard evaluation. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class by the results of this analysis, though they may not be applicable to the event scenario in DBA No. 4E.

3.4.2.12.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-79 are those that are discussed in the AA as providing protection to the public and collocated workers through a reduction in consequence or frequency. Other ACs protecting the assumptions of the analysis and providing DID are discussed in the hazard evaluation. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches A-D Retrieval Activities BGTRUCSKU-2-001</td>
<td>TRU Waste Drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU Waste Drum in the defined area.</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences of accidents involving multiple containers</td>
<td>This control is credited in this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance BGTRUCSKU-2-001</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduces the likelihood of fire progression between defined areas.</td>
<td>This control is credited in this DBA.</td>
</tr>
<tr>
<td>Fire Protection – Control of Transient Combustibles – Fuel Package Limit BGTRUCSKU-2-001</td>
<td>Transient combustible controls within defined areas. Transient fuel packages &gt; 100 lb are attended. Unattended transient combustible fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal containers by a minimum of 3 ft in order to reduce fire progression</td>
<td>SAC (SS Function)</td>
<td>Reduces the radiological consequences by limiting fire progression and limiting the MAR involved.</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.13 DBA No. 4F – BGTRUCSK-2-014, Container Deflagration Caused by a Forklift Puncture

3.4.2.13.1 Scenario Development

This DBA involves two metal TRU waste containers retrieved from Trenches A-D that are punctured by forklift tines and deflagrate, resulting in a release of radiological material. The HA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Flammable headspace
- Mechanical failure
- Operator error

Assumptions

- The MAR is 1,500 PE-Ci, (two Trenches A-D TRU waste containers with 20% margin)
- The MAR is 100% combustible

3.4.2.13.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 1,500 PE-Ci (Trenches A-D)/

DR

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 × 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6

ARF × RF

The ARF × RF values for spill/flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-80.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
</tr>
</tbody>
</table>
LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 6.00E-02 PE-Ci
- Fires = 7.50E-01 PE-Ci

3.4.2.13.3 Consequence Analysis

Table 3-81 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 1.40E+01 rem PE-Ci; the DSF for the fire component with no buoyancy is 9.61E+00 rem PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE-Ci (fire).

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>6.00E-02</td>
<td>1.40E+01</td>
<td>8.40E-01</td>
<td>4.50E+02</td>
<td>2.70E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
<td>3.10E+02</td>
<td>2.33E+02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Public Dose</td>
<td>8.05E+00</td>
</tr>
<tr>
<td>Total Collocated Worker Dose</td>
<td>2.60E+02</td>
</tr>
</tbody>
</table>

3.4.2.13.4 Comparison to the Evaluation Guideline

The unmitigated 8.05E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 2.60E+02 rem to the collocated workers is High.

Analysis

Event Frequency/ Risk Rank

This unmitigated event has Moderate consequence to the public and High to the collocated workers, with an unmitigated frequency of Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in an unmitigated risk ranking II for the public, and I for the collocated workers. Thus, safety-significant controls are required for the protection of the public and collocated worker.
Control Selection

The unmitigated dose contribution of 7.21E+00 rem from the fire dominates the total dose to the public (8.05E+00 rem). The dose from the spill term is 8.40E-01 rem. Since the two components are the result of the same event and cannot be separated, control selection is focused on reducing the frequency of the deflagration.

To reduce the consequences of the event, the following control is credited:

- The safety-significant SAC, TRU Waste Drums ≥ 200 PE-Ci retrieved from Trenches A through D shall be doublepacked before retrieval of an additional TRU Waste Drum in the defined area.

In this case, the deflagration within an overpacked container is modeled as contained burning, and the dose consequence is mitigated to 7.21E-01 rem to the public and 2.33E+01 rem to the collocated worker, for a mitigated risk rank III.

If two containers with 199 PE-Ci each are retrieved from Trenches A through D and deflagrate due to the forklift puncture, the dose consequence is 2.14E+00 rem to the public and 6.89E+01 rem to the collocated worker, both Moderate consequences resulting in a risk rank II. Additional controls are required to reduce risk.

The reduction in frequency of this DBA can be accomplished by the following controls:

- The safety-significant SAC, Elevated Waste Movements and Critical Lifts – Spotter, requires that a spotter support forklift and crane operations during elevated lifts (> 4 to < 12 ft) and placement/removal (e.g., stacking/unstacking, loading/unloading) of TRU waste containers to reduce the frequency of container puncture, topple, and impacts.
- The safety-significant SAC requires isolation of unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container, and thus reduces frequency of deflagration.

The combination of these preventive controls reduces the frequency to Extremely Unlikely for an overall mitigated risk rank III.

Conclusion

Overall mitigation for DBA No. 4F

Based on the credited controls selected and discussed, reductions in consequence to Moderate are achieved by the safety-significant SAC on doublepacking drums with MAR > 200 PE-Ci. The frequency is reduced to Extremely Unlikely by crediting a safety-significant SAC requiring a spotter for elevated lifts and the isolation of unvented drums. A mitigated risk rank III results from the control suite.

Applicability of selected control set for DBA No. 4F, to bounded events

Table 3-83 lists the mitigative and preventive controls in DBA No. 4F. Table 3-83 also lists HA events that are bounded by DBA No. 4F, based on event scenario or High consequences.

3.4.2.13.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-82 are those that are discussed in the AA as providing protection to the public and collocated workers through a reduction in frequency. Other ACs protecting the
assumptions of the analysis and providing DID are discussed in the hazard evaluation. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
<table>
<thead>
<tr>
<th>Control</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doublepacking TRU Waste Drums with MAR ≥ 200 PE-Ci during Trenches A-D</td>
<td>TRU Waste Drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU Waste Drum in the defined area.</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences of accidents involving multiple containers.</td>
<td>This is a credited control for this DBA.</td>
</tr>
<tr>
<td>BGTRUCSK-2-014</td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts– Spotter</td>
<td>Spotter supports forklift/ rigger/ crane operations during elevated (&gt; 4 to ≤ 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for container puncture, topple, and impacts.</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>BGTRUCSK-2-014</td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
<tr>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for deflagration.</td>
<td>This is a credited control for this DBA and the listed bounded HA events.</td>
</tr>
<tr>
<td>BGTRUCSK-2-014</td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
<tr>
<td>BGTRUCSK-2-013</td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAC</td>
<td>SAC (SS Function)</td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.14  DBA No. 5A – AGTRU-2-007, Multiple Above-Ground Waste Container Deflagration

3.4.2.14.1 Scenario Development

This DBA involves two unvented metal waste containers. A deflagration occurs in one unvented metal TRU waste container that causes a sympathetic deflagration of the second TRU waste container, resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- Chemical reaction
- Unvented or under-vented container
- External heat source (sparks, fire, thermal radiation, solar, lightning)
- Flammable headspace
- Ignition source
- Pyrophorics
- Seismic event
- Shock-sensitive material
- Static electricity
- Violent shaking

Assumptions

- The MAR is 609 PE-Ci, two metal TRU waste containers (one maximum and the other at 99th percentile).
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20:
  - Combustible: 3.1%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%
3.4.2.14.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 609 PE-Ci.

DR

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 \times 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6

ARF \times RF

The ARF \times RF values for spill/ flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-83.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 1.76E-02 PE-Ci
- Fires = 1.06E-02 PE-Ci

3.4.2.14.3 Consequence Analysis

Table 3-84 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the
release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

### Table 3-84. DBA No. 5A – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.76E-02</td>
<td>5.33E+01</td>
<td>9.37E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>1.06E-02</td>
<td>3.65E+01</td>
<td>3.86E-01</td>
</tr>
<tr>
<td><strong>Total Public Dose</strong></td>
<td><strong>1.32E+00</strong></td>
<td><strong>Total Collocated Worker Dose</strong></td>
<td><strong>1.12E+01</strong></td>
</tr>
</tbody>
</table>

#### 3.4.2.14.4 Comparison to the Evaluation Guideline

The unmitigated 1.32E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 1.12E+01 rem to the collocated workers is Low.

**Analysis**

**Event Frequency/Risk Rank**

This unmitigated event has Moderate consequence to the public and Low consequences to the collocated workers, with an unmitigated frequency of Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II to the public and III to the collocated worker for the unmitigated event. Thus, safety-significant controls are required for the protection of the public.

**Control Selection**

There are no available controls would reduce the public consequence of the event from Moderate to Low for sympathetic deflagration accident scenario. Therefore, the control section is focused on reducing the frequency of the deflagration.

To reduce the frequency of this event, the following control is credited:

- The safety-significant SAC requires isolation of unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container, and thus reduces the frequency of deflagration.

This control reduces the frequency of the event to Extremely Unlikely.

It is noted that the CHA identified an additional control for this accident:

- The safety-significant SAC requires that unvented TRU waste drums are not stacked, and thus reduces the radiological consequences from a sympathetic deflagration.

The implementation of this control may provide a reduction in consequence; however, the reduction cannot be quantified for this DBA. With the Extremely Unlikely frequency, the mitigated risk ranking is III for the public and IV for the collocated workers.
The CHA identified no ICs for this event.

Conclusion

**Overall mitigation for DBA No. 5A**

Based on the credited controls selected and discussed, a reduction in frequency is achieved. Crediting isolation of unvented drums reduces the frequency to Extremely Unlikely. The SAC on prohibiting stacking of unvented drums provides some reduction in consequences; however, the consequence reduction cannot be quantified in this DBA. The dose to the public is 1.32E+00 rem and the dose to the collocated workers is 1.12E+01 rem. The final mitigated risk rank for this event is reduced to III for the public and IV for the collocated workers. Given that Area G is a limited lifetime facility, and the mitigated frequency of this event is Extremely Unlikely, the residual risk is judged to be acceptable.

**Applicability of selected control set for DBA No. 5A, to bounded events**

None.

3.4.2.14.5 **Summary of the Safety SSCs, SACs, and TSR Controls**

The credited controls listed in Table 3-85 are those that are discussed in the AA as providing protection to the public and collocated workers through a reduction in frequency. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRU Waste Container Management – Isolate Unvented Containers AGTRU-2-007</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for deflagration</td>
<td>This control is credited in this DBA.</td>
</tr>
<tr>
<td>TRU Waste Container Management – Unvented Containers are not Stacked AGTRU-2-007</td>
<td>Unvented TRU waste containers are not stacked</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood of inadvertent container toppling.</td>
<td>This control is credited in this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.15 DBA No. 5B – BGTRUCSK-2-007, Multiple Trenches A-D Waste Container Deflagration

3.4.2.15.1 Scenario Development

This DBA involves two Trenches A-D metal waste containers in a cask. Chapter 2 describes that two drums are positioned one on top of the other within each cask in Trenches A-D. When the cask lid is removed, a deflagration occurs in one unvented TRU waste drum that causes a sympathetic deflagration of the second TRU waste container, resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Extremely Unlikely.

The causes that could potentially result in this accident are as follows:

- Chemical reaction
- Drop
- Flammable headspace
- Ignition source
- Inadequate venting
- Incompatible chemicals
- Pyrophorics
- Shock-sensitive material
- Static electricity

Assumptions

- The MAR is 1,500 PE-Ci (two maximum Trenches A-D TRU waste containers)
- The MAR is 100% combustible

3.4.2.15.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 1,500 PE-Ci.

DR

- Flexing in air of waste ejected from drum following lid loss, DR = 0.4 (DOE-STD-5506-2007 [DOE 2007])
- Fire terms:
  - Of the 40% waste ejected, 5% burns unconfined, DR = 0.4 × 0.05 = 0.02
  - All the waste remaining in the drum burns confined, DR = 0.6
The ARF × RF values for spill/ flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-86.

### Table 3-86. DBA No. 5B – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 6.00E-02 PE-Ci
- Fires = 7.50E-01 PE-Ci

### 3.4.2.15.3 Consequence Analysis

Table 3-87 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 1.40E+01 rem PE-Ci; the DSF for the fire component with no buoyancy is 9.61E+00 rem PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill) and 3.10E+02 rem PE-Ci (fire).

### Table 3-87. DBA No. 5B – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td></td>
</tr>
<tr>
<td>Spill</td>
<td>6.00E-02</td>
<td>1.40E+01</td>
<td>8.40E-01</td>
<td>4.50E+02</td>
<td>2.70E+01</td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
<td>3.10E+02</td>
<td>2.33E+02</td>
<td></td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>8.05E+00</td>
<td>Total Collocated Worker Dose</td>
<td>2.60E+02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.15.4 Comparison to the Evaluation Guideline

The unmitigated 8.05E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 2.60E+02 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

This unmitigated event has Moderate consequence to the public and High consequence to the collocated workers with an unmitigated frequency of Extremely Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank III for the public and risk rank II for the collocated workers. Thus, safety-significant controls are required for the protection of the collocated workers.

Control Selection

The unmitigated contribution of 7.21E+00 rem from the fire dominates the total dose to the public (8.05E+00 rem). The dose from the spill term is 8.40E-01 rem. Since the two components are the result of the same event and cannot be separated, control selection is focused on reducing the frequency and consequences of the deflagration.

To reduce the frequency of this event, elements of the following controls are credited:

- The safety-significant SAC requires that a spotter support forklift and crane operations during elevated lifts (> 4 to ≤ 12 feet) placement/ removal (e.g., stacking/ unstacking, loading/ unloading) of TRU waste containers, which reduces the frequency of container puncture, topple, and impacts.
- The safety-significant SAC requires a critical lift plan for planned lifts where the bottom surface of the waste container is planned to be > 12 ft above the surface that is directly below the waste container.

The combination of these controls reduces the frequency to Beyond Extremely Unlikely.

The following control was credited for reducing the consequence of the event to the worker and collocated worker:

- Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker.

The CHA identified no ICs for this event.

Conclusion

Overall mitigation for DBA No. 5B

Based on the credited controls selected and discussed, a reduction in frequency is achieved. Crediting the combination of SACs on lifting containers reduces the frequency to Beyond Extremely Unlikely. The SAC for handling of unvented drums is credited for reducing dose consequences to the collocated worker to Moderate. The final mitigated risk rank for this event is reduced to IV for both receptors.
Applicability of selected control set for DBA No. 5B, to bounded events

None

3.4.2.15.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-88 are those that are discussed in the AA as providing protection to the public and collocated workers through a reduction in frequency. (The facility worker is the receptor at greatest risk during deflagration events. See Section 3.3.2.3.3 for a discussion of the facility worker controls in the deflagration event.)
Table 3-88.  DBA No. 5B - Summary of TSR Safety Controls for Multiple Trenches A-D Waste Container Deflagration

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated Waste Movement and Critical Lifts - Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (&gt; 4 to (\leq 12) ft) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>SAC</td>
<td>(SS Function)</td>
<td>Reduces likelihood for container puncture, topple, and impacts</td>
</tr>
<tr>
<td>Elevated Waste Movement and Critical Lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 ft above the surface directly below the waste container (excluding mobile loader payload lifts)</td>
<td>SAC</td>
<td>(SS Function)</td>
<td>Reduces likelihood for load drops resulting in release of radiological material</td>
</tr>
<tr>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>SAC</td>
<td>(SS Function)</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
</tr>
</tbody>
</table>
3.4.2.16 DBA No. 6 – BGTRUPIT-2-011, Below-Ground Waste Container Deflagration Caused by External Flame

3.4.2.16.1 Scenario Development

This DBA involves one below-ground Pit 9 waste container. A radiological containment hut may be established around the container in situ. A flammable atmosphere develops within the hut during an in-situ remediation activity. In coincidence with an ignition source, the flammable gas ignites and causes a deflagration, resulting in a release of radiological material due to an overpressure impact and shrapnel puncture of the drums. The CHA identified the unmitigated frequency of this DBA as Extremely Unlikely.

The causes that could potentially result in this accident are as follows:

- Equipment malfunction
- Flammable gas
- Ignition source
- Operator error
- Static electricity

Assumptions

- The percentage composition of each waste type in the statistical Pit 9 metal container used in the analysis is taken from Table 3-21:
  - Combustible: 22.0%
  - Dispersible, non-combustible: 48.1%
  - Non-dispersible, non-combustible: 29.9%
- The container in the in-situ hut is the maximum MAR container – 232 PE-Ci
- The container in the in-situ hut has questionable structural integrity
- Due to the deflagration pressure wave, all material in the container of questionable structural integrity experiences flexing in air, and 5% of the material that experiences flexing in air burns unconfined.
- The first row of the waste face experiences moderate impact (DR = 0.1) due to the pressure wave.
- The first row of the waste face experiences puncture (DR = 0.1) caused by shrapnel from the deflagration.
- The first row of the waste face is assumed to be made up of 60 containers 5 high stacked x 10 containers wide, based on Figure 2-7.
- The impacted waste face MAR is 129 PE-Ci = (20.06 + (2×9.27) + (57×1.27))
3.4.2.16.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 361 PE-Ci.

- Container in situ = 232 PE-Ci
- Waste Face = 129 PE-Ci

DR

- Flexing in air of waste from container of questionable structural integrity due to VCE pressure wave, DR=1.0
- Spill due to VCE pressure wave moderate impact, DR = 0.1
- Spill due to puncture by shrapnel, DR = 0.1
- Fire terms:
  - Of the waste ejected, 5% burns unconfined, DR = 1.0 × 0.05 = 0.05

ARF × RF

The ARF × RF values for spill/flexing in air, unconfined burning, and confined burning for each of the waste types are shown in Table 3-89.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low–energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 2.35E-02 PE-Ci
- Fires = 2.59E-02 PE-Ci
### 3.4.2.16.3 Consequence Analysis

Table 3-90 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+1 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spill</strong></td>
<td>2.35E-02</td>
<td>5.33E+01</td>
<td>1.25E+00</td>
<td>4.50E+02</td>
<td>1.06E+01</td>
</tr>
<tr>
<td><strong>Fire</strong></td>
<td>2.59E-02</td>
<td>3.65E+01</td>
<td>9.44E-01</td>
<td>3.10E+02</td>
<td>8.02E+00</td>
</tr>
<tr>
<td><strong>Total Public Dose</strong></td>
<td>2.19E+00</td>
<td></td>
<td><strong>Total Collocated Worker Dose</strong></td>
<td>1.86E+01</td>
<td></td>
</tr>
</tbody>
</table>

### 3.4.2.16.4 Comparison to the Evaluation Guideline

The unmitigated 2.19E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose to the collocated worker of 1.86E+01 rem is Low.

**Analysis**

**Event Frequency/Risk Rank**

This unmitigated event has Moderate consequences to the public and Low consequences to the collocated workers, with an unmitigated frequency of Extremely Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in an unmitigated risk rank III for the public and IV for the collocated workers. In this case, the SMPs identified in the hazard evaluation are sufficient to mitigate the risk associated with this event.

**Control Selection**

Reviewing the available controls, it is not possible to select a single engineered control to prevent the deflagration. To reduce the frequency of this event, the CHA has identified the following controls which provide defense-in-depth:

- The SMP-AC, implemented through the Fire Protection Program, is credited for requiring the control of hot work and ignition sources within all defined areas, reducing the frequency for ignition of flammable gases.
- The SMP, Maintenance Program, is credited for requiring periodic inspection and maintenance of LANL vehicles/ equipment (e.g., forklift, transport truck). This control reduces the frequency of equipment malfunction, which could trigger a deflagration.
• The SMP, Training and Qualification Program ensures that personnel maintain applicable LANL qualifications for vehicle and equipment operation.

• The SAC, acetylene cylinders are not stored or used inside or within 50-feet of a defined area when MAR is present. This eliminates one possible ignition source.

Though not quantitatively credited, the implementation of the fire protection program, maintenance program and training and qualification program further reduces the likelihood of this accident. The Radiation Protection Program evaluates conditions and processes that help to protect the facility worker.

The CHA identified no ICs for this event.

Conclusion

Overall mitigation for DBA No. 6

Based on the controls selected and discussed, radiation protection program, fire protection program, and maintenance program controls, the accident is effectively controlled by defense-in-depth programs.

Applicability of selected control set for DBA No. 6, to bounded events

None

3.4.2.16.5 Summary of the Safety SSCs, SACs, and TSR Controls

The controls (c) listed in Table 3-90a are those that are discussed in the AA as providing protection to the public and collocated workers through a reduction in frequency.

Table 3-90a DBA No. 6 - Summary of TSR Safety Controls for Below-Ground Waste Container Deflagration Caused by External Flame

<table>
<thead>
<tr>
<th>Control /Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene Cylinder Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
<td>SAC</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste.</td>
<td>The AA bounds the scenario and consequences of the listed HA event.</td>
</tr>
</tbody>
</table>

BGTRUPIT-2-011

3.4.2.17 DBA No. 7A - AGTRU-3-012, Vehicle Transporting Waste Impacts Storage Array

3.4.2.17.1 Scenario Development

The AGTRU-3-012 DBA involves a vehicle transporting multiple compliant (metal) TRU waste containers at > 10 mph and < 35 mph which impacts non-metal TRU waste containers, resulting in a release of radiological material. The accident is assumed to occur at TA-54-412, to conservatively represent the Storage Area location that is closest to the site boundary. The CHA identified the unmitigated frequency of this DBA as Anticipated.
The causes that could potentially result in this accident are as follows:

- Degraded/ inadequate road condition (e.g., erosion or potholes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering or brakes)

**Assumptions**

- The ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis for the waste on the truck.
- The percentage composition of each waste type in the compliant (metal) container used in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.13%
  - Dispersible non-combustible: 3.9%
  - Non-dispersible non-combustible: 93.0%
- The percentage composition of each waste type in the statistical non-metal containers is used for the analysis and is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.77%
  - Dispersible non-combustible: 95.3%
  - Non-dispersible non-combustible: 0%
- The truck is transporting metal waste containers with a statistically calculated MAR equal to 864 PE-Ci (including the four statistically high MAR drums).
- The containers on the truck experience moderate stress (DR = 0.1) from the impact, consistent with Table 4.4.4-1, item 5, of DOE-STD-5506-2007 [DOE 2007] for vehicles traveling > 10 mph and < 35 mph.
- The impacted non-metal containers of waste in the storage array are assumed to be in a three-high stacked array.
- Two stacks of non-metal containers are impacted by the truck.
- The MAR of 855 PE-Ci for the six impacted non-metal containers is based on a statistical bounding methodology discussed in Table 3-18.
- The impacted non-metal containers are assumed to fail with a DR=1.0.
### 3.4.2.17.2 Source Term Analysis

**MAR**

The unmitigated MAR for the event is determined as follows:

- Transport truck = 864 PE-Ci
- Storage area = 855 PE-Ci

The total unmitigated MAR used in this analysis is 1719 PE-Ci.

**DR**

DRs are considered for the MAR that is on the truck and in the storage area:

Truck:

- Spill from initial impact, DR = 0.1

Containers in storage area:

- Spill from initial impact, DR = 1.0

**ARF × RF**

The ARF × RF values for spill/flexing in air for each of the waste types are shown in Table 3-91.

#### Table 3-91. DBA No. 7A – AGTRU-3-012, ARF × RF values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills from truck = 6.23E-03 PE-Ci
- Spills in storage array = 8.55E-02 PE-Ci
3.4.2.17.3 Consequence Analysis

Table 3-92 shows the public and collocated worker doses. Table 3-25 (Section 3.4) lists the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact is 4.63E+01 rem/PE-Ci. This DSF is based on the \( \chi/Q95\% \) value for a release from TA-54-412, which is closer to the site boundary than the defined Storage Areas. The collocated worker dose at 100 m from the release point and is derived from a DSF value of 450E+02 rem/PE-Ci.

Table 3-92. DBA No. 7A – AGTRU-3-012, Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>9.17E-02</td>
<td>4.63E+01</td>
<td>4.24E+00</td>
<td>4.50E+02</td>
<td>4.13E+01</td>
</tr>
</tbody>
</table>

3.4.2.17.4 Comparison to the Evaluation Guideline

The unmitigated 4.24E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 4.13E+01 rem to the collocated worker is Moderate.

Analysis

Event Frequency/Risk Rank

This unmitigated event has Moderate consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event to both the public and collocated worker. Thus, safety-significant controls for the protection of the public and collocated workers are required.

Control Selection

Using the LANL site-specific DSF, the unmitigated dose for the spill contribution is 3.95E+00 rem from the stored non-metal containers, which dominates the total dose to the public of 4.24E+00 rem. The dose from the spill term from the compliant (metal) containers on the truck is 2.88E-01 rem. Thus, the control selection is focused on reducing the consequences of the spill STs related to the MAR in the storage area.

The spill contribution from the storage array can be prevented by keeping the vehicle from reaching the storage area at high-risk locations:

The safety-significant SSC, Vehicle Barriers, ensuring that barriers capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lb and a ground clearance of < 40 in. are installed at high-risk locations, is credited for preventing vehicles from impacting defined areas at TA-54, Area G, thereby reducing the consequences to only the MAR in transport. (The vehicle barriers at high-risk locations are safety-class for other accident scenarios.) Vehicle barriers at high-risk locations and along the roadway are positioned to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location. A complementary (uncredited) control is an SMP requiring the installation of defense-in-depth vehicle barriers along the roadways running next to the defined areas. This works in conjunction
with the safety-significant SSC Vehicle Barriers to prevent vehicles from impacting waste in defined areas adjacent to the roadway.

**Table 3-93. DBA No. 7A – Mitigated Consequence Analysis; Effect of Vehicle Barrier (LANL Site Specific)**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>6.23E-03</td>
<td>4.63E+01</td>
<td>2.88E-01</td>
</tr>
</tbody>
</table>

The implementation of the barrier control at high-risk locations mitigated the dose consequences to the public to 2.88E-01 rem. This dose is from the ST for the initial vehicle accident. The Low mitigated consequence of 2.88E-01 rem and the Anticipated frequency results in a risk rank III. Collocated worker dose consequences are also Low. No other controls are required.

The CHA identified the following IC that protects the assumptions of the AA:

- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effect to contained waste.

**Conclusion**

**Overall mitigation for DBA No. 7A**

Based on the credited controls selected and discussed, a reduction in consequences is achieved. Crediting the vehicle barriers at high-risk locations as mitigators reduces the consequences to the public from 4.24E+00 rem (unmitigated) to 2.88E-01 rem (mitigated), and the collocated workers from 4.13E+01 rem (unmitigated) to 2.80E+00 rem (mitigated). Therefore, the final mitigated risk ranking for this event is III for the public and collocated workers.

**Applicability of selected control set for DBA No. 7A to bounded events**

None

**3.4.2.17.5 Summary of the Safety SSCs, SACs, and TSR Controls**

The credited controls listed in Table 3-94 are those that are discussed in the AA and indicated as providing protection to the public and collocated workers through significant reduction in consequences.
### Table 3-94. DBA No. 7A – AGTRU-3-012, Summary of TSR Safety Controls for Vehicle Accidents Impacting Stored TRU Waste

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Barriers—High-Risk Locations AGTRU-3-012</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lb and a ground clearance of &lt; 40 in. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>SS-SSC (SC-SSC for other accident scenarios)</td>
<td>Reduces likelihood for vehicle impact of stored radiological waste containers. When the vehicle is carrying radiological waste, the barrier reduces consequences by limiting the amount of MAR involved to that on the transportation vehicle.</td>
<td>This control is credited for the DBA.</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity AGTRU-3-012</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is credited for the DBA.</td>
</tr>
</tbody>
</table>
3.4.2.18 DBA No. 7B - AGTRU-3-016, Crane Topples onto Staged TRU Waste

3.4.2.18.1 Scenario Development

This DBA involves a large crane toppling and impacting staged waste during Type B container activities. The accident is assumed to occur at a location that is closest to the site boundary. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Crane topples
- Equipment failure
- Equipment malfunction
- High wind
- Improper equipment use
- Mechanical failure
- Operator error
- Seismic event

Assumptions

- The ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis.
- TRUPACT II container payloads involve a maximum MAR of 1,200 PE-Ci each. However, TA-54 Area G imposes a more restrictive MAR limit of 1,100 PE-Ci for the subsequent transportation of compliant metal waste containers from Area G. Therefore, for this event, the crane is assumed to impact 1,100 PE-Ci in metal waste drums staged for payload transportation.
- The percentage composition of each waste type in the compliant (metal) container used in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible non-combustible: 3.9%
  - Non-dispersible non-combustible: 93.0%

  DOE-STD-5506 [DOE 2007] evaluates drops from the fourth tier of stacked drums (nominally 12 ft) to be low-impact and to result in a damage ratio of 0.1 or less [LANL 2010b].

3.4.2.18.2 Source Term Analysis

MAR

The total unmitigated MAR used in this analysis is 1,100 PE-Ci.

DR

- Spill from impacted containers, DR = 1.0
ARF × RF

The ARF × RF values for spill/ flexing in air for each of the waste types are shown in Table 3-95.

Table 3-95. DBA No. 7B – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (impacts)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated ST is as follows:

- Spill from Crane Impact = 7.93E-02 PE-Ci

3.4.2.18.3 Consequence Analysis

Table 3-96 shows the public and collocated worker doses. Table 3-25 (Section 3.4) lists the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from a DSF value of 4.50E+02 rem/PE-Ci.

Table 3-96. DBA No. 7B – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>7.93E-02</td>
<td>5.33E+01</td>
<td>4.23E+00</td>
</tr>
</tbody>
</table>

3.4.2.18.4 Comparison to the Evaluation Guideline

The unmitigated 4.23E+00 rem dose to the public is Moderate and does not challenge the EG. In addition, the unmitigated dose of 3.57E+01 rem to the collocated worker is Moderate.
Analysis

Event Frequency/Risk Rank

This unmitigated event has Moderate consequences to the public and collocated workers and an unmitigated frequency of Anticipated. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event to both the public and collocated worker. Thus, safety-significant controls for the protection of the public and collocated workers are required.

Control Selection

Reviewing the available controls, it is not possible to select an engineered control to prevent the toppling of the large crane. Thus, the control selection is focused on reducing the consequences and frequency of the crane toppling.

As stated, the dose consequences to the public and collocated worker presented in Table 3-96 are based on an IC that MAR subject to transportation is limited to $\leq 1,100$ PE-Ci. As such, the following safety-class control is specified to protect this IC:

- The safety-significant SAC, Defined Area MAR Control limiting MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports), imposed on the TRUPACT II payload with a MAR limit of 1,100 PE-Ci, limits the consequences to Moderate.

The consequences for this event are Moderate with a risk rank II. Hence, additional safety-significant controls are required.

To reduce the frequency of the crane toppling, the following controls are credited:

- The safety-significant SAC requires that a spotter support forklift and crane operations during elevated lifts (> 4 to < 12 ft) and placement/ removal (e.g., stacking/ unstacking, loading/ unloading) of TRU waste containers, which reduces the frequency of container puncture, topple, and impacts.

- The safety-significant SAC requires a critical lift plan for lifts where the bottom surface of the waste container is planned to be > 12 feet, which reduces the likelihood for high impact load drops resulting in a release of radiological material.

The implementation of these controls reduces the event frequency to Extremely Unlikely.

The CHA identified the following IC that protects the assumptions of the AA, TRU waste packaging control:

- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequence of mechanical and thermal effects to contained waste.

It is noted that the CHA identified an additional control:

- The SAC requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.
Implementation of this control may provide some additional reduction in consequences. However, the reduction in consequences cannot be quantified in this DBA because at any one time it is not known how many containers may be doublepacked during a lift.

Conclusion

Overall mitigation for DBA No. 7B

Based on the credited controls selected and discussed, a reduction in frequency and consequences is achieved. Crediting the SAC requiring spotters reduces the frequency from Anticipated to Extremely Unlikely. Therefore, the final mitigated risk ranking for this event is III for the public and collocated workers. Given that Area G is a limited lifetime facility, and the mitigated frequency of this event is Extremely Unlikely, the residual risk is judged to be acceptable.

Applicability of selected control set for DBA No. 7B to bounded events

Table 3-98 lists the mitigative and preventive controls in DBA No. 7B. Table 3-98 also lists HA events that are bounded by DBA No. 7B, based on event scenario or High consequences. Controls unique to the HA events that are bounded by the DBA are discussed if required to be safety-class by the results of this analysis, though they may not be applicable to the event scenario in DBA No. 7B.

3.4.2.18.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-98 are those that are discussed in the AA and indicated as providing protection to the public and collocated workers through significant reduction in consequences or frequency. Other ACs protecting the assumptions of the analysis and providing DID are listed in the hazard evaluation for this event.
### Table 3-98. DBA No. 7B – Summary of TSR Safety Controls for a Large Crane Toppling during Type B activities

<table>
<thead>
<tr>
<th>Control / Applicable Events</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>IC</td>
<td>SAC (SS Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>Elevated Waste Movement and Critical Lifts</td>
<td>Spotter supports forklift/rigger/crane operations during elevated lifts (&gt; 4 to ≤ 12 ft) placement/removal (stacking/unstacking, loading/unloading) of TRU waste containers</td>
<td>SAC (SS Function)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevated Waste Movement and Critical Lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the surface directly below the waste container (excluding mobile loader payload lifts)</td>
<td>SAC (SS Function)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.19 DBA No. 8 - AGTRU-3-017, Crane Drops TRUPACT II Payload Assembly

3.4.2.19.1 Scenario Development

This DBA involves a large crane moving a TRU waste payload assembly and dropping the loaded payload assembly onto another payload assembly from a height of > 12 ft, resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The causes that could potentially result in this accident are as follows:

- Crane drops load
- Equipment failure
- Mechanical failure
- Operator error
- Securing devices failure

Assumptions

- ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis.
- Total MAR is the Mobile Loading Process Areas MAR limit of 1,100 PE-Ci.
- The percentage composition of each waste type in the compliant (metal) container used in the analysis is taken from Table 3-20:
  - Combustible: 3.1%
  - Dispersible non-combustible: 3.9%
  - Non-dispersible non-combustible: 93.0%
- Per DOE-STD-5506-2007 [DOE 2007], the TRUPACT II payload configuration is a two 7-pack, plastic-wrapped drum configuration.

Per DOE-STD-5506-2007, Section 4.4.4, Damage Ratios for Mechanical Insults (10th paragraph), for a drop of the TRUPACT II payload configuration (two 7-pack, plastic-wrapped drum configuration), an initial DR=0.5 is recommended, based on either the lower 7 drums being breached, or half of the 14 drums on either tier failing. DOE-STD-5506 then states that the DR=0.5 is further adjusted for the type of contents, assuming maximum spillage for two drums, and an average spillage for the other 5 drums from the Hanford test data. Appendix C of DOE STD 5506, pg 24 (second-to-last paragraph) states that “Considering other uncertainties in drum performance, the 0.14 value is rounded to 0.2 for sand-like materials and 0.1 for bulkier contaminated items for this scenario of a crane drop of the two 7-pack wrapper drum configurations.” The 0.14 value with adjustments is based on Hanford palletized drum falls from 11 ft, although the Rocky Flats palletized drum tests dropped drums from 15 ft with no loss of contents from the 4 of 12 drums whose lids failed. Although the Hanford 11-ft drop height is slightly less than the approximate 13-ft TRUPACT-II lift height at Area G, the rounding up of adjusted DRs to 0.2 for sand-like materials and 0.1 for bulkier materials accounts for this uncertainty. Therefore, a highest value of DR=0.2 will be used for the TRUPACT II payload drop involving 14 drums.
3.4.2.19.2 Source Term Analysis

MAR

The unmitigated MAR is 1,100 PE-Ci, the Mobile Loading Process Areas limit.

DR

Spill from TRUPACT II payload, DR = 0.2 for sand-like material.

ARF × RF

The ARF × RF values for spill/flexing in air, for both a low-energy and high-energy impact for each of the waste types, are shown in Table 3-99. The high-energy impact value is used in the unmitigated analysis, because the TRUPACT-II may fall from a height of 13 ft, which is equated to a fall from a 5th tier row. DOE-STD-5506 [DOE 2007], Section 4.5.3, Mechanical Insults, summarizes that “…freefall spills, as described in DOE-HDBK-3010, are based on a testing apparatus that dropped materials from a 10 to 12 ft distance. This distance closely approximates the height of the third tier in a stacked array of drums.” In addition, this section cites that “… mechanical stresses are…drops from either 3rd and 4th tier falls and low-energy impacts, labeled as ‘Spills’, or from higher energy drops and other higher-energy mechanical insults, labeled as ‘Impacts.’ The high-energy impact is associated with 25% of the drum volume being crushed and failure of drum confinement. However, no experiments have been conducted to show that a TRUPACT-II payload incurs this type of damage, and, as a result, the assignment of a high-energy impact to drops from 12 ft or higher is considered bounding, though it is probably over-conservative.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (impacts)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Spill, shock, and vibration of expelled material (high energy impact)</td>
<td>2E-3</td>
<td>1E-3</td>
<td>7E-4</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated ST is as follows:

- Spill = 1.65E-01 PE-Ci
3.4.2.19.3 Consequence Analysis

Table 3-100 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the ST. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem PE-Ci (spill).

Table 3-100. DBA No. 8 – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.65E-01</td>
<td>5.33E+01</td>
<td>8.82E+00</td>
</tr>
</tbody>
</table>

3.4.2.19.4 Comparison to the Evaluation Guideline

The unmitigated 8.82E+00 rem dose to the public is a Moderate consequence and does not challenge the EG. In addition, the unmitigated dose of 7.44E+01 rem to the collocated workers is a Moderate consequence.

Analysis

Event Frequency/ Risk Rank

This unmitigated event has Moderate consequences to the public and to the collocated workers and an unmitigated frequency of Anticipated. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results a risk rank II binning for the unmitigated event. Thus, safety-significant controls for the protection of the public and collocated worker are required.

Control Selection

Reviewing the available controls, it is not possible to select an engineered control to prevent the large crane from dropping its payload. Thus, the control selection is focused on reducing the consequences and frequency of the event with SACs.

To reduce the consequences of the event, a safety-significant SAC requires that TRUPACT-II (or half-TRUPACT [HalfPACT]) payloads that are lifted > 12 ft are limited to a MAR value of 925 PE-Ci, and payloads are not allowed to be lifted above other payloads.

- Mobile loader payloads with MAR > 925 PE-Ci shall not be lifted > 12 ft, measured from the bottom of the payload to the ground.
- Mobile loader payloads shall not be lifted over TRU waste, excluding another payload within the Type B container.

In this case, the accident scenario of concern is the payload drop to the ground. Dose consequences for a 925 PE-Ci payload drop to the ground are shown in Table 3-101.
The mitigated Moderate consequences and the Anticipated frequency result in a mitigated risk rank II, so additional controls are required.

To reduce the frequency of the event, the following controls are credited:

- The SAC, Elevated Waste Movement and Critical Lifts requires a critical lift plan for TRU waste containers lifted so that the bottom face of the container is > 12 ft higher than the surface directly below the container (i.e. ground or waste container).
- The safety-significant SAC requires that a spotter support forklift and crane operations during elevated lifts (> 4 to ≤ 12 ft) and placement/ removal (e.g., stacking/ unstacking, loading/ unloading) of TRU waste containers, which reduces the frequency of container puncture, topple, and impacts.

The combination of these controls reduces the event frequency to Extremely Unlikely. With mitigated consequences that are Moderate, the risk rank is reduced to III.

To account for payloads with a MAR value > 925 PE-Ci that are prohibited from lifts > 12 ft, the payload drop to the ground will result in a spill from a low-energy impact. In this case, the MAR is limited to 1100 PE-Ci.

For lifts < 12 ft with a maximum MAR limit of 1,100 PE-Ci, the unmitigated consequences are 4.23E-01 rem to the public and 3.57E+00 rem to the collocated worker, Table 3-102. In this case, a risk rank III is achieved in the unmitigated case; therefore, SMPs are sufficient to mitigate the Low consequences for the (unmitigated) Anticipated event.

Table 3-102.  DBA No. 8 – Mitigated Consequence Analysis; MAR limit = 1,100 PE-Ci; Lifts > 12 ft are prohibited for payloads with MAR > 925 PE-Ci and < 1,100 PE-Ci

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>7.93E-03</td>
<td>5.33E+01</td>
<td>4.23E-01</td>
</tr>
</tbody>
</table>

The CHA identified the following IC that protects the assumption of the AA, Hazardous Material and Waste Management Program:
• Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequences of mechanical and thermal effects to contained waste.

It is noted that the CHA identified this additional control:

• The SAC requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.

Note that the mitigation provided by the doublepacking control cannot be quantified because the number of doublepacked containers will vary.

Conclusion

Overall mitigation for DBA No. 8

Based on the credited controls selected and discussed, a reduction in consequence and frequency is achieved. Crediting a safety-significant SAC limiting the amount of MAR in a payload lift > 12 ft, the dose consequences are Moderate. Crediting a safety-significant SAC requirement prohibiting the lift of one payload over another payload for a critical lift plan, and the Maintenance and Training and Qualification SMPs, reduces the frequency from Anticipated to Extremely Unlikely. For payload lifts with MAR > 925 PE-Ci and < 1,100 PE-Ci, lifts > 12 ft are prohibited, and Low dose consequences result from a (low-energy impact) payload drop.

Applicability of selected control set for DBA No. 8 to bounded events

None

3.4.2.19.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-103 are those that are discussed in the AA as providing protection to the public and collocated workers through reduction in consequences or frequency.
### Table 3-103. DBA No. 8 – Summary of TSR Safety Controls for Crane Drops TRUPACT II Payload Assembly

<table>
<thead>
<tr>
<th>Control</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Applicable Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Loader Payload Restriction – Lifts</td>
<td>Mobile loader payloads shall not be lifted over TRU waste</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Mobile Loader Payload Restrictions – MAR Limit</td>
<td>Mobile loader payloads with MAR &gt; 925 PE-Ci and ≤ 1,100 PE-Ci shall not be lifted &gt; 12 ft, measured from the bottom of the payload to the ground</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting source term involved in payload drop</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Elevated Waste Movement and Critical Lifts – Critical Lift</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the surface directly below the waste container (excluding mobile loader payload lifts)</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for load drops resulting in release of radiological material</td>
<td>This control is credited for this DBA and the listed HA event.</td>
</tr>
<tr>
<td>Elevated Waste Movement and Critical Lifts Spotter</td>
<td>Spotter supports forklift/rigger/ crane operations during elevated lifts (&gt; 4 to ≤ 12 ft) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood for container puncture, topple, and impacts</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>IC (SC Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Control</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Applicable Events</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------</td>
<td>-------</td>
<td>-------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effect to contained waste</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>AGTRU-3-017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This control provides defense-in-depth for this DBA.</td>
</tr>
<tr>
<td>AGTRU-3-017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.2.20  DBA No. 9 – AGTRU-6-001, Aircraft Impacts TRU Waste in Area G with Follow-on Pool Fire

3.4.2.20.1  Scenario Development

This DBA involves a small single-engine aircraft impacting a TRU waste storage array in TA-54, Area G, with a subsequent pool fire resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Extremely Unlikely.

The cause of this accident is an airplane crash.

Assumptions

- ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  o Combustible: 3.1%
  o Dispersible, non-combustible: 3.9%
  o Non-dispersible, non-combustible: 93.0%
- The unmitigated MAR for this event is as follows:
  o AGTRU compliant (metal) containers (e.g., drums) = 3,216 PE-Ci
- Impact on compliant (metal) waste containers (Section 3.4.1.5.4, Aircraft Accident):
  o 27 containers (including four statistical high drums) experience catastrophic stress and High Energy Impact
    - 27 containers have a MAR of 762 PE-Ci \[ = ((1 \text{ drum} \times 553 \text{ PE-Ci/drum}) + (1 \text{ drum} \times 56 \text{ PE-Ci/drum}) + (2 \text{ drums} \times 21 \text{ PE-Ci/drum}) + 4.84 \text{ PE-Ci/drum} \times 23 \text{ drums}) \]
  o 26 containers experience moderate to severe stress and High-Energy Impact
    - 26 containers have a MAR of 126 PE-Ci = (4.84 PE-Ci/drum \times 26 drums)
  o 52 containers experience minor stress and Low Energy Impact
    - 52 containers have a MAR of 252 PE-Ci = (4.84 PE-Ci/drum \times 52 drums)
- Spilled waste from containers ruptured during aircraft impact event is assumed to burn unconfined.
- All waste in impacted containers that is not released due to impact (and subject to unconfined burning) burns confined.
- Pool fire affects the waste in the storage array.
- Once the spilled fuel is consumed by the pool fire, the waste continues burning for the remainder of the 20-min duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.
- It is assumed that the drums are arranged in three tiers.
The maximum fuel capacity for the small single-engine plane (Section 3.4.1.5.4) is 56 gal. From Table 8, SB-DO:CALC-12-001, Rev. 0 [LANL 2012b], a 56-gal pool fire will engulf 297 drums arranged in a three-tier array. There are 96 drums in the first row along the edge of the pool fire, and 36 drums on the top tier in the second row outside of the pool fire, for a total of 429 drums of waste potentially affected by the fuel pool fire. The spilled or retained waste from the 105 waste drums impacted by the crashing aircraft is also assumed to be forced into or near the burning fuel pool.

### 3.4.2.20.2 Source Term Analysis

**MAR**

The unmitigated MAR for the event is determined based on a statistical bounding methodology outlined in Table 3-18, and using the information in Table 3-16:

- **Aircraft Impact** = 1140 PE-Ci \[762\text{PE-Ci} + 126\text{PE-Ci} + 252 \text{PE-Ci}\]
- **Pool Fire** = 2,076 PE-Ci
  - 1437 PE-Ci \[(99+198 \text{ drums}) \times 4.84 \text{PE-Ci/drum}\]\ engulfed by the pool fire
  - 465 PE-Ci \[(32+64) \text{ drums} \times 4.84 \text{PE-Ci}\]\ available in the first row outside the pool fire
  - 174 PE-Ci \[36 \text{ drums} \times 4.84 \text{PE-Ci/drum}\]\ available in the second row outside of the pool fire

The total unmitigated MAR (from impact plus pool fire) used in this analysis is 3,216 PE-Ci.

**DR**

Compliant (metal) Containers

Impact, Spill, and Unconfined Burning:

- 27 containers experience catastrophic stress, DR=1.0, High Energy ARF × RF
- 52 containers experience minor stress, DR=0.01, Low Energy ARF × RF
- 26 containers experience moderate to severe stress, DR=0.1, High Energy ARF × RF
- Material ejected/spilled by the aircraft impact is assumed to burn unconfined. Material remaining in the impacted and breached drums that does not burn as unconfined is assumed to experience confined burning.
- Material ejected from drums in the pool fire is included in the impact/spill source term.

Fuel Pool Fire:

- 25% of the drums in the top tier of the array engulfed by the pool fire, and in the first row adjacent to that engulfed portion, are modeled as drums experiencing lid ejection:
  - 1/3 of contents experience ejection
    - Flexing in air, DR = 0.25 × 0.33 = 0.083
    - Unconfined burning, DR = 0.25 × 0.33 = 0.083
The remainder of MAR experiences confined burning, DR = 1-0.083 = 0.917
- The drums in the lower tiers engulfed in the pool, in the first row adjacent to the pool, and in the top tier of the second row experience confined burning.
- Burning of material ejected from or retained in the impacted drums is assumed, in addition to the burning of material in drums within the stacked arrays engulfed by or adjacent to the fuel pool fire.

**ARF × RF**

The ARF × RF values for high-energy impact, low-energy impact, unconfined burning, and confined burning for each of the waste types are shown in Table 3-104.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material</td>
<td>2E-3</td>
<td>1E-3</td>
<td>7E-4</td>
</tr>
<tr>
<td>(high-energy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spill, shock, and vibration of expelled material</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>(low-energy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:
- Spills = 1.59E-01 PE-Ci
- Fires = 1.36E-01 PE-Ci

### 3.4.2.20.3 Consequence Analysis

Table 3-105 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).
Table 3-105.  DBA No. 9 – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>5.86E-01</td>
<td>5.33E+01</td>
<td>3.13E+01</td>
<td>4.50E+02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.64E+02</td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>3.01E-01</td>
<td>3.65E+01</td>
<td>1.10E+01</td>
<td>3.10E+02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.34E+01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total Public Dose</td>
<td>4.23E+01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total Collocated Worker Dose</td>
<td>3.57E+02</td>
</tr>
</tbody>
</table>

3.4.2.20.4  Comparison to the Evaluation Guideline

The unmitigated 4.23E+01 rem dose to the public is High and challenges the EG. The unmitigated dose of 3.57E+02 rem to the collocated workers is High.

Analysis

Event Frequency/ Risk Rank

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Extremely Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank II binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

Control Selection

The unmitigated dose contribution from the spilled material is 31.3 rem to the public and 264 rem to the collocated worker. The remaining dose contribution is from material released due to the aviation fuel spill and subsequent fuel pool fire: public dose of 11.0 rem; collocated worker dose of 93.4 rem. The preferred control would be prevention of the aircraft impact, eliminating both the spill and the fire-related dose components. The airspace over the Area G facility is already restricted, so there is no additional control that is more likely to prevent a pilot error or aircraft malfunction leading to a crash. If the extremely unlikely crash cannot be prevented, the potential controls can only seek to limit the effect of the impact and/or the aviation fuel spill and fire. The following controls were considered in the context of the control’s economic feasibility balanced against the lifetime of the facility:

- Above-Ground Inventory Doublepack – An engineered control to doublepack the entire above-ground inventory, the retrieved below-ground inventory, and all newly generated waste with a value ≥ 56 PE-Ci was considered. This engineered control would reduce consequences to all receptors. All waste contained in drums would be doublepacked into larger metal containers (e.g., 85-gal drums) of sound integrity to ensure a significant risk reduction. A problem is that doublepacked waste containers will not fit into waste characterization equipment, which is designed for a 55-gal drum. Also, the large number and type of containers to be procured, the associated handling risk to doublepack the required inventory, and the storage space taken up by increased container size is not operationally feasible. As a result, this engineered control to doublepack all drums with MAR above 56 PE-Ci was deemed not viable for TA 54, Area G.


- Installation of additional robust barriers (such as the vehicle barriers already in place) around the perimeter of container storage areas could reduce the impact energy from an aircraft crashing near the edge of the Area G site and skidding into the stored containers, but would offer no benefit for a direct strike, and is not proposed.

- Erection of a containment structure robust enough to (1) resist penetration by a crashing or skidding aircraft and (2) withstand a resulting aviation fuel pool fire is the only control that could fully mitigate the effects of an aircraft crash. Design and construction of such a structure to fully enclose the existing facility and operations is not considered fiscally feasible.

- Segregation of the TRU waste at Area G may limit the amount of MAR that is acted upon during an aircraft impact, depending on the angle and speed of impact, such that only a minimum number of containers are impacted. But putting in place a segregation control on inventory placement would be of low reliability, is an unreasonable use of valuable resources required for Area G closure activities, and is not proposed.

- A significant reduction in allowable MAR inventory could reduce the spill- and fire-related consequences of this unlikely event, but is not realistically implementable given the current inventory of legacy waste, and is not operationally feasible. Required resources to achieve a significant reduction in allowable MAR must be expended on Area G closure activities.

The dispersion analysis takes no credit for plume heating and buoyancy due to the burning of fuel and spilled combustible material. Fires that involve aviation fuel produce significant heat addition rates. For at least some portion of the fire duration, plume heating could realistically be 25 MW or greater. As indicated in LANL 2009c, the atmospheric dispersion factor \( \chi/Q_{95\%} \) (and thus the relative downwind concentration, associated DSF, and receptor dose) for a heat addition rate of 25 MW is nearly 10 times less than for the 0.0 MW heat addition rate used in the unmitigated analysis.

**Mitigated Consequences:**

The CHA identified the following ICs that protect the assumptions of the AA:

- Radiological Waste Container Controls. Radiological waste is packaged, reducing the radiological consequences as waste is agglomerated and burns as packaged.

- Hazardous Material and Waste Management Program. Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007, which reduces the consequence of mechanical and thermal effects to contained waste.

It is noted that the CHA identified two additional controls for this accident:

- The SAC, Radiological Inventory Management, requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.

- The SAC, Radiological Waste Inventory Controls, limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports).

Implementation of these controls may provide some reduction in consequences. However, the reduction in consequences cannot be quantified in this DBA.

**Conclusion**

**Overall mitigation for DBA No. 9**
Based on the implementation of significant contributors to DID, a reduction in risk is expected. However, the risk reduction cannot be quantified in this DBA. The mitigated risk rank for the event is II to the public and collocated workers.

The residual risk of this event is judged to be acceptable due to the following considerations:

The number of containers that are impacted due to the airplane crashing into the dome will be less than what is analyzed, which will generally result in a lower MAR that is being impacted. Some number of containers will be doublepacked, which will result in a lower releasable MAR and lower consequences. The analysis conservatively estimated that all of the impact energy would go into the domes and that the impact was purely inelastic.

As discussed above, crediting physical phenomena such as buoyancy has the potential to significantly reduce the consequences if energy contributions to the plume from the burning waste and the fuel pool fire are considered. Reduction by a minimum factor-of-4 conservatism will occur that is inherent to the methodology of the dispersion analysis.

Given that Area G is a limited-lifetime facility, and the frequency of this event is Extremely Unlikely, acceptance of the overall risk associated with this accident is recommended.

**Applicability of selected control set for DBA No. 9, to bounded events**

None

**3.4.2.20.5 Summary of the Safety SSCs, SACs, and TSR Controls**

The credited controls listed in Table 3-106 are those that are discussed in the AA as providing protection to the public and collocated workers through reduction in consequences.
Table 3-106. DBA No. 9 – Summary of TSR Safety Controls for Aircraft Impact with Follow-On Pool Fire

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity AGTRU-6-001</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control AGTRU-6-001</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack AGTRU-6-001</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control AGTRU-6-001</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC (SC Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This control is applicable to this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.21 DBA No. 10 – AGTRU-6-002, External Fire Propagates to Area G

3.4.2.21.1 Scenario Development

This DBA involves an external fire that propagates to Area G waste, resulting in burning of waste and a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated.

The cause that could potentially result in this accident is a wildland fire. (The fire event initiating from a lightning strike is covered in Section 3.4.2.21a, DBA No. 10a.)

TA-54 is located on Mesita del Buey, a narrow mesa near the eastern edge of LANL with canyons along both sides. The predominant vegetation type along the sides of the mesa is piñon-juniper woodlands. The piñon and juniper trees are relatively sparse and do not burn with the intensity of the ponderosa pine forests at higher elevations of the Laboratory. The top of the mesa has been cleared and has many graveled roads, asphalt pads, and structures, though grasses and weeds tend to grow in cleared areas.

A wildland fire could start at the bottom of one of the adjacent canyons and burn up to the edge of the mesa. Because of the open (cleared) spaces on the mesa, a fire cannot propagate directly through Area G. However, sparks and lofted embers from a fire on the side of the mesa could travel significant distances [Anthenien 2006] over the mesa and ignite secondary fires. These secondary fires are the predominant risk for Area G associated with wildland fires.

Assumptions

- The MAR involved in this event is as follows (assuming a widespread conflagration):
  - 57,000 PE-Ci (above-ground TRU waste inventory) distributed as follows:
    - 49,464 PE-Ci (compliant metal containers in storage)
    - 2,000 PE-Ci (non-metal above-ground TRU)
    - SSSR area with 18 PE-Ci in-process, unconfined
    - SSSR area with 18 PE-Ci staged, in closed containers
    - 1,500 PE-Ci (non-metal retrieved below-ground containers)
    - 4,000 PE-Ci, total, in Process areas
  - 100 PE-Ci exposed, in LLW area(s)
  - 4,000,000 Ci (tritium)
  - 3,000 Tritium Ci in LLW areas
- For the compliant (metal) containers in an ordinary combustible fire, a DR of 0.5 can be applied for populations of 10 drums or more in a fire, consistent with Figure 4.4.3-1 of DOE-STD-5506-2007 [DOE 2007].
- The percentage composition of waste type in the SSSR Process Area is:
  - Combustible: 100%
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
Combustible: 3.1%
Dispersible, non-combustible: 3.9%
Non-dispersible, non-combustible: 93.0%

- The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.7%
  - Dispersible, non-combustible: 95.3%
  - Non-dispersible, non-combustible: 0%

- The percentage composition of each waste type in the statistical Pit 9 container used in the analysis is taken from Table 3-22 (Section 3.4):
  - Combustible: 0.1%
  - Dispersible, non-combustible: 99.9%
  - Non-dispersible, non-combustible: 0.0%

- All other containers (i.e., LLW, and tritium), do not have a waste type composition.

### 3.4.2.21.2 Source Term Analysis

**MAR**

The unmitigated MAR for the event is as follows:

- AGTRU compliant (metal) containers in storage = 49,464 PE-Ci
- 4,000 PE-Ci, total, in Process Areas
- SSSR area with 18 PE-Ci in-process, unconfined
- SSSR area with 18 PE-Ci staged, in closed containers
- AGTRU non-metal containers (e.g., FRP boxes) = 2,000 PE-Ci
- BGTRU Pit 9 non-metal containers (e.g., FRP boxes) = 1,500 PE-Ci
- LLW = 100 PE-Ci
- LLW pits tritium-contaminated waste = 3,000 Tritium Ci
- Above-ground storage tritium waste = 4,000,000 Ci

The total unmitigated MAR used in this analysis is 57,000 PE-Ci TRU waste, 100 PE-Ci LLW, and 4,000,000 Ci tritium.

**DR**

DRs are considered for the MAR that is in compliant (metal) containers, non-metal containers, and the LLW pit, and tritium affected by the Fire.
Burning of TRU Waste:

- Burning of waste in compliant (metal) containers, DR = 0.5
- Burning of waste in non-metal containers, DR = 1.0
- Burning of LLW, DR = 1.0
- Fire release of tritium in waste containers, DR = 1.0
- Fire release of tritium contamination on LLW, DR = 1.0

**ARF × RF**

The ARF × RF values for confined burning for each of the waste types are shown in Table 3-107.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
<th>Tritium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Compliant (metal) Containers = 4.97E-01 PE-Ci
- SSSR = 1.89E-01 PE-Ci
- Non-metal Containers (includes LLW) = 2.55E-01 PE-Ci
- Tritium = 4.00E+06 Ci

**3.4.2.21.3 Consequence Analysis**

Table 3-108 shows the public and collocated worker doses. Table 3-24 (Section 3.4) lists the DSF used to calculate dose consequences from the STs. The DSF for the fires is 3.65E+01 rem PE-Ci for containers assumed to be located as close to the site boundary as dome TA-54-33, and 3.17E+01 for those stored at or beyond TA-54-412. The collocated worker doses are at 100 m from the release point and are derived from a DSF value of 3.10E+02 rem PE-Ci. The tritium DSFs for fires are also from Table 3-24 (Section 3.4), and are 1.45E-05 for the public and 2.12E-04 for the collocated worker.
### Table 3-108. DBA No. 10 – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire/TRU Compliant (metal) process &amp; storage</td>
<td>3.72E-02</td>
<td>3.65E+01</td>
<td>1.36E+00</td>
<td>3.10E+02</td>
<td>1.15E+01</td>
</tr>
<tr>
<td></td>
<td>4.60E-01</td>
<td>3.17E+01</td>
<td>1.46E+01</td>
<td>3.10E+02</td>
<td>1.43E+02</td>
</tr>
<tr>
<td>SSSR</td>
<td>1.89E-01</td>
<td>3.17E+01</td>
<td>5.98E+00</td>
<td>3.10E+02</td>
<td>5.86E+01</td>
</tr>
<tr>
<td>Fire/TRU Non-Metal</td>
<td>2.55E-01</td>
<td>3.65E+01</td>
<td>9.33E+00</td>
<td>3.10E+02</td>
<td>7.91E+01</td>
</tr>
<tr>
<td>Tritium*</td>
<td>4.00E+06</td>
<td>1.45E-05</td>
<td>5.81E+01</td>
<td>2.12E-04</td>
<td>8.49E+02</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>8.93E+01</td>
<td>Total Collocated Worker Dose</td>
<td>1.14E+03</td>
<td></td>
</tr>
</tbody>
</table>

*Reported in rem/Ci

### 3.4.2.21.4 Comparison to the Evaluation Guideline

The unmitigated 8.93E+01 rem dose to the public is High and exceeds the EG. In addition, the unmitigated dose of 1.14E+03 rem to the collocated worker is High.

#### Analysis

**Event Frequency/Risk Rank**

This unmitigated event has High consequences to the public and collocated worker and an unmitigated frequency of Anticipated. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

**Control Selection**

The unmitigated dose to the public is 8.93E+01 rem and the collocated worker dose is 1.14E+03 rem. Since this is an external event, the frequency cannot be reduced. Therefore, the control selection is focused on reducing the consequences; however, an engineered control is not available to mitigate the consequences of this event.

The CHA identified the following ICs that protect the assumptions of the AA:

- Radiological waste is packaged, reducing the radiological consequences as waste is agglomerated and burns as packaged.
- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007, which reduces the consequence of mechanical and thermal effects to contained waste.
Several controls are identified in the CHA to mitigate the consequences of this event:

- The safety-class SAC, Transient Combustible Control – Fuel Package Limit requires that fuel packages $\geq 100$ lb are attended; unattended fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal TRU waste containers by a minimum of 3 ft in order to reduce fire progression.

- The safety-class SAC, a thermal distance or equivalent barrier limits heat flux to radiological waste containers to reduce the likelihood of the involvement of radiological waste. The thermal separation distance SAC is not applicable to Low Activity Areas or to $\leq 4,000$ PE-Ci in Process Area(s), and $9,000$ PE-Ci in a Storage Area with only metal containers.

- The safety-significant SAC requires doublepacking of radiological waste drums $\geq 200$ PE-Ci, reducing the radiological consequences by limiting amount of MAR involved.

- The safety-significant SAC limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports).

- The SMP, Fire Protection Program, good housekeeping and inspections, transient combustible controls (e.g., housekeeping, vegetation control, and periodic inspections) reduces the radiological consequences by limiting the MAR involved by limiting fire size.

A wildland fire could start in the bottom of one of the adjacent canyons and burn up to the edge of the mesa that Area G resides on. Because of the open (cleared) spaces on the mesa, a fire cannot propagate directly through Area G. There is an open buffer space between the edge of the mesa and the structures. This is noted in the FHA [LANL 2013c]. However, sparks and lofted embers from a fire on the sides of the mesa could travel significant distances over the mesa and ignite secondary fires. These secondary fires are the predominant risk for Area G associated with wildland fires. Sparks and embers do not represent a direct threat to compliant metal waste containers and probably not to FRP boxes. The bigger threat comes from secondary fires (trash, dry grasses, or weeds) ignited by embers igniting a container, the contents of a container, or a box. Drums have been subjected to a number of fire experiments. Reference WEST 1995 describes what may be the most relevant experiment for this situation: simulated trash was spread over an area of about 2 ft x 6 ft between two rows of instrumented drums spaced 2 ft apart. The total quantity of the simulated trash was 38.7 kg (85 lb), consisting of:

- 10 kg – Plastic bags
- 10 kg – 10-mil plastic sheet
- 4.0 kg – Rubber (6 x 12 in. sheets)
- 3.3 kg – Brown paper
- 3.3 kg – Bond paper
- 3.3 kg – Cut paper
- 2.1 kg – Cotton towels
- 2.7 kg – Cotton fabric

For the test, these materials were ignited using a flammable liquid and then allowed to burn. The primary test drums experienced a radiant flux of about 25 kW/m². There was leakage through the drum seals, but the drum lids stayed intact and in place.
Tests were performed on FRP boxes at INEL in the late 1970s [INEL 1979]. Two tests exposed stacked FRP boxes to pool fires. These tests were configured to produce direct flame impingement on the edges and lower corners of the boxes. The first test used 15 gal of #2 diesel in a salt-filled pan. The salt acts to wick the fuel, producing a more controlled burn. This test was terminated after 40 min when the DOT 7A FRP-coated boxes were considered to be in a state of sustained combustion. That is, it took 40 min of direct flame impingement on sides and lower corners to produce sustained combustion. The second test used 4 gal of #2 diesel in the same pan without the salt wicking material. This produced a hotter fire, which burned out after approximately 15 min. The FRP-coated boxes never reached a state of sustained combustion.

The conclusion of this test is that substantial secondary fires would be necessary to challenge the integrity of compliant metal containers and FRP boxes.

Tritium wastes are stored in double-walled metal containers filled with getter materials and located in metal sheds. These containers have to be heated to high temperatures to release tritium and so would also have to be subjected to a substantial secondary fire to cause tritium to be released.

The SSSR operations are located in metal structures resistant to embers and could only be challenged by a substantial secondary fire located nearby.

The fabric of the domes used at Area G, as originally installed, was fire-resistant. The FHA notes that degradation of the coatings on the fabric may have reduced the fire-resistant characteristics. The FHA also notes that, even if the fabric of a dome catches fire, it is unlikely to drop large quantities of burning material onto the packaged waste inside the dome.

The containers used at Area G were all designed to provide substantial fire protection to the materials stored within. The first and second (IC) controls listed above require that hazardous materials are sealed in containers of sound integrity.

Area G is located on top of a mesa. Much of the surface of Area G is graveled roads, asphalt pads, and structures that are fire-resistant. This means that a wildland fire cannot propagate directly through Area G. Lofted sparks and embers could readily be transported across Area G; however, structures and containers are resistant to the challenges of these sparks and embers and are unlikely to ignite. Combustibles such as dry grasses and trash could be ignited by these sparks and embers and serve as kindling, allowing structures, containers, or the contents of containers to ignite. The rest of the controls limit combustible materials and the proximity of combustible materials to waste containers so that substantial fires cannot propagate to the waste containers within these protected areas at Area G.

The FHA [LANL 2013c] makes the case that direct propagation of a fire through Area G is unlikely because of the large expanses with little fuel. The FHA did identify the transport of firebrands onto Area G as a credible threat. A further review (documented in a Safety Basis Division calculation [LANL 2011d]) identifies secondary fires started by firebrands as the primary threat to waste containers. These secondary fires could involve seasonal vegetation (grass, weeds) or common combustibles (trash, or possibly work-related items).

The waste containers are fire-resistant by design. As noted above, in testing of FRPs exposed to a pool fire [INEL 1979], it took about 40 min to reach sustained combustion of the test FRPs. Relatively large fires are needed to damage the waste container types at Area G.

The transient combustible controls AC-SMP (housekeeping, vegetation control, periodic inspections) and the Transient Combustible Control—Defined Area SAC are credited with limiting the amount of
combustible material in proximity to waste containers that could be ignited by firebrands. This limits the release to a low but unquantifiable amount.

Implementation of these controls prevents the release of containerized waste so that the dose to the public approaches zero. The release of small quantities of unconfined radioactive materials cannot be entirely ruled out, so final mitigated consequences cannot be quantified. However, consequences for the public and collocated worker receptors are judged as Low.

**Conclusion**

**Overall mitigation for DBA No. 10**

A wildland fire could burn up a side of Mesita del Buey toward TA-54, Area G. Area G has been cleared, and much of the area of this mesa has roads, storage areas, or structures that prevent the direct propagation of a wildland fire across Area G. Sparks and embers could be carried over all parts of the mesa. Because waste is in fire-resistant containers, these sparks and embers are not a direct threat. The greatest risk comes from sparks or embers starting secondary fires. A substantial fire is required to threaten the integrity of these waste containers; the size of fire needed to challenge the integrity of a container depends on the type of container.

Controls (safety-significant ICs) ensure that waste is in containers or is buried deep enough to not be threatened by a fire.

The SACs for thermal separation distance and control for transient combustible fuel packages prevents fuel packages that present the risk of ignition or progression of a significant fire from being located near stored waste or other combustibles.

The AC-SMP fire protection program—transient fuel controls (housekeeping, vegetation control, periodic inspections)—provides defense-in-depth against the build-up of the large quantities of combustible materials that could result in a significant secondary fire.

Implementation of these controls prevents the release of containerized waste so that the dose to the public approaches zero. The release of small quantities of radioactive materials cannot be entirely ruled out, so final mitigated consequences cannot be quantified.

**Applicability of selected control set for DBA No. 10 to bounded events**

None.

**3.4.2.21.5 Summary of the Safety SSCs, SACs, and TSR Controls**

The credited controls listed in Table 3-109 are those that are discussed in the AA as providing protection to the public and collocated workers through reduction in consequences.
<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Protection – Thermal Separation Distance – Defined Area</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC (SC Function)</td>
<td>Reduce the likelihood of fire progression between defined areas.</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Fire Protection - Control of Transient Combustibles – Fuel Package Limit</td>
<td>Transient combustible controls within defined areas. Transient fuel packages ≥ 100 lb are attended; Unattended fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal TRU waste containers by a minimum of 3 ft in order to reduce fire progression</td>
<td>SAC (SC Function)</td>
<td>Reduce radiological consequences by limiting fire progression within a defined area and the amount of MAR involved.</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC (SC Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is credited for this DBA.</td>
</tr>
</tbody>
</table>
### Table 3-109.  DBA No. 10 – Summary of TSR Safety Controls for External Fire Propagating to Area G

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Packaging Control AGTRU-6-002</td>
<td>Waste is packaged.</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This control is credited for this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.21a DBA No. 10a – AGTRU-7-002, Lightning Strikes Multiple TRU Waste Containers

3.4.2.21a.1 Scenario Development

This DBA involves multiple TRU waste containers experiencing a breach, resulting in release of radiological material. The CHA identified the unmitigated frequency of this DBA as Anticipated. In this scenario, it is postulated that lightning strikes a 3-tier stack of TRU waste drums. The top four TRU waste drums experience a deflagration due to a flammable atmosphere. The other two tiers of TRU waste drums experience a low-energy impact and contained burning. The accident is assumed to occur at a location that is closest to the site boundary (Dome 54-33).

A lightning strike is the initiating event that could potentially result in this accident.

Assumptions

- The lightning strike impacts the top four containers in a 12-container stack (4 containers stack/pallet × 3 tiers).
- The top four containers are conservatively assumed to consist of 4 drums containing the highest MAR values.
- The analysis is based on the top 4 metal containers having a combustible headspace due to lack of vent, clogged vent, etc.
- The analysis uses source term parameters applicable to (compliant) waste containers of sound integrity. This bounds the case where a non-compliant waste container is impacted, because the non-compliant container is postulated to not build up a flammable gas pressure, and the container is postulated to experience only contained burning.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%

3.4.2.21a.2 Source Term Analysis

MAR

The postulated MAR involved when a lightning strikes a stack of containers is as follows:

For the deflagrating containers:

- One Maximum Container = 553 PE-Ci
- One UTL95/99 Percentile Container = 56.2 PE-Ci
- Two UTL95/95 Percentile Container at 20.9 PE-Ci each = 41.8 PE-Ci

For the remaining 8 containers in the stack that experience a low-energy impact and contained burning:

- The remainder at UTL95 for the mean each = 8 × 4.84 PE-Ci = 38.7 PE-Ci
Damage Ratios

The DR methodology for drums that undergo an impact spill with subsequent fire and a deflagration follows the guidance in DOE-STD-5506, Table 4.4.2-1 [DOE 2007].

Impact Spill:

- Spill from initial impact, DR = 0.01
- Fire terms:
  - Initially spilled material that burns uncontained, DR = 0.01
  - 99% of the containers that did not expel waste contents upon impact will experience contained burning, DR = 0.99

Container Deflagration:

- Container experiences lid loss and ejection of 40% of the waste, DR = 0.4
  - Flexing in air: DR = 0.4
  - Unconfined burning: DR = 0.4 × 0.05 = 0.02
- Remaining 60% of the waste burns contained within the drum, DR = 0.6

ARF × RF

The ARF × RF values for spill/ flexing in air, contained burning, and uncontained burning for each of the waste types is shown in Table 3-110, and is consistent with DOE-HDBK-3010 [DOE 2000a] and DOE-STD-5506 [DOE 2007].

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>6E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined Burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined Burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.
The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills: 2.39E-02 PE-Ci
- Fires: 1.21E-02 PE-Ci

### 3.4.2.21a.3 Consequence Analysis

Table 3-111 shows the public and collocated worker doses. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 5.33E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.65E+01 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>2.39E-02</td>
<td>5.33E+01</td>
<td>1.27E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>1.21E-02</td>
<td>3.65E+01</td>
<td>4.43E-01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td>1.72E+00</td>
<td>Total Collocated Worker Dose</td>
<td>1.45E+01</td>
</tr>
</tbody>
</table>

### 3.4.2.21a.4 Comparison to the Evaluation Guideline

The unmitigated 1.72E+00 rem dose to the public is Moderate and does not challenge the EG; collocated worker doses are 1.45E+01, a Low consequence.

### Analysis

#### Event Frequency/Risk Rank

This event (unmitigated) has Moderate consequences to the public and Low consequences to the collocated worker and a postulated unmitigated frequency of Anticipated. Per guidance contained in DOE-STD-5506 [DOE 2007], this results in a public risk rank II and a collocated worker binning of III for the collocated worker for the unmitigated event. Thus, safety-significant controls for the protection of the public are required.

### Control Selection

The lightning strike, in and of itself, cannot be prevented. However, the selected control should reduce the frequency of the lightning strike impacting unvented containers on the top of a stack or within a stack at Area G.
A lightning protection system is the preferable control to prevent the occurrence of this HE. For a credited SSC, a reduction in one bin frequency (a factor of 100) should be attained. However, the LPS system at Area G must be considered in context of a report by Morris [LANL 2004]. This report cites data from the Federal Interagency Lightning Protection User Group [FED 2001], which states that only 1/16th as many lightning-caused fires occur in NFPA 780 [NFPA 2011]-protected structures as in unprotected structures. This means that a NFPA 780-compliant lightning protection system provides only a factor-of-16 reduction in lightning-induced fires within a structure. Based on this data, the LPS system at Area G is more appropriately classified as defense-in-depth because it does not provide a factor-of-100 reduction for a credited SSC. The Morris report also cites that lightning strikes on metal containers result in pin-hole-type accidents and confined fires. In this case, the pin-hole caused by the lightning strike may cause the single container to experience confined burning.

Two SACs are selected to mitigate the consequences of this accident, requiring that (1) drums with ≥ 200 PE-Ci are double-packed into sound containers and (2) unvented drums are isolated and not stacked. These two controls will lower the consequences from lightning strike and damage. The requirement for double-packing drums with MAR ≥ 200 PE-Ci reduces the potential dose contribution from the higher-MAR containers. The requirement for only vented containers within the stacks prevents the deflagration accident. The two SACs, along with the information in the Morris report, result in dose consequences that are from a single container impacted by a lightning strike and experiencing confined burning. In this case, the dose consequences are approximately 4 rem (199 [MAR, assuming 100% combustible, instead of the statistical waste composition] × 5E-4 [ARF × RF] × 36.5 [DSF]; DR=1); or approximately 31 rem to the collocated worker (DSF = 310 rem/PE-Ci).

The dose consequences still result in Moderate consequences to both receptors.

The accident frequency of Anticipated is attributed to the area of dome impacted by the lightning strike. If the area of the drum impacted by the lightning strike is considered, the frequency of the lightning strike upon the drum is probably very low (< 1E-6/yr⁻¹). In this case, the frequency of the event is Beyond Extremely Unlikely.

The frequency of Beyond Extremely Unlikely for a lightning strike upon a single container, along with the credited SACs, results in a mitigated risk rank III.

To protect the assumptions of the accident analysis with respect to container DRs, the Hazardous Material and Waste Management Program is also credited for the following:

- All waste is packaged (burns as packaged agglomerated material).
- Waste containers are maintained as safety SSCs to ensure that they meet the inspection requirements for a container of sound integrity as indicated in DOE-STD-5506 [DOE 2007]. A corollary (control) to this assumption is that drums that are found with loss of integrity are overpacked into containers of sound integrity.

**Conclusion**

Based on the credited controls selected and discussed, with reduction in mitigated consequences, the final mitigated risk ranking for this event is III and the event is considered to be sufficiently mitigated.
3.4.2.21a.5 Summary of Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-112 are those that are discussed in the AA as providing protection to the public and collocated workers from a lightning strike. The suite of defense-in-depth controls for the event is in Section 3.3.
Table 3-112.  DBA No. 10a – Summary of TSR Safety Controls for Lightning Strike Impacting Multiple Containers

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood of deflagration</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste drums are not stacked</td>
<td>SAC (SS Function)</td>
<td>Reduces likelihood of inadvertent container toppling.</td>
<td>This is a credited control for this DBA and the listed bounded HA event.</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>TRU waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This control is applicable to this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.22 DBA No. 11 – AGTRU-7-005, High Wind Damages Multiple TRU Waste Containers

3.4.2.22.1 Scenario Development

This DBA involves high wind damaging multiple TRU waste containers, resulting in a release of radiological material. TRU waste containers can be stored inside or outside of the domes. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The causes that could potentially result in this accident are as follows:

- High wind
- High straight-wind-generated missiles

Assumptions

- The storage domes provide no protection to the TRU storage arrays.
- The storage arrays collapse or topple due to impact from debris or wind.
- A PC-3 level straight-line wind (117 mph) (DOE-STD-1020-2002, Table 3-1 [DOE 2002c]).
- Tornados are not credible for LANL (DOE-STD-1020-2002, Table 3-2).
- 12 compliant (metal) containers are impacted by wind-generated missiles.
- TRU waste containers subject to missile impact have a DR = 1.0 (DOE-STD-5506-2007, Table 4.4.4-1 Line 6 [DOE 2007]).
- Two existing AGTRU and two retrieved non-metal containers (e.g., FRP boxes) are impacted by wind-generated missiles.
- The MAR involved in this event is as follows:
  - 12 Compliant (metal) Containers – 690 PE-Ci
  - 2 Existing non-metal containers (e.g., FRP boxes) – 475 PE-Ci
  - 2 Retrieved below ground non-metal containers (e.g., FRP boxes) – 260 PE-Ci.
  - 100 PE-Ci of LLW
  - 4,000,000 Ci (tritium)
  - 3,000 Ci (LLW)
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
  - Dispersible, Non-combustible: 3.9%
  - Non-dispersible, Non-combustible: 93.05%
- The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.7%
The percentage composition of each waste type in the statistical Pit 9 container used in the analysis is taken from Table 3-22 (Section 3.4):

- Combustible: 0.1%
- Dispersible, non-combustible: 99.9%
- Non-dispersible, non-combustible: 0.0%

All other containers (i.e., below-ground retrieval, LLW, tritium, and CMPs) do not have a waste type composition.

3.4.2.22.2 Source Term Analysis

MAR

The unmitigated MAR for the event is as follows:

- AGTRU compliant (metal) containers = 690 PE-Ci
- AGTRU non-metal containers (e.g., FRP boxes) = 475 PE-Ci
- BGTRU non-metal containers (e.g., FRP boxes) = 260 PE-Ci
- LLW = 100 PE-Ci
- Above-ground storage tritium waste = 4,000,000 Ci
- LLW pits tritium-contaminated waste = 3,000 Ci

The total unmitigated MAR used in this analysis is 1,525 PE-Ci, and 4,003,000 Ci tritium.

DR

DRs are considered for the MAR that is in compliant (metal) containers and non-metal containers affected by the high wind and the LLW.

Impact by flying debris:

- Spill from compliant (metal) containers, DR = 1.0
- Spill from non-metal containers, DR = 1.0
- Release from LLW, DR = 1.0
- Spill from tritium waste containers, DR = 0.0

ARF × RF

The ARF × RF values for spill/flexing in air for each of the waste types are shown in Table 3-113.
### Table 3-113. DBA No. 11 – ARF × RF Values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>6E-4</td>
<td>7E-05</td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- AGTRU compliant (metal) container spills = 4.97E-02 PE-Ci
- LLW high wind releases = 1.00E-02 PE-Ci
- Non-metal container spills = 7.35E-02 PE-Ci

#### 3.4.2.22.3 Consequence Analysis

Table 3-114 shows the public and collocated worker doses. Table 3-25 (Section 3.4) lists the DSF used to calculate dose consequences from the STs. The DSF for the spills is 1.75E+00 rem/PE-Ci. The collocated worker doses are at 100 m from the release point and are derived from a DSF value of 7.08E+00 rem/PE-Ci.

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGTRU Compliant (metal) Containers</td>
<td>4.97E-02</td>
<td>1.75E+00</td>
<td>8.70E-02</td>
<td>7.08E+00</td>
<td>3.52E-01</td>
</tr>
<tr>
<td>LLW</td>
<td>1.00E-02</td>
<td>1.75E+00</td>
<td>1.75E-02</td>
<td>7.08E+00</td>
<td>7.08E-02</td>
</tr>
<tr>
<td>Non-metal Containers</td>
<td>7.35E-02</td>
<td>1.75E+00</td>
<td>1.29E-01</td>
<td>7.08E+00</td>
<td>5.20E-01</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td></td>
<td></td>
<td>2.33E-01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Collocated Worker Dose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.43E-01</td>
</tr>
</tbody>
</table>
3.4.2.22.4 Comparison to the Evaluation Guideline

The unmitigated 2.33E-01 rem dose to the public is Low. The unmitigated dose of 9.43E-01 rem to the collocated workers is Low.

Analysis

Event Frequency/Risk Rank

This unmitigated event has Low consequences to the public and collocated worker receptors and an unmitigated frequency of Unlikely. Per guidance contained in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank III binning for the unmitigated event. Thus, no controls other than SMPs are required for protection of the public and collocated workers.

Control Selection

The CHA identified the following ICs to protect the assumption of the AA:

- Hazardous Material and Waste Management Program, Metal TRU waste have sound integrity as indicated in DOE-STD-5506-2007, which reduces the consequence of mechanical and thermal effects to contained waste.

It is noted that the CHA identified the following controls:

- The SAC, Radiological Inventory Management Program, requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.
- The SAC, Radiological Waste Inventory Controls, limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports).

The implementation of the following controls may provide some reduction in consequences. However, this reduction in consequences cannot be quantified in this DBA.

Conclusion

Overall mitigation for DBA No. 11

Based on the implementation of the SSCs and programmatic elements discussed above, the risk rank for the event is III, with Low consequences to the public and to the collocated workers.

Applicability of selected control set for DBA No. 11, to bounded events

None

3.4.2.22.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-115 are those that are discussed in the AA as providing protection to the public and collocated workers through reduction in consequences.
### Table 3-115. DBA No. 11 – Summary of TSR Safety Controls for High Winds Damage TRU Containers

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management – Doublepack AGTRU-7-005</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduces radiological consequences by limiting amount of MAR involved</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Control AGTRU-7-005</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC (SS Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This control is applicable to this DBA.</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity AGTRU-7-005</td>
<td>Metal TRU waste container have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is applicable to this DBA.</td>
</tr>
</tbody>
</table>
3.4.2.23 DBA No. 12 – AGTRU-7-007, Seismic Event Affects Area G

3.4.2.23.1 Scenario Development

Case 1 – Seismic event causes collapse of the HE-RTR

The HE-RTR vault is unique among Area G structures in that the robust construction would result in high impact to TRU waste containers given a seismic collapse. An ensuing fire is not considered credible because of the non-combustible construction of the vault and because of the lack of sources of ignition. The CHA identifies the unmitigated frequency of this DBA as unlikely.

Assumptions:

- MAR = 1,100 PE-Ci limit for HE-RTR process area.
- The damage ratio for substantial building collapse onto a few drums is 1.0.
- Drums are 100% combustible, dispersable.

Case 2:

This DBA involves a seismic event affecting Area G, with a subsequent fire which propagates throughout the facility, resulting in a release of radiological material. The CHA identified the unmitigated frequency of this DBA as Unlikely.

The cause of this accident is a seismic event.

Assumptions

- The MAR involved in this event is as follows:
  - 57,000 PE-Ci (above-ground TRU waste inventory) distributed as follows:
    - 53,464 PE-Ci (compliant [metal] containers) in storage or process areas
    - SSSR area with 18 PE-Ci in-process, unconfined
    - SSSR area with 18 PE-Ci staged, in closed containers
    - 2,000 PE-Ci (non-metal above-ground TRU)
    - 1,500 PE-Ci (non-metal retrieved below-ground containers)
  - 100 PE-Ci (LLW)
  - 1,000,000 Ci (tritium) in one above-ground storage location
- For the compliant (metal) containers in an ordinary combustible fire, a DR of 0.5 can be applied for populations of 10 drums or more in a fire, consistent with Figure 4.4.3-1 of DOE-STD-5506-2007 [DOE 2007].
- The percentage composition of waste type in the SSSR Process Area is 100% combustible.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.1%
The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):

- Combustible: 4.7%
- Dispersible, non-combustible: 95.3%
- Non-dispersible, non-combustible: 0%

The percentage composition of each waste type in the statistical Pit 9 non-metal container used in the analysis is taken from Table 3-22 (Section 3.4):

- Combustible: 0.1%
- Dispersible, non-combustible: 99.9%
- Non-dispersible, non-combustible: 0%

Seismic Event:

- The domes at Area G are considered to be of light construction, Table 4.4.5-1 in DOE-STD-5506-2007 [DOE 2007]. Therefore, an additional source term from structural members impacting compliant metal waste containers is not considered.

- One third (i.e., top tier) of the compliant (metal) container AGTRU MAR is released due to toppling, Table 4.4.4-1, DOE-STD-5506-2007.

- SWBs, TDOPs, FRP, and TRUPACT II payloads are not expected to topple, Appendix C of DOE-STD-5506-2007 [DOE 2007].

- Non-metal containers are subject to damage due to falling debris.

- Exposed MAR in LLW Area(s) is affected by the motion (vibration) caused by the earthquake.

- Stored tritium is not released due to the effects of the seismic motion, but could be affected by a fire of sufficient intensity.

Subsequent Fire:

- It is unreasonable to assume that all of the defined areas experience a post-seismic fire. Therefore, it is assumed that one defined area where there is metal container storage does experience a post-seismic fire. The fire is caused as a result of a downed electrical wire and resultant short, or by a pole transformer that falls on top of the TRU waste containers within the defined area.

- The TRU waste that is spilled from the third tier drums dropping is the material that experiences unconfined burning. In order for all of the spilled material to burn unconfined, as well as for the TRU waste material that is not spilled to experience confined burning, it is assumed that ordinary combustible material is strewn about the defined storage areas. The amount of ordinary combustible material is sufficient to cause the fire to propagate through the spilled material; in addition, the radiant heat from the ordinary combustible material fire is sufficient to cause confined burning of the TRU waste containers. The fire in the metal container storage defined area is the bounding post-seismic fire. It is assumed that an electrical short will not be sufficient in and of itself to cause waste spilled from non-metal containers to burn unconfined. The burning of spilled waste is a result of the fire spreading from the metal container storage defined area that
experiences the post-seismic fire due to burning of sufficient ordinary combustible material. It is assumed that a downed pole transformer will not cause burning of the non-metal containers because non-metal container storage areas are sufficiently distanced from pole-mounted transformers containing flammable/combustible liquids. (Because a post-seismic fire involving non-metal containers as a result of a downed pole transformer may result in significant doses, the presumption that non-metal containers are stored at a sufficient distance near pole-mounted transformers is protected as a safety-class SAC.)

- Waste from non-breached metal containers in the defined area is assumed to burn confined.
- The post-seismic fire is also spread to the staged and in-process combustible material in one SSSR area.
- Exposed LLW is affected by the post-seismic fire and burns agglomerated.
- All tritium in one storage location and all of the tritium contamination on the LLW is released.

### 3.4.2.23.2 Source Term Analysis

**Case 1:**

The Source Term is $1,100 \times 1.0E-04 \times 1.0 (DR) = 0.11$ PE-Ci.

**Case 2:**

**MAR**

The unmitigated MAR for the event is as follows:

- AGTRU compliant (metal) containers in storage or process areas = 53,464 PE-Ci
- SSSR area with 18 PE-Ci in-process, unconfined
- SSSR area with 18 PE-Ci staged, in closed containers
- AGTRU non-metal containers (e.g., FRP boxes) = 2,000 PE-Ci
- BGTRU non-metal containers (e.g., FRP boxes) = 1,500 PE-Ci
- LLW = 100 PE-Ci
- LLW pits tritium-contaminated waste = 3,000 Ci tritium
- Above-ground storage tritium waste = 1,000,000 Ci tritium

The total unmitigated MAR used in this analysis is 57,000 PE-Ci TRU waste, 100 PE-Ci LLW, and 1,003,000 Ci tritium.

**DR**

**Seismic Event:**

- One third of the compliant (metal) containers fall from third tier, $DR = 0.01 \times 0.33 = 0.0033$
- Non-metal containers impacted by debris from collapsing domes, $DR = 0.1$
- LLW Area(s) experience release due to seismic event, $DR = 1.0$
• No Tritium is released from the seismic event, DR = 0.0
• No release from the CMPs due to seismic vibrations, DR = 0.0

**Post Seismic Fire:**

• Non-metal container MAR spilled burns unconfined, DR = 0.1
• Non-metal container MAR not spilled burns confined, DR = 0.9
• Metal container MAR spilled burns unconfined, DR = 0.0033
• Metal container MAR not spilled burns confined, DR = 0.5 x (1- 0.0033) = 0.498
• Open, in-process MAR in one SSSR Area burns unconfined, DR = 1.0
• Staged MAR in one SSSR Area burns confined, DR = 1.0
• Burning of LLW Area, DR = 1.0
• Fire release of tritium in waste containers, DR = 1.0
• Fire release of tritium contamination on LLW, DR = 1.0

**ARF × RF**

The ARF × RF values for low energy impact (spill), unconfined burning, and confined burning for each of the waste types are shown in Table 3-116.

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
<th>Tritium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Energy Impact (spill)</td>
<td>1E-4</td>
<td>1E-4</td>
<td>7E-5</td>
<td>0.0</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
<td>1.0</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
<td></td>
</tr>
</tbody>
</table>

**LPF**

The LPF is 1 and is, therefore, excluded from the ST calculation.

**ST**

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

• Impact (spill) AGTRU Compliant (metal) Containers in storage or process = 1.27E-02 PE-Ci
• Impact (spill) AGTRU Non-metal Containers in storage = 2.00E-02 PE-Ci
• Impact (spill) retrieved BGTRU non-metal Containers = 1.50E-02 PE-Ci
• Impact (spill) LLW = 6.96E-04 PE-Ci
• Fire – Material in SSSR Area (confined and unconfined) = 1.89E-01 PE-Ci
• Fire AGTRU in Storage & Process Areas with Metal Containers = 2.67E-01 PE-Ci
• Fire AGTRU compliant (metal) containers in DVS Process area = 1.13E-02 PE-Ci
• Fire AGTRU Non-metal Containers in storage= 2.50E-1 PE-Ci
• Fire retrieved BGTRU non-metal Containers = 1.88E-01 PE-Ci
• Fire LLW = 3.48E-03 PE-Ci
• Fire Tritium (in LLW and stored) = 1.003E+06 Ci

3.4.2.23.3 Consequence Analysis

Case 1:

The consequences to the public and collocated worker from a seismic collapse of the HE-RTR would be:

- Public: 0.11 PE-Ci (ST) × 5.3E+1 (DSF) = 5.83 rem, consequence moderate
- Collocated Worker: 0.11 PE-Ci (ST) × 4.50E+02 (DSF) = 49.5 rem, consequence moderate

Case 2:

Table 3-117 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSFs for the spills resulting from the seismic event and for the fire component with no buoyancy are shown in Table 3-117, for the public and for the collocated worker at 100 m from the release point. The release locations associated with the DSF values are documented in the DBA 12 unmitigated analysis worksheets in Appendix 3C.
Table 3-117. DBA No. 12 – Unmitigated Consequence Analysis for Case 2

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Impact/ AGTRU Compliant Metal Containers (Storage &amp; Process)</td>
<td>1.27E-02</td>
<td>4.63E+01</td>
<td>5.88E-01</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Impact/ retrieved TRU Non-Metal Containers</td>
<td>1.50E-02</td>
<td>4.63E+01</td>
<td>6.94E-01</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Impact/ stored TRU Non-Metal Containers</td>
<td>2.00E-02</td>
<td>4.63E+01</td>
<td>9.25E-01</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Impact/ LLW</td>
<td>6.96E-04</td>
<td>5.33E+01</td>
<td>3.71E-02</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Fire/ SSSR Area</td>
<td>1.89E-01</td>
<td>3.17E+01</td>
<td>5.98E+00</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Fire/ DVS Process Area, 54-33</td>
<td>1.13E-02</td>
<td>3.65E+01</td>
<td>4.13E-01</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Fire/TRU Metal Containers in Storage and Process Areas</td>
<td>2.67E-01</td>
<td>3.17E+01</td>
<td>8.47E+00</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Fire/retrieved TRU Non-Metal Containers</td>
<td>1.88E-01</td>
<td>3.17E+01</td>
<td>5.94E+00</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Fire/stored TRU Non-Metal Containers</td>
<td>2.50E-01</td>
<td>3.17E+01</td>
<td>7.92E+00</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Fire/ LLW</td>
<td>3.48E-03</td>
<td>3.65E+01</td>
<td>1.27E-01</td>
<td>3.10E+02</td>
</tr>
<tr>
<td>Tritium* (fire release from LAA &amp; storage shed)</td>
<td>1.003E+06</td>
<td>1.45E-05</td>
<td>1.45E+01</td>
<td>3.08E-04</td>
</tr>
<tr>
<td></td>
<td>Total Public Dose</td>
<td>4.56E+01</td>
<td></td>
<td>Total Collocated Worker Dose</td>
</tr>
</tbody>
</table>

*Reported in rem/Ci. An additional 50% of the inhalation intake is absorbed through the skin [DOE 2002a].

3.4.2.23.4 Comparison to the Evaluation Guideline

For Case 1, the unmitigated 5.83 rem to the public is Moderate and the 49.5 rem dose to the collocated worker is moderate. For Case 2, the unmitigated 4.56E+01 rem dose to the public is High and exceeds the EG. The unmitigated dose of 6.12E+02 rem to the collocated workers is High.

Analysis

Event Frequency/Risk Rank

Case 1:

The unmitigated collapse of the HE-RTR has Moderate consequences to the public and to the collocated worker, with a risk ranking of II. The contribution to the overall dose from seismic collapse with fire at Area G is less than 10%.
Case 2:

This unmitigated event has High consequences to the public and collocated workers and an unmitigated frequency of Unlikely. Per guidance in DOE-STD-5506-2007 [DOE 2007], this results in a risk rank I binning for the unmitigated event. Thus, in addition to safety-class controls for the protection of the public, safety-significant controls for the protection of the collocated workers are required.

Control Selection

The unmitigated dose of 4.56E+01 rem is High to the public, and the dose of 6.12E+02 is High to the collocated worker. Since this is an NPH event, the initiating event frequency cannot be reduced. Therefore, the control selection is focused on reducing the consequences. More specifically, the controls focus on removing the radiological release due to fire.

The CHA identified the following control to mitigate the frequency and consequences from the progression of a seismically initiated fire:

- The safety-class SAC, Control of Transient Combustibles – Fuel Package Limit, minimizes the combustible loading in the Defined Areas. With this control to prevent the spread of fire, all of the fire source terms are mitigated to zero, except for fires involving MAR in an area in which the control is not applicable (i.e., exposed LLW in a Low Activity Area) and the initial fire involving an electrical spark causing unconfined waste in one SSSR process area that burns.

The safety-class SAC, a thermal separation distance limits heat flux to radiological waste containers in applicable areas to reduce the likelihood of the involvement of radiological waste. The thermal separation distance SAC is not applicable to Low Activity Areas or ≤ 4,000 PE-Ci in Process Area(s), and 9,000 PE-Ci in a Storage Area with only metal containers. In addition, it is unreasonable to assume that all of the spilled material within the defined area burns unconfined because the spilled material will be strewn about and not in direct contact to allow such fire propagation.

In this case the dose consequences are mitigated to a public dose of 9.79E+00 rem, and a collocated worker dose of 9.36E+01 rem, both Moderate consequences, as shown in Table 3-118. Frequency that the seismic event will cause fire initiation and progression sufficient to burn this much MAR is Extremely Unlikely.
Table 3-118. DBA No. 12 – Case 2 Mitigated Consequence Analysis – Fire Source Terms
Reduced

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact/ AGTRU Compliant Metal Containers (Storage &amp; Process)</td>
<td>1.27E-02</td>
<td>4.63E+01</td>
<td>5.88E-01</td>
<td>4.50E+02</td>
<td>5.72E+00</td>
<td></td>
</tr>
<tr>
<td>Impact/ stored TRU Non-Metal Containers</td>
<td>2.00E-02</td>
<td>4.63E+01</td>
<td>9.25E-01</td>
<td>4.50E+02</td>
<td>9.00E+00</td>
<td></td>
</tr>
<tr>
<td>Impact/ retrieved TRU Non-Metal Containers</td>
<td>1.50E-02</td>
<td>4.63E+01</td>
<td>6.94E-01</td>
<td>4.50E+02</td>
<td>6.75E+00</td>
<td></td>
</tr>
<tr>
<td>Impact/ LLW</td>
<td>1.10E-03</td>
<td>5.33E+01</td>
<td>5.87E-02</td>
<td>4.50E+02</td>
<td>4.95E-01</td>
<td></td>
</tr>
<tr>
<td>Fires/unconfined SSSR, in-process</td>
<td>1.80E-01</td>
<td>3.17E+01</td>
<td>5.70E+00</td>
<td>3.10E+02</td>
<td>5.58E+01</td>
<td></td>
</tr>
<tr>
<td>Fire/TRU Metal Containers in Process Areas</td>
<td>0.00E+00</td>
<td>3.65E+01</td>
<td>0.00E+00</td>
<td>3.10E+02</td>
<td>0.00E+00</td>
<td></td>
</tr>
<tr>
<td>Fires/TRU Metal Containers in Storage Areas</td>
<td>0.00E+00</td>
<td>3.17E+01</td>
<td>0.00E+00</td>
<td>3.10E+02</td>
<td>0.00E+00</td>
<td></td>
</tr>
<tr>
<td>Fires/TRU Non-Metal Containers</td>
<td>0.00E+00</td>
<td>3.65E+01</td>
<td>0.00E+00</td>
<td>3.10E+02</td>
<td>0.00E+00</td>
<td></td>
</tr>
<tr>
<td>Fire/ exposed LLW</td>
<td>5.50E-03</td>
<td>3.65E+01</td>
<td>2.01E-01</td>
<td>3.10E+02</td>
<td>1.71E+00</td>
<td></td>
</tr>
<tr>
<td>Tritium*, in LLW</td>
<td>3.00E+03</td>
<td>1.45E-05</td>
<td>4.35E-02</td>
<td>1.85E-04</td>
<td>5.55E-01</td>
<td></td>
</tr>
</tbody>
</table>

Total Public Dose: 8.21E+00
Total Collocated Worker Dose: 8.00E+01

*Reported in rem/Ci. An additional 50% of the inhalation intake is absorbed through the skin [DOE 2002a].

The CHA identified the following ICs that protect the assumptions of the AA:

- Radiological waste is packaged, reducing the radiological consequences as waste is agglomerated and burns as packaged.
- Metal TRU waste containers have sound integrity as indicated in DOE-STD-5506-2007 [DOE 2007], which reduces the consequences of mechanical and thermal effects to contained waste.
- The IC, implemented as a safety-class SAC, protects the presumption that TRU waste storage areas are a sufficient distance from pole-mounted transformers containing flammable/combustible liquids to prevent the pole-mounted transformer from falling on top of a storage area during a seismic event, or any fuel pool fire from spilled fuel from the pole-mounted transformer from impacting the TRU waste storage areas.
For Case 1, the safety significant MAR limit of 1,100 PE-Ci limits the radiological consequences of the seismic collapse of a building (HE-RTR) of substantial construction upon TRU waste containers.

The CHA also identified additional controls for this accident:

- The SAC requires doublepacking of radiological waste drums > 200 PE-Ci, reducing the radiological consequences by limiting the amount of MAR involved.
- The SAC limits MAR in defined areas and facilities (e.g., Process, Retrieval, within Building 54-412, and Transports).

Conclusion

Overall mitigation for DBA No. 12

It is conservatively assumed that the entire compliant (metal) container inventory of Area G on the third tier will fall and experience light stress. This conservative assumption does not credit the defense-in-depth effect of drum banding in reducing toppling of stacked pallets of drums. In reality, some portion of the containers will provide an elevated surface to land on, and only a portion of those top-tier containers will experience a release. Additionally some fraction of the containers at Area G will be doublepacked, which will reduce the consequences.

Using MAR in defined areas, and controlling the combustibles within these areas, provides protection against fires initiating, developing, and spreading. Essentially, the source term from fire-induced radiological release is significantly reduced. This major reduction in dose consequences is accomplished by crediting the safety-class SAC on Combustible Loading within defined areas. This is because it is judged unreasonable that more than one defined area, in addition to one SSSR area, would be impacted by a post-seismic fire as a result of the initiating electrical spark or downed pole transformer.

Tritium release from molecular sieves and from LLW contamination only occurs with fire (see Section 3.4.1.5). Therefore, the safety-class SAC control of combustibles also removes the dose consequences attributed to the release of tritium.

With these controls, the mitigated dose consequences do not challenge the EG. With the corresponding reduction in frequency of the fire progression, the mitigated risk rank is III for the seismic event with fires.

Another control was considered to reduce the frequency of a fire associated with a seismic event:

- Seismic switch system, consisting of seismic switches and an associated control, recording, and signaling system. It would function to isolate electrical power from the site during a design-basis seismic event.

This control was eliminated from consideration because of economic constraints, given the short operating life of the facility. Also, because of the comparatively light construction of the storage domes, the electrical system is subject to substantial vibration due to high wind, etc., and vibration-sensitive switches would not be feasible.

Applicability of selected control set for DBA No. 12 to bounded events

None
3.4.2.23.5 Summary of the Safety SSCs, SACs, and TSR Controls

The credited controls listed in Table 3-119 are those that are discussed in the AA as providing protection to the public and collocated workers through reduction in consequences.
## Table 3-119. DBA No. 12 – Summary of TSR Safety Controls for Seismic Event with Follow-on Fire

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Attribute</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Protection - Control of Transient Combustibles – Fuel Package Limit AGTRU-7-007</td>
<td>Transient combustible controls within defined areas. Transient fuel packages ≥ 100 lb are attended. Unattended transient fuel packages are separated from nonmetal TRU waste containers or other fuel packages by a minimum of 9 ft and from metal TRU waste containers by a minimum of 3 ft in order to reduce fire progression</td>
<td>SAC (SC Function)</td>
<td>Reduces the radiological consequences by limiting fire progression within a defined area and the amount of MAR involved.</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Controls AGTRU-7-007</td>
<td>Limit MAR in defined areas and facilities (Process, within Bldg 412, LAA, and Transports)</td>
<td>SAC (SC Function)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>Radiological Inventory Management – Defined Area MAR Controls AGTRU-7-007</td>
<td>Limit MAR in HE-RTR Process Area</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences by limiting the MAR subject to impact in a seismic collapse</td>
<td>This control is credited for Case 1 of this DBA.</td>
</tr>
<tr>
<td>Pole-Mounted Transformers AGTRU-7-007</td>
<td>Prevents pole-mounted transformers containing flammable/combustible liquids dropping onto TRU storage areas during seismic event.</td>
<td>SAC (SC Function)</td>
<td>Prevent pole-mounted transformers from falling onto or in close proximity to waste storage areas, to prevent a post-seismic transformer fuel pool fire from impacting waste, thereby mitigating consequences from a post-seismic fire.</td>
<td>This control is an initial assumption for this DBA.</td>
</tr>
<tr>
<td>Control / Applicable Event</td>
<td>Control Attribute</td>
<td>Level</td>
<td>Control Safety Function</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management – TRU Waste Container Integrity</td>
<td>Metal TRU waste containers have sound integrity</td>
<td>IC (SS Function)</td>
<td>Reduces the consequence of mechanical and thermal effects to contained waste</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>AGTRU-7-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>IC (SS Function)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>AGTRU-7-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management – Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PE-Ci</td>
<td>SAC (SS Function)</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>AGTRU-7-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Protection – Thermal Separation Distance</td>
<td>A thermal distance or equivalent barrier limits heat flux to radiological waste containers</td>
<td>SAC (SS Function)</td>
<td>Reduces the likelihood of fire progression between defined areas.</td>
<td>This control is credited for this DBA.</td>
</tr>
<tr>
<td>AGTRU-7-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.24  DBA No. 13 – AGTRU-2-034a, Acetylene Gas Explosion

3.4.2.24.1  Scenario Development

The scenario assumes that an acetylene gas explosion occurs when a cylinder leaks or a cylinder is subject to a flashback while hot work is performed. The resulting explosion affects stored waste in a storage dome. This scenario is considered to be Extremely Unlikely.

A number of safety factors are intrinsic to acetylene gas cylinders. Acetylene is shipped and stored in a metal cylinder with porous filling (Agamassan) wetted with or dissolved in acetone or dimethylformamide (DMF), which renders it safe to transport and use. Nonetheless, acetylene has been known to detonate under certain conditions.

An explosion hazard exists if acetylene is released in a confined space. Acetylene-air mixtures have a wide flammability range, ignitable at concentrations between 2.5% and 81%. Above 81% concentration, even though true combustion does not take place for acetylene, it can undergo an explosive decomposition reaction. The flash point for acetylene is 32 °F and the auto ignition temperature is 581 °F. The minimum ignition energy for acetylene in air is only 17 micro joules. This is an extremely low ignition energy compared to more common gases such as methane.

To determine if an ignitable concentration of acetylene gas is likely to result from a leaking acetylene cylinder in a storage area, a size B cylinder is assumed to leak into the storage dome with the smallest volume. The cylinder contains up to 40 ft³ of acetylene gas (about 1.36 kg), and the volume of Dome 54-224 is more than 166,000 ft³ (from dimensions in Table 2-1). With uniform mixing of the gas throughout the dome before an ignition source is encountered, the concentration of acetylene gas in air would be only 0.02%, well below the ignitable concentration. If an ignition source were encountered while the acetylene gas cloud was expanding from the leaking cylinder, a flammable acetylene-air concentration could be reached in a localized portion of the dome volume, resulting in a deflagration. The fire and overpressure from the deflagration could damage some of the stored waste containers.

The overpressure at various distances can be estimated by calculating the TNT equivalent mass for the acetylene deflagration.

Energy available = 1.36 kg Acetylene x (48.220 MJ/kg Acetylene) = 65.6 MJ

TNT equivalent mass, TNT\text{eq} = (65.6 MJ / 4.6 MJ /kg of TNT) x 0.15 efficiency factor = 2.14 kg TNT

= 4.72 lb TNT

\[ P_{\text{over}} = 29/Z + 552/Z^2 + 1106/Z^3 \]

where \( Z = R / (\text{TNT}_{\text{eq}})^{1/3} = R / (4.72)^{1/3} = R / 1.677 \)

at 10 ft, \( P_{\text{over}} = 25.62 \text{ psig} \) at 11 ft, \( P_{\text{over}} = 21.18 \text{ psig} \)

at 20 ft, \( P_{\text{over}} = 6.97 \text{ psig} \)

at 30 ft, \( P_{\text{over}} = 3.54 \text{ psig} \)

at 40 ft, \( P_{\text{over}} = 2.27 \text{ psig} \)

at 50 ft, \( P_{\text{over}} = 1.64 \text{ psig} \)

at 60 ft, \( P_{\text{over}} = 1.27 \text{ psig} \)
3.4.2.24.2 Source term

Because of the high yield of an acetylene gas explosion, significant overpressure could be experienced for a significant distance within a storage dome. As a result, a portion of the inventory of a storage dome could sustain a high impact, with the most highly impacted drums sustaining a damage ratio of 1.0. Because the acetylene gas detonation creates an ignition source, the impacted and spilled waste could be subject to unconfined burning. According to Section 6.3.6.6 of the Rocky Flats Safety Analysis and Risk Assessment Handbook [SARAH 2001], the overpressure required to cause drum rupture due to an external explosion is at least 22 psig. Only those few drums located within about 11 feet of the acetylene explosion would be likely to experience crushing overpressure, but more drums would be within the fire-affected area where radiant energy is high enough to cause a material release. The unruptured drums located farther from the explosion but within the fire area could experience ejection and unconfined burning of some additional waste, and confined burning of the remaining unexpelled waste.

The storage area is assumed to be filled to the metal container MAR limit of 22,000 PE-Ci. Ten percent of the waste is assumed to be in drums close enough to experience shrapnel penetration or acetylene explosion blast overpressure severe enough to fail the drums and spill all the waste. The top tier drums in the remaining 90% of the inventory experience lid ejection and confined burning, and the lower tier drums experience confined burning of the contained waste.

The spill source term is 1.59E+00 PE-Ci and the fire source term is 8.85E-01 PE-Ci.

3.4.2.24.3 Consequence and Comparison to Evaluation Guidelines

The consequences would be strongly dependent upon where the leaking cylinder deflagration was, in relation to the stored TRU waste containers. With the assumptions stated above, the public dose from the fire would be 3.23E+01 rem and the dose from the spill would be 8.49E+01 rem, for a total of 1.17E+02 rem. The total collocated worker dose would be 9.90E+02. (See Appendix 3C for the detailed analysis and summary of public and collocated worker doses for DBA 13.) The public and collocated worker doses are High, with a risk rank of II.

The control to prevent this accident imposed as a safety class SAC:

- Acetylene cylinders shall not be stored or used inside or within 50 feet of defined areas when MAR is present.

This prevents the acetylene explosion accident. The distance beyond the defined areas is well in excess of that necessary to prevent crushing overpressure of waste containers, and also sufficient to ensure radiant energy from an acetylene explosion and fire will not cause a release of MAR from a metal or non-metal container stored nearby (i.e., it exceeds applicable Thermal Separation Distance requirements). With this control in place, the accident becomes Beyond Extremely Unlikely.

Conclusion

The unmitigated consequences of this event are High with an unmitigated frequency of Extremely Unlikely, giving a risk ranking of II. Based on the credited controls selected and discussed, a reduction in frequency to Beyond Extremely Unlikely is achieved. As a result, the final mitigated risk ranking for this event is III for the public and collocated workers.

Applicability of selected control set for DBA No. 13 to bounded events
None

3.4.2.24.4 Summary of the Safety SSCs, SACs and TSR Controls

Table 3-120 provides a summary of TSR safety controls to prevent/mitigate consequences of an acetylene gas explosion.
Table 3-120. DBA No. 13 - Summary of TSR Safety Controls for Acetylene Explosion

<table>
<thead>
<tr>
<th>Control / Applicable Event</th>
<th>Control Description</th>
<th>Level</th>
<th>Control Safety Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene Gas Cylinder Control AGTRU-2-034a</td>
<td>Acetylene cylinders shall not be stored or used in defined areas where MAR is present, or within 50 ft of those defined areas.</td>
<td>SAC (SC Function)</td>
<td>Reduces likelihood of an acetylene gas explosion impacting MAR.</td>
<td>This is a credited control for this DBA.</td>
</tr>
</tbody>
</table>
3.4.3 BEYOND DESIGN BASIS ACCIDENTS

3.4.3.1 High-Speed Vehicle Accident with Fuel Pool Fire

3.4.3.1.1 Scenario Development

This BDBA involves a refueling truck traveling at > 35 mph and crashing into a storage array containing compliant (metal) TRU waste drums. The refueling truck tank ruptures, spilling its fuel cargo; the fuel ignites, engulfing the storage array. The fuel pool fire spreads to engulf an adjacent storage array containing TRU waste in non-metal containers, resulting in a release of radiological materials. All waste in both storage arrays is consumed in this event.

The causes that could potentially result in this accident are as follows:

- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering or brakes)

Assumptions

- ST parameters for compliant (metal) waste containers (sound integrity) are used in the analysis.
- The percentage composition of each waste type in the statistical compliant (metal) container used for the above-ground compliant (metal) containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 3.13%
  - Dispersible, non-combustible: 3.9%
  - Non-dispersible, non-combustible: 93.0%
- The percentage composition of each waste type in the statistical non-metal container used for the above-ground non-metal containers in the analysis is taken from Table 3-20 (Section 3.4):
  - Combustible: 4.7%
  - Dispersible, non-combustible: 95.3%
  - Non-dispersible, non-combustible: 0%
- The percentage composition of each waste type in the statistical Pit 9 container used in the analysis is taken from Table 3-22 (Section 3.4):
  - Combustible: 0.1%
  - Dispersible, non-combustible: 99.9%
  - Non-dispersible, non-combustible: 0.0%
- The truck releases 5000 gal of fuel.
Once the spilled fuel is consumed by the pool fire, the waste continues burning for the remainder of the 20-min duration of the release from the event, as modeled in MACCS2. Buoyancy is not modeled for the releases for conservatism.

The unmitigated MAR for this event is as follows:
- AGTRU compliant (metal) containers (e.g., drums) = 22,000 PE-Ci
- AGTRU non-metal containers (e.g., FRP boxes) = 2,000 PE-Ci
- BGTRU Pit 9 non-metal containers (e.g., FRP boxes) = 1,500 PE-Ci

Impact on compliant (metal) waste containers:
- 10% of the containers experience catastrophic stress
- 10% of the containers experience moderate to severe stress
- 80% of the containers experience minor stress

All non-metal waste burns uncontained.

### 3.4.3.1.2 Source Term Analysis

**MAR**

The unmitigated MAR for the event is as follows:
- AGTRU compliant (metal) containers (e.g., drums) = 22,000 PE-Ci
- AGTRU non-metal containers (e.g., FRP boxes) = 2,000 PE-Ci
- BGTRU Pit 9 non-metal containers (e.g., FRP boxes) = 1,500 PE-Ci

The total unmitigated MAR for this event is 25,500 PE-Ci.

**DR**

**Compliant (metal) Containers**

Impact and Unconfined Burning:
- 10% of the containers experience catastrophic stress: DR=1.0 × 0.1 = 0.1
- 10% of the containers experience moderate to severe stress: DR=0.1 × 0.1 = 0.01
- 80% of the containers experience minor stress: DR=0.01 × 0.8 = 0.08

**Fuel Pool Fire**

- 25% of MAR not released due to impact is modeled as drums experiencing lid ejection:
  - 1/3 of contents experience ejection
    - Flexing in air: DR = (1-0.1-0.01-0.008) × 0.25 × 0.33 = 0.074
    - Unconfined burning: DR = (1-0.1-0.01-0.008) × 0.25 × 0.33 = 0.074

The remainder of MAR experiences confined burning, DR = 1-0.1-0.01-0.008-0.074 = 0.809
Non-metal Containers

Containers are not impacted by truck and only experience contained burning due to the fuel pool fire, DR = 1.0.

ARF × RF

The ARF × RF values for spill/flexing in air, confined burning, and unconfined burning for each of the waste types are shown in Table 3-120.

Table 3-121. BDBA – ARF × RF values

<table>
<thead>
<tr>
<th>Failure Mechanism</th>
<th>Combustible</th>
<th>Non-Combustible, Dispersible</th>
<th>Non-Combustible, Non-Dispersible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill, shock, and vibration of expelled material (high-energy)</td>
<td>2E-3</td>
<td>1E-3</td>
<td>7E-4</td>
</tr>
<tr>
<td>Spill, shock, and vibration of expelled material (low-energy)</td>
<td>1E-4</td>
<td>6E-4</td>
<td>7E-5</td>
</tr>
<tr>
<td>Unconfined burning</td>
<td>1E-2</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
<tr>
<td>Confined burning</td>
<td>5E-4</td>
<td>6E-5</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

LPF

The LPF is 1 and is, therefore, excluded from the ST calculation.

ST

The ST and consequence analysis calculations are shown in Appendix 3C. The unmitigated STs are as follows:

- Spills = 1.84E+00 PE-Ci
- Fires = 1.89E+00 PE-Ci

3.4.3.1.3 Consequence Analysis

Table 3-121 shows the public and collocated worker doses, assuming a non-buoyant release. Tables 3-24 and 3-25 (Section 3.4) list the DSF used to calculate dose consequences from the STs. The DSF for the spills resulting from the initial impact and flexing in air is 4.63E+01 rem/PE-Ci; the DSF for the fire component with no buoyancy is 3.17E+01 rem/PE-Ci. These DSF values are based on the $\chi/Q_{95\%}$ values for a spill and fire release from TA-54-412, which is closer to the site boundary than the defined Storage Areas. The collocated worker doses are at 100 m from the release point and are derived from DSF values of 4.50E+02 rem/PE-Ci (spill) and 3.10E+02 rem/PE-Ci (fire).
### Table 3-122. BDBA – Unmitigated Consequence Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th><strong>Public</strong></th>
<th></th>
<th><strong>Collocated Worker</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.84E+00</td>
<td>4.63E+01</td>
<td>8.50E+01</td>
<td>4.50E+02</td>
</tr>
<tr>
<td>Fire</td>
<td>1.89E+00</td>
<td>3.17E+01</td>
<td>5.98E+01</td>
<td>3.10E+02</td>
</tr>
</tbody>
</table>

| Total Public Dose | 1.45E+02 | 1.41E+03 |
| Total Collocated Worker Dose | 1.41E+03 |

#### 3.4.3.1.4 Comparison to the Evaluation Guideline

The unmitigated 1.45E+02 rem dose to the public exceeds the EG. The unmitigated dose of 1.41E+03 rem to the collocated workers is High.

**Analysis**

**Event Frequency/ Risk Rank**

Not required per DOE-STD-3009-2007 [DOE 2006a]

This accident involving a refueling truck traveling at high speed which impacts and defeats the safety-class SSC vehicle barriers is considered a BDBA. Per DOE-STD-3009-2007, the focus of the BDBA is evaluation of the magnitude of consequences of the BDBA, not the frequency or the risk ranking of the event.

**Conclusion**

Using the LANL site-specific DSF, the unmitigated dose contribution of 8.50E+01 rem from the spill dominates the total dose to the public (1.45E+02 rem). The dose from the spill term is 5.98E+01 rem.

Controls identified to prevent or mitigate accidents in this BIO provide limited benefit as DID controls.
ATTACHMENT A NATIONAL CONSENSUS CODES AND STANDARDS

**Environmental Protection**
- 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs)
- 40 CFR 63, National Emission Standards for Hazardous Air Pollutants for Source Categories
- 40 CFR 68, Chemical Accident Prevention Provisions (Environmental Protection Agency Risk Management Program)
- 40 CFR 82, Protection of Stratospheric Ozone
- 40 CFR 261, Identification and Listing of Hazardous Waste
- 40 CFR 263, Standards Applicable to Transporters of Hazardous Waste (RCRA)
- 40 CFR 268, Land Disposal Restrictions
- 40 CFR 302, Designation, Reportable Quantities, and Notification (Comprehensive Environmental Response, Compensation, and Liability Act-CERCLA)
- 40 CFR 370, Hazardous Chemical Reporting: Community Right-to-Know
- 40 CFR 372, Toxic Chemical Release Reporting: Community Right-to-Know
- 40 CFR 700–799, Environmental Protection Agency
- 10 CFR 1021, National Environmental Policy Act Implementing Procedures
- 40 CFR 355, Emergency Planning and Notification
- 40 CFR 262, Standards Applicable to Generators of Hazardous Waste

**Fire Protection**
- NFPA 30, Flammable and Combustible Liquids Code

**Transportation**
- 49 CFR 171-180, Department of Transportation Hazardous Materials Regulations

**Hazard Communication**
- 29 CFR 1926.59, Hazard Communication

**Occupational Safety and Health**
- 29 CFR 1926.21, Safety Training and Education
- 29 CFR 1910 Subpart Z, Toxic and Hazardous Substances
- 10 CFR 851, Worker Safety and Health Program

**Hoisting and Rigging**
- ANSI B30.5, B30.14, B30.4, B30.3, B30.8, B30.6, B30.16, A92.6, A92.3, A92.2, A90.1, B15.1, B56.1, and B56.6

**Electrical Safety**
- NFPA 70: National Electrical Code
- NFPA 70E: Standard for Electrical Safety In the Workplace
- OSHA 29 CFR 1910: Occupational Safety and Health Standards, Subpart S, .269
- OSHA 29 CFR 1926: Safety and Health Regulations for Construction, Subpart K
Excavation
29 CFR 1926, Subpart P, Excavations
29 CFR 1910, General Industry

Fall Protection
ANSI Standard A1264.1-1995 (R2002), Safety Requirements for Workplace Floor and Wall Openings, Stairs, and Railing Systems.
ANSI Standard A92.2, Ladders
29 CFR 1910 Subpart D (Walking-Working Surfaces),
Subpart F (Powered Platforms, Manlift, and Vehicle-Mounted Work Platforms), and
Subpart I (Personal Protective Equipment)
29 CFR 1926 Subpart E (Personal Protective and Life Saving Equipment),
Subpart L (Scaffolds),
Subpart M (Fall Protection),
Subpart R (Steel Erection), and
Subpart X (Stairways and Ladders)

Forklifts and Powered Industrial Trucks
ANSI/ASME, Safety Standard for Powered Industrial Trucks—Low-Lift and High-Lift Trucks, Section 5.
ANSI/NFPA, Fire Safety Standard of Powered Industrial Trucks
OSHA. DOE Hoisting Rigging Standard, Title 29, Part 1910.178
NFPA, National Electrical Code, NFPA 70.

Lock Out/Tag out
29 CFR 1910.147 The Control of Hazardous Energy (Lockout/Tagout), (July 1, 2002).
Selection and Use of Work Practices,
29 CFR 1910.333 Standard for Electrical Safety in the Workplace,

Noise
29 CFR 1910.95, Occupational Noise Exposure

Personal Protective Equipment
10 CFR 851 Worker Health and Safety Rule
29 CFR 1910, Subpart I, Personal Protective Equipment
29 CFR 1910 Subpart Q, Welding, Cutting and Brazing
29 CFR 1910.1030 (d)(3)(x), Bloodborne Pathogens
29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories
29 CFR 1926.102, Eye and Face Protection
29 CFR 1926.96, Occupational Foot Protection
ANSI/ISEA 105-2005 American National Standard for Hand Protection Selection Criteria
ASTM F2412-05 Standard Test Methods for Foot Protection
ASTM F 2413-05 Standard Specification for Performance Requirements for Foot Protection.
**Pressure Safety**
API Standard 510, 572, 573 - *Pressure Vessel Inspection*.
API Standards 520, 521, 576 - *Pressure Relief Devices*.
ASME Boiler and Pressure Vessel Code, Sections I through XI.
International Conference of Building Officials, *Uniform Fire Code*, Articles 74 and 80
National Board of Boiler and Pressure Vessel Inspectors, *National Board Inspection Code*
NFPA. Hazardous Chemicals Data, NFPA 49,
NFPA. Manual of Hazardous Chemical Reactions, NFPA 491M,
NFPA. Liquefied Petroleum Gases, NFPA 58,

**Criticality Safety**
ANSI/ANS-8.1, *Nuclear Criticality Safety in Fissionable Material Operations Outside of Reactors*

**Radiation Generation Devices**
(ANSI 1993)
21 CFR 1020, *Performance Standards for Ionizing Radiation-Emitting Products*
DOE-G 441.1-5, *Radiation-Generating Devices Guide*

**Radiation Protection**
10 CFR 835, Radiation Protection

**Emergency Management**
10 CFR 30.72, *Schedule C, Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release.*
3.5 REFERENCES

ANSI 2007 ANSI/HPS N43.6, Sealed Radioactive Source Classification, American National Standards Institute, New York, 2007


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Basis for Interim Operation Rev. 3.0
Los Alamos National Laboratory


INEL 1979 TREE-1367, DOT 7A FRP Box Fire Test at the INEL, Idaho National Engineering Laboratory, Idaho Falls Idaho, June 1979


LANL 2001 REPORT-TWISP-001, R0, Basis for Interim Operation at TWISP Retrieval from PAD2, Technical Area 54, Los Alamos National Laboratory, Los Alamos NM, November 2001

LANL 2004 Morris, Lightning Protection Assessment of TA-54, Area G Waste Storage Domes, LANL FWO-WFM 04-076, Los Alamos National Laboratory, Los Alamos NM, May 2004

LANL 2009b  CALC-09-TA54-AREAG-004, *Analysis of TA-54 Area G Pit 9 Inventory*, Los Alamos National Laboratory, Los Alamos, NM, August 2009


LANL 2010b  AD-NHHO:10-373, Rev. 1, *Submittal of Justification for Page Changes to Modify Section 5.6.8.1 Drum Drop-Height and Handling Limits Specific Administrative Controls*, Los Alamos National Laboratory, Los Alamos, NM, December 22, 2010


LANL 2011a  SB-DO:CALC-11-014, Rev 1, *Calculation for Radiant Energy at a Distance Away from Object for “Ordinary” Combustibles and Pool Fires*, Los Alamos National Laboratory, Los Alamos, NM, August 2011

LANL 2011b  CALC-11-TA-54-AREAG-009, Rev. 0, *Accident Analysis Fuel Flow Rate Determination*, Los Alamos National Laboratory, Los Alamos, NM, June 2011


LANL 2012b  SB-DO:CALC-12-001, Rev 0, *Numbers of Drums In Pool Fires as a Function of Fire Size*, Los Alamos National Laboratory, Los Alamos, NM, January 2012


LANL 2013b  CAL-000448, *Projection of Area G Inventory to July 2013*, Los Alamos National Laboratory, Los Alamos NM, March 2013

LANL 2013c  REPORT-WFM-017, R. 5, *Fire Hazard Analysis for Technical Area 54, Area G*, Los Alamos National Laboratory, Los Alamos NM, March 2013


APPENDIX 3A

UNIQUE AND REPRESENTATIVE EVENTS FOR TA-54 AREA G ACCIDENT ANALYSIS
<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Type</td>
<td>5506 Hazard Evaluation Event</td>
<td>Bounded Events</td>
<td>Candidate Unique and Representative Events</td>
<td>Selected Unique and Representative Events</td>
<td>DBA</td>
</tr>
<tr>
<td>------------</td>
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<tr>
<td>E-1 (Cont’d)</td>
<td>Event 1 (Cont’d)</td>
<td>BGTRUPIT-1-001, BGTRUPIT-1-035</td>
<td>BGTRUPIT-1-002</td>
<td>AGTRU-1-044</td>
<td>AGTRU-1-044</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AGTRU-1-046, AGTRU-1-070, AGTRU-1-076, BGTRUCSK-1-011, BGTRUPIT-1-020, BGTRUPIT-1-040, BLDG412-1-014, H3-1-002, H3-1-015</td>
<td>AGTRU-1-044</td>
<td>AGTRU-1-044</td>
<td>AGTRU-1-044</td>
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<tr>
<td></td>
<td></td>
<td>AGTRU-1-082</td>
<td>AGTRU-1-081</td>
<td>None</td>
<td>AGTRU-1-033, LLW-1-013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BGTRUPIT-1-033, LLW-1-013</td>
<td>AGTRU-1-048</td>
<td>AGTRU-1-048</td>
<td>AGTRU-1-048</td>
</tr>
<tr>
<td>Small Fire (Event 2)</td>
<td></td>
<td>AGTRU-1-027, AGTRU-1-028, AGTRU-1-029, AGTRU-1-030, AGTRU-1-073, AGTRU-1-074, AGTRU-1-080, BGTRUCMP-1-002, BGTRUPIT-1-005, BGTRUPIT-1-015, BGTRUPIT-1-023, BLDG412-1-005, RANTTOG-1-007, RANTTOG-1-008, RANTTOG-1-009, RANTTOG-1-010, RANTTOG-1-011, RANTTOG-1-012, TRU LLW-1-002, H3-1-012</td>
<td>AGTRU-1-031</td>
<td>AGTRU-1-031</td>
<td>AGTRU-1-031</td>
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<td></td>
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<td>AGTRU-1-040, AGTRU-1-045, AGTRU-1-053, AGTRU-1-060, AGTRU-1-062, BGTRUCSK-1-005, BGTRUCSK-1-016</td>
<td>BGTRUCSK-1-003</td>
<td>BGTRUCSK-1-003</td>
<td>BGTRUCSK-1-003</td>
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<tr>
<td>Event Type</td>
<td>5506 Hazard Evaluation Event</td>
<td>Bounded Events</td>
<td>Candidate Unique and Representative Events</td>
<td>Selected Unique and Representative Events</td>
<td>DBA</td>
</tr>
<tr>
<td>------------</td>
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<tr>
<td>E-1 (Cont’d)</td>
<td>Small Fire (Event 2)</td>
<td>BGTRUCSK-1-006</td>
<td>BGTRUCSK-1-007</td>
<td>BGTRUPIT-1-027</td>
<td>BGTRUPIT-1-017</td>
</tr>
<tr>
<td>Enclosure Fire (Event 3)</td>
<td></td>
<td>The following events were identified as enclosure-related events. However, no unique controls were identified as a result of the events beyond those already identified for Small Fire events, and the consequences of the Small Fire events bounded the Enclosure Fire events. Therefore, no Event 3 DBA was developed. The following enclosure events were bounded by the indicated Event 2 Unique and Representative events.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 3A-1 Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
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<tbody>
<tr>
<td><strong>E-2 Events - Explosion Events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignition of Fumes Results in a Deflagration/ Detonation (external to container) (Event 5)</td>
<td></td>
<td>External deflagration/ detonation events (e.g., AGTRU-2-001 and AGTRU-2-003,) were identified. However, the risk of these events was determined to be low to the public (i.e., Risk Rank III or IV) or NPP. Therefore, no Event 5 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Waste Container Deflagration (Event 6)</td>
<td></td>
<td></td>
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<tr>
<td>None</td>
<td></td>
<td>AGTRU-2-034</td>
<td>AGTRU-2-034</td>
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<td>AGTRU-2-034 DBA-13</td>
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<tr>
<td>None</td>
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<td>AGTRU-2-012</td>
<td>AGTRU-2-012</td>
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<td>AGTRU-2-012 DBA-4A</td>
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<tr>
<td>None</td>
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<td>AGTRU-2-028a</td>
<td>AGTRU-2-028a</td>
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<td>AGTRU-2-028</td>
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<td>BGTRUPIT-2-010</td>
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<td>AGTRU-2-032</td>
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Appendix 3A
<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>None</td>
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<td>AGTRU-2-030</td>
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<td>BGTRUPIT-2-005</td>
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<td>BGTRUCSK-2-005</td>
<td>DBA-4D</td>
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<td>AGTRU-2-024, BGTRUCSK-2-012, BGTRUPIT-2-012</td>
<td>RANTTOG-2-001</td>
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<tr>
<td></td>
<td></td>
<td>None</td>
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<td>BGTRUCSK-2-011</td>
<td>BGTRUCSK-2-011</td>
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<td></td>
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<td>BGTRUCSK-2-003, BGTRUCSK-2-004, BGTRUCSK-2-006, BGTRUCSK-2-017, BGTRUPIT-2-002, BGTRUPIT-2-006</td>
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<td>BGTRUCSK-2-002</td>
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<tr>
<td></td>
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<td>AGTRU-2-020, BGTRUCSK-2-001a, BGTRUPIT-2-001, BGTRUPIT-2-004, BGTRUPIT-2-013</td>
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<td>BGTRUCSK-2-014</td>
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<td>AGTRU-2-013</td>
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<td>BGTRUCSK-2-014</td>
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<tr>
<td>Multiple Waste Container Deflagration (Event 7)</td>
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<td>AGTRU-2-025</td>
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<td>None</td>
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<td>BGTRUCSK-2-007</td>
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Table 3A-1  Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
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</thead>
<tbody>
<tr>
<td><strong>E-3 Events - Loss of Confinement/ Containment</strong></td>
<td>Vehicle/ Equipment Impacts Waste/Waste Containers (Event 9)</td>
<td>AGTRU-3-001, AGTRU-3-002, AGTRU-3-003, AGTRU-3-004, AGTRU-3-010, AGTRU-3-011, AGTRU-3-021, AGTRU-3-023, AGTRU-3-029, AGTRU-3-035, AGTRU-3-038, AGTRU-3-042, AGTRU-3-044, BGTRUCSK-3-001, BGTRUCSK-3-014, BGTRUCSK-3-015, BGTRUCSK-3-016, BGTRUPIT-3-001, BGTRUPIT-3-002, BGTRUPIT-3-003, BGTRUPIT-3-004, BGTRUPIT-3-009, BGTRUPIT-3-010, BGTRUPIT-3-011, BGTRUPIT-3-012, BGTRUPIT-3-013, BGTRUPIT-3-014, BGTRUPIT-3-017, BGTRUPIT-3-020, BGTRUPIT-3-030, BGTRUPIT-3-031, BGTRUPIT-3-032, BGTRUPIT-3-033, RANTTOG-3-001, RANTTOG-3-002, TRU LLW-3-001, LLW-3-001, LLW-3-002, LLW-3-003, LLW-3-004, LLW-3-005, LLW-3-006, LLW-3-016</td>
<td>AGTRU-3-012</td>
<td>AGTRU-3-012</td>
<td>DBA-7A</td>
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<tr>
<td>E-3 (Cont’d)</td>
<td>Event 9 (Cont’d)</td>
<td>AGTRU-3-008, AGTRU-3-015, AGTRU-3-026, AGTRU-3-027, BGTRUCKSK-3-008, BGTRUCKSK-3-010, BGTRUPIT-3-008, BGTRUPIT-3-016, BGTRUPIT-3-026, LLW-3-011, LLW-3-013, LLW-3-014, LLW-3-017</td>
<td>AGTRU-3-016</td>
<td>AGTRU-3-016</td>
<td>DBA-7B</td>
</tr>
<tr>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. (Event 10)</td>
<td>AGTRU-3-005, AGTRU-3-006, AGTRU-3-007, AGTRU-3-009, AGTRU-3-014, AGTRU-3-022, AGTRU-3-030, AGTRU-3-037, AGTRU-3-040, AGTRU-3-041, BGTRUCMP-3-013, BGTRUCKSK-3-002, BGTRUCKSK-3-003, BGTRUCKSK-3-004, BGTRUCKSK-3-005, BGTRUCKSK-3-006, BGTRUCKSK-3-011, BGTRUCKSK-3-013, BGTRUPIT-3-005, BGTRUPIT-3-006, BGTRUPIT-3-007, BGTRUPIT-3-015, BGTRUPIT-3-016, BGTRUPIT-3-018, BGTRUPIT-3-027, BGTRUPIT-3-028, BGTRUPIT-3-029, BGTRUPIT-3-034, BGTRUPIT-3-035, BGTRUPIT-3-036, BGTRUPIT-3-037, BGTRUPIT-3-038, BGTRUPIT-3-039, LLW-3-007, LLW-3-008, LLW-3-009, LLW-3-010, LLW-3-012, LLW-3-015</td>
<td>AGTRU-3-017</td>
<td>AGTRU-3-017</td>
<td>DBA-8</td>
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Table 3A-1  Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
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</thead>
<tbody>
<tr>
<td>E-3 (Cont’d)</td>
<td>Collapse of Stacked Containers (Event 11)</td>
<td>The following events were identified as stacked container collapse events. However, no unique controls were identified as a result of the events beyond those already identified for vehicle/equipment impact events, and the consequences of the vehicle/equipment impact events bounded the stacked container collapse events. Therefore, no Event 11 DBA was developed. The following enclosure events were bounded to the indicated Event 9 Unique and Representative events.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stack Collapse Event</td>
<td>AGTRU-3-010, AGTRU-3-023, BGTRUPIT-3-010, BGTRUPIT-3-012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Container Over-Pressurization (Event 12)</td>
<td>Waste container over-pressurization events (i.e., AGTRU-3-024, AGTRU-3-025, and BGTRUCSK-3-007) were identified. However, the risk of these events was determined to be low (i.e., Risk Rank III or IV). Therefore, no Event 12 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3A-1  Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E-4 Events - Direct Exposure to Radiation</strong></td>
<td></td>
<td>Direct exposure events (e.g., AGTRU-4-006) were identified. However, the risk of these events was determined to be low to the public (i.e., Risk Rank III or IV) or NPP. Therefore, no Event 13 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Direct Exposure to Radiation Events (Event 13)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E-5 Events - Criticality Events</strong></td>
<td></td>
<td>Criticality events (e.g., AGTRU-5-001) were identified. However, the risk of these events was determined to be low to the public (i.e., Risk Rank III or IV) or NPP. Therefore, no Event 14 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Criticality Events (Event 14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E-6 Events - Externally Initiated Events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft Impact with Fire (Event 15)</td>
<td>BGTRUCSK-6-001, BGTRUPIT-6-001</td>
<td>AGTRU-6-001</td>
<td>AGTRU-6-001</td>
<td></td>
<td>DBA-9</td>
</tr>
<tr>
<td>External Vehicle Accident (Event 16)</td>
<td></td>
<td>It is NPP that an external vehicle could impact waste due to the site configuration of Area G (i.e., no external roads approach the facility boundary, and natural canyons surround the facility). Therefore, no Event 16 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>
## Table 3A-1  Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-6 (Cont’d)</td>
<td>External Vehicle Accident with Fire (Combustible or Pool) (Event 17)</td>
<td>It is NPP that an external vehicle could impact waste due to the site configuration of Area G (i.e., no external roads approach the facility boundary, and natural canyons surround the facility). Therefore, no Event 17 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>External Explosion (Event 18)</td>
<td>There are no natural gas pipelines or other sources of explosions operating in proximity to Area G. Therefore, no Event 18 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>External Fire (Event 19)</td>
<td>LLW-6-002</td>
<td>AGTRU-6-002</td>
<td>AGTRU-6-002</td>
<td>DBA-10</td>
</tr>
</tbody>
</table>

### E-7 Events - NPH Initiated Events

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightning (Event 20)</td>
<td>AGTRU-7-001, AGTRU-7-002, BGTRUCSK-7-001, BGTRUPIT-7-001, H3-7-002, LLW-7-003, LLW-7-004</td>
<td>AGTRU-7-002a</td>
<td>AGTRU-7-002a</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>High Wind (Event 21)</td>
<td>LLW-7-005</td>
<td>AGTRU-7-005</td>
<td>AGTRU-7-005</td>
<td>DBA-11</td>
<td></td>
</tr>
<tr>
<td>Tornado (Event 22)</td>
<td>Due to the high altitude of Los Alamos, tornado events are not environmentally plausible, and Event 21 does address high winds. Therefore, no Event 22 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
Table 3A-1  Unique and Representative Event Selection for TA-54, Area G Accident Analysis

<table>
<thead>
<tr>
<th>Event Type</th>
<th>5506 Hazard Evaluation Event</th>
<th>Bounded Events</th>
<th>Candidate Unique and Representative Events</th>
<th>Selected Unique and Representative Events</th>
<th>DBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-7 (Cont’d)</td>
<td>Snow/ Ice/ Volcanic Ash Build-up (Event 23)</td>
<td>The consequences of Snow/Ice/Volcanic Ash Build-up events are bounded by the consequences of Container Collapse events (Event 11) and the control sets are the same. Therefore, no Event 23 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Seismic Event (Impact Only) (Event 24)</td>
<td>The consequences of Seismic Events are bounded by the consequences of the Seismic Event with Fire, and the control sets are the same. Therefore, no Event 24 DBA was developed.</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Seismic Event with Fire (Event 25)</td>
<td>AGTRU-7-006, LLW-7-001, LLW-7-002</td>
<td>AGTRU-7-007</td>
<td>AGTRU-7-007</td>
<td>DBA-12</td>
</tr>
</tbody>
</table>
APPENDIX 3B

DELETED
APPENDIX 3C

ACCIDENT ANALYSIS WORKBOOKS
### Source Terms from MAR on Truck (Overall MAR storage waste composition)

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF (PE-Ci)</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-04</td>
<td>3.37E-04</td>
<td>7.93E-03</td>
<td>3.67E-01</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.E-04</td>
<td>4.28E-04</td>
<td>3.41E-02</td>
<td>1.08E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.E-05</td>
<td>7.16E-03</td>
<td>5.89E-03</td>
<td>2.41E+00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-02</td>
<td>3.37E-02</td>
<td>2.53E-02</td>
<td>6.39E-01</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.1</td>
<td>6.E-05</td>
<td>2.57E-04</td>
<td>2.53E-02</td>
<td>8.01E-01</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.E-05</td>
<td>5.32E-03</td>
<td>2.53E-02</td>
<td>5.35E-01</td>
</tr>
<tr>
<td>25% of unbreached containers lose their lids and</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.07</td>
<td>1.E-04</td>
<td>3.18E-04</td>
<td>5.89E-03</td>
<td>2.41E+00</td>
</tr>
<tr>
<td>eject 33% of the material. Flexing in Air</td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.07</td>
<td>6.E-05</td>
<td>1.91E-04</td>
<td>2.53E-02</td>
<td>8.01E-01</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.9304</td>
<td>0.07</td>
<td>7.E-05</td>
<td>7.60E-05</td>
<td>2.53E-02</td>
<td>5.35E-01</td>
</tr>
<tr>
<td>The remainder of the material burns confined.</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.83</td>
<td>5.E-04</td>
<td>1.39E-02</td>
<td>1.69E-02</td>
<td>1.45E+01</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.83</td>
<td>6.E-05</td>
<td>2.12E-03</td>
<td>1.69E-02</td>
<td>5.70E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.9304</td>
<td>0.83</td>
<td>7.E-05</td>
<td>8.45E-04</td>
<td>1.69E-02</td>
<td>5.70E+00</td>
</tr>
</tbody>
</table>

### Source Terms from nearby MAR in closed container(s), awaiting SSSR Processing or Removal of closed containers

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF (PE-Ci)</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>18</td>
<td>1.0</td>
<td>1.0</td>
<td>1.E-04</td>
<td>1.80E-03</td>
<td>1.80E-03</td>
<td>8.33E-02</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>18</td>
<td>0.0</td>
<td>1.0</td>
<td>1.E-04</td>
<td>0.00E+00</td>
<td>5.70E+00</td>
<td>8.33E-02</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>18</td>
<td>0.0</td>
<td>1.0</td>
<td>7.E-05</td>
<td>0.00E+00</td>
<td>5.70E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>18</td>
<td>1.0</td>
<td>1.0</td>
<td>1.E-02</td>
<td>1.80E-01</td>
<td>1.80E-01</td>
<td>5.70E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>18</td>
<td>0.0</td>
<td>1.0</td>
<td>6.E-05</td>
<td>0.00E+00</td>
<td>5.70E+00</td>
<td>5.70E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>18</td>
<td>0.0</td>
<td>1.0</td>
<td>1.E-06</td>
<td>0.00E+00</td>
<td>5.70E+00</td>
<td>0.00E+00</td>
</tr>
</tbody>
</table>

### Source Terms from in-process SSSR material -- Unconfined Burning of contents of open container

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF (PE-Ci)</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSSR Process Area -- Unconfined burning of MAR</td>
<td>C</td>
<td>18</td>
<td>1.0</td>
<td>1.0</td>
<td>1.E-02</td>
<td>1.80E-01</td>
<td>1.80E-01</td>
<td>1.45E+01</td>
</tr>
</tbody>
</table>
### SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated Worker DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>1.56E-02</td>
<td>4.63E+01</td>
<td>7.23E-01</td>
<td>4.50E+02</td>
<td>7.03E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>4.36E-01</td>
<td>3.17E+01</td>
<td>1.38E+01</td>
<td>3.10E+02</td>
<td>1.35E+02</td>
</tr>
<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td><strong>1.45E+01</strong></td>
<td></td>
<td></td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
<td><strong>1.42E+02</strong></td>
</tr>
</tbody>
</table>

- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (nearest SSSR Area to site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412, with NO plume heating.

### DBA 1A - MITIGATED SOURCE TERM AND CONSEQUENCE ANALYSIS

#### Metal Container MAR Limit on Transport Vehicle and Use of Vehicle Barriers at High Risk Locations

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source Terms from reduced MAR (1,100 PE-Ci) on Transport Truck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-04</td>
<td>3.37E-04</td>
<td>7.93E-03</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.E-04</td>
<td>4.28E-04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.0304</td>
<td>0.1</td>
<td>7.E-05</td>
<td>7.16E-03</td>
<td></td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-02</td>
<td>3.37E-02</td>
<td>3.41E-02</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.1</td>
<td>6.E-05</td>
<td>2.57E-04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.0304</td>
<td>0.1</td>
<td>1.E-06</td>
<td>1.02E-04</td>
<td></td>
</tr>
<tr>
<td>90% of containers that do not expel contents upon initial impact and experience lid ejection, expulsion of waste, Flexing in air</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.07</td>
<td>1.E-04</td>
<td>2.50E-04</td>
<td>5.89E-03</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.07</td>
<td>1.E-04</td>
<td>3.18E-04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.0304</td>
<td>0.07</td>
<td>7.E-05</td>
<td>5.32E-03</td>
<td></td>
</tr>
<tr>
<td>90% of containers that do not expel contents upon initial impact and experience lid ejection, expulsion of waste, and unconfined burning of waste</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.07</td>
<td>1.E-02</td>
<td>2.50E-02</td>
<td>2.53E-02</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.07</td>
<td>6.E-05</td>
<td>1.91E-04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.0304</td>
<td>0.07</td>
<td>1.E-06</td>
<td>7.60E-05</td>
<td></td>
</tr>
<tr>
<td>Confined burning of remaining waste material</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.826</td>
<td>5.E-04</td>
<td>1.39E-02</td>
<td>1.69E-02</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.826</td>
<td>6.E-05</td>
<td>2.12E-03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.0304</td>
<td>0.826</td>
<td>1.E-06</td>
<td>8.45E-04</td>
<td></td>
</tr>
</tbody>
</table>
### DBA 1A - SUMMARY PUBLIC AND COLLOCATED WORKER DOSES

**Metal Container MAR Limit on Transport Vehicle and Use of Vehicle Barriers at High Risk Locations**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Total Public Dose (rem)</th>
<th>Total Collocated Worker Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>1.3E-02</td>
<td>4.63E+01</td>
<td>6.39E-01</td>
<td>4.50E+02</td>
<td>6.22E+00</td>
<td>3.05E+00</td>
<td>2.99E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>7.62E-02</td>
<td>3.17E+01</td>
<td>2.41E+00</td>
<td>3.10E+02</td>
<td>2.36E+01</td>
<td>2.99E+01</td>
<td></td>
</tr>
</tbody>
</table>

### DBA 1A - MITIGATED SOURCE TERM AND CONSEQUENCE ANALYSIS

**Maximum Metal Container MAR on Transport Vehicle without Rolling Roadblock**

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>800</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-04</td>
<td>2.45E-04</td>
<td>5.77E-03</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>800</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.E-04</td>
<td>3.11E-04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>800</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.E-05</td>
<td>5.21E-03</td>
<td></td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>800</td>
<td>0.0306</td>
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### DBA 1A - SUMMARY PUBLIC AND COLLOCATED WORKER DOSES

**Maximum Metal Container MAR on Transport Vehicle without Rolling Roadblock**

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<th>Collocated DSF (rem/PE-Ci)</th>
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### DBA No. 1B  AGTRU-1-044

#### UNMITIGATED

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#### DBA 1B - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOES

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<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
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<td>DSF</td>
<td>Dose (rem)</td>
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<td>Fire</td>
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<tr>
<td>Total Public</td>
<td>2.05E+01</td>
<td>Total Collocated</td>
<td>2.01E+02</td>
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- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (closer than the nearest Storage Area to site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412, with NO plume heating.
### DBA 1B - Mitigated Analysis - Limit flammable liquid spill to 100 gallons, highest MAR drum doublepacked

<table>
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<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
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**Total Public Dose (rem) 3.55E+00**

**Total Collocated Worker Dose (rem) 3.48E+01**
### DBA 1B - Mitigated Analysis - Limit unattended flammable liquid spill to 7 gallons, highest MAR drum doublepacked

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Source Terms from MAR in Storage Array</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
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<tbody>
<tr>
<td>25% of 1st tier, 1st row, on edge of fuel pool fire; 25% of 1st tier containers inside pool; experience lid ejection -- 1/3 experience flexing in air</td>
<td>C</td>
<td>406.88</td>
<td>0.0306</td>
<td>0.08</td>
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<td>0.08</td>
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<td>0.9304</td>
<td>0.08</td>
<td>7.E-05</td>
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<td>9.96E-01</td>
</tr>
<tr>
<td>25% of 1st tier, 1st row, on edge of fuel pool fire; 25% of 1st tier containers inside pool; experience lid ejection -- 1/3 experience unconfined burning</td>
<td>C</td>
<td>406.88</td>
<td>0.0306</td>
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<td>NC, ND</td>
<td>406.88</td>
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<tr>
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<td>0.0306</td>
<td>0.17</td>
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<td>1.E-06</td>
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<td>75% of 1st tier, 1st row on edge of fuel pool fire; 75% of 1st tier containers inside pool; experience confined burning</td>
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<td>100% of bottom 2 tiers, 1st row on edge of fuel pool fire; 100% of 1st tier, 2nd row from edge of fuel pool fire; 100% of bottom 2-tiers inside pool area: experience confined burning</td>
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### DBA 1B - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

**Limit unattended flammable liquid spill to 7 gallons**

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<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
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<tr>
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<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
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<td>Fire</td>
<td>3.15E-02</td>
<td>3.17E+01</td>
<td>9.96E-01</td>
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| Total Public Dose (rem) | 1.11E+00 |
| Total Collocated Worker Dose (rem) | 1.08E+01 |
### DBA No. 1C AGTRU-1-048

**Source Terms from MAR (Compliant [metal] containers) Impacted by Fuel Truck then burned in fuel fire**

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<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
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<tbody>
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<tr>
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<td>NC, D</td>
<td>863.8</td>
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<td>1.0E-04</td>
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<td>1.61E-03</td>
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<td>90% of containers that do not expel contents upon initial impact and experience lid ejection, expulsion of waste, Flexing in air</td>
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<td>863.8</td>
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<td>0.07</td>
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<td>2.50E-04</td>
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<td>90% of containers that do not expel contents upon initial impact and experience lid ejection, expulsion of waste, and uncontained burning of waste</td>
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<td>NC, D</td>
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<td>0.83</td>
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**Source Terms from remaining MAR in Storage Array in compliant (metal) containers**

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>25% of 1st tier-- 1/3 experience flexing in air</td>
<td>C</td>
<td>21,136.20</td>
<td>0.0306</td>
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<td>1.0E-04</td>
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<td>NC, D</td>
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<tr>
<td>25% of 1st tier, -- 1/3 experience unconfined burning</td>
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**Total** | **2.21E+01**
### DBA 1C - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

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<tr>
<th>Component</th>
<th>ST</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated Worker DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
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<td>Total Co-located Worker Dose (rem) 2.17E+02</td>
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- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (closer than the nearest Storage Area to site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412, with NO plume heating.

**DBA 1C  Vehicle Barriers and Escort prevent the accident - Consequences mitigated to 0.0 rem**
DBA No. 1D  BGTRUPIT-1-016

**DBA No. 1D  BGTRUPIT-1-016**

<table>
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<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Source Term from FRPs</th>
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- **DBA No. 1D - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES**

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<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
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<tr>
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<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
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<tr>
<td>Fire</td>
<td>4.50E-01</td>
<td>3.17E+01</td>
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Total Public Dose (rem) = 1.45E+01
Total Collocated Worker Dose (rem) = 1.42E+02

- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (closer than Pit 9 to the site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412, with NO plume heating.
### DBA 1D - Mitigated Analysis - MAR reduction to 1,500 PE-Ci Limit at Pit 9

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<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST  (PE-Ci)</th>
<th>MACCS – 38 cm SR</th>
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<td>Public Dose (rem)</td>
<td>Dose from fire (rem)</td>
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<tr>
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<td>0.08</td>
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<td>1.19E-05</td>
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<td>9.25E+00</td>
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<tr>
<td>25% of top-most tier, lid ejection -- 2/3 experience confined burning</td>
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<td>0.220</td>
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### DBA 1D - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOES

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<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
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### DBA No. 2A AGTRU-1-031

#### UNMITIGATED

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<th>Dose from fire (rem)</th>
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**Total** | | | | | | | | | 2.46E+01 | | |

#### DBA 2A - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
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<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>6.33E-02</td>
<td>46.3</td>
<td>2.93E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>6.83E-01</td>
<td>31.7</td>
<td>2.16E+01</td>
</tr>
</tbody>
</table>

- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (nearest SSSR Area to site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412, with NO plume heating.
### DBA 2A - Mitigated Analysis - With Vehicle Barriers & Separation, MAR on Transport Vehicle Only - Defined Area MAR not involved

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Public Dose (rem)</th>
<th>Dose from fire (rem)</th>
<th>Dose from spill (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact – Spilled Material</td>
<td>C</td>
<td>615</td>
<td>0.047</td>
<td>1.0</td>
<td>1.E-04</td>
<td>2.88E-03</td>
<td>6.15E-02</td>
<td>2.85E+00</td>
<td>1.02E+01</td>
<td>2.85E+00</td>
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<tr>
<td></td>
<td>NC, D</td>
<td>615</td>
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<td>1.0</td>
<td>1.E-04</td>
<td>5.86E-02</td>
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<td>NC, ND</td>
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<td>1.0</td>
<td>7.E-05</td>
<td>0.00E+00</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>615</td>
<td>0.047</td>
<td>1.0</td>
<td>1.E-02</td>
<td>2.88E-01</td>
<td>3.23E-01</td>
<td>1.02E+01</td>
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<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>1.31E+01</td>
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### DBA 2A - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>6.15E-02</td>
<td>46.3</td>
<td>2.85E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>3.23E-01</td>
<td>31.7</td>
<td>1.02E+01</td>
</tr>
<tr>
<td>Total Public Dose (rem)</td>
<td>1.31E+01</td>
<td>Total Collocated Worker Dose (rem)</td>
<td>1.28E+02</td>
</tr>
</tbody>
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### DBA 2A - Mitigated Analysis - Maximum Non-Metal Container MAR (450 PE-Ci) on Transport Vehicle without Escort

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Public Dose (rem)</th>
<th>Dose from fire (rem)</th>
<th>Dose from spill (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>450</td>
<td>0.047</td>
<td>1.0</td>
<td>1.E-04</td>
<td>2.10E-03</td>
<td>4.50E-02</td>
<td>2.08E+00</td>
<td>7.48E+00</td>
<td>2.08E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>450</td>
<td>0.953</td>
<td>1.0</td>
<td>1.E-04</td>
<td>4.29E-02</td>
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<td></td>
<td></td>
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<td>NC, ND</td>
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<td>1.0</td>
<td>7.E-05</td>
<td>0.00E+00</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>450</td>
<td>0.047</td>
<td>1.0</td>
<td>1.E-02</td>
<td>2.10E-01</td>
<td>2.36E-01</td>
<td>7.48E+00</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>450</td>
<td>0.953</td>
<td>1.0</td>
<td>6.E-05</td>
<td>2.57E-02</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
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<td>0</td>
<td>1.0</td>
<td>1.E-06</td>
<td>0.00E+00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.56E+00</td>
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### DBA 2A - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
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</thead>
<tbody>
<tr>
<td>Spill</td>
<td>4.50E-02</td>
<td>46.3</td>
<td>2.08E+00</td>
<td>4.50E+02</td>
<td>2.02E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>2.36E-01</td>
<td>31.7</td>
<td>7.48E+00</td>
<td>3.10E+02</td>
<td>7.32E+01</td>
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<tr>
<td>Total Public Dose (rem)</td>
<td>9.56E+00</td>
<td>Total Collocated Worker Dose (rem)</td>
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<td></td>
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### DBA No. 2B  BGTRUCSK-1-003

#### DBA No. 2B  BGTRUCSK-1-003  UNMITIGATED

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>MACCS 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieved Drums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confined burn</td>
<td>C</td>
<td>7,500</td>
<td>1</td>
<td>1.0</td>
<td>5.0E-04</td>
<td>3.75E+00</td>
<td>3.60E+01</td>
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#### DBA 2B - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
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</thead>
<tbody>
<tr>
<td>Fire</td>
<td>3.75E+00</td>
<td>9.61E+00</td>
<td>3.60E+01</td>
<td>3.10E+02</td>
<td>1.16E+03</td>
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<tr>
<td>Total Public Dose (rem)</td>
<td>3.60E+01</td>
<td>Total Collocated Worker Dose (rem)</td>
<td>1.16E+03</td>
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<td></td>
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</table>

- 9.6 rem/PE-Ci = DSF value for fires, using the X/Q value for releases from Trenches A-D
### DBA 2B - Mitigated Analysis with MAR limited to 1,500 PE-Ci exposed at Trenches

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>MACCS 38 cm SR</th>
<th>Public Dose (rem)</th>
<th>Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieved Drums</td>
<td>Confined burn</td>
<td>C</td>
<td>1500</td>
<td>1</td>
<td>1.0</td>
<td>5.0E-04</td>
<td>7.50E-01</td>
<td>7.21E+00</td>
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</tr>
</tbody>
</table>

### DBA 2B - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

Mitigated Analysis with MAR limited to 1,500 PE-Ci exposed at Trenches

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td></td>
<td>7.21E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
<tr>
<td>(rem)</td>
<td></td>
<td></td>
<td>(rem)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
</tr>
<tr>
<td>Total Public Dose</td>
<td></td>
<td>7.21E+00</td>
<td>Total Collocated Worker Dose</td>
</tr>
<tr>
<td>(rem)</td>
<td></td>
<td></td>
<td>(rem)</td>
</tr>
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</table>
### DBA 2b - Mitigation with overpack each container upon retrieval from the trench cask

<table>
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<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>MACCS 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieved Drums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unmitigated</td>
</tr>
<tr>
<td>Confined burn</td>
<td>C</td>
<td>1,500</td>
<td>1</td>
<td>0.1</td>
<td>5.0E-04</td>
<td>7.50E-02</td>
<td>7.21E-01</td>
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</tbody>
</table>

### DBA 2B - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

Mitigated Analysis with overpack upon retrieval of >200 PE-Ci

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-02</td>
<td>9.61E+00</td>
<td>7.21E-01</td>
</tr>
</tbody>
</table>

- **Total Public Dose (rem)**: 7.21E-01
- **Total Collocated Worker Dose (rem)**: 2.33E+01
### DBA No. 3 AGTRU-1-041

#### Basis for Interim Operation, Rev. 3.0

#### November 2014

#### DBA No. 3 AGTRU-1-041 UNMITIGATED

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Public Dose</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(rem) Unmitigated</td>
</tr>
</tbody>
</table>

- **Source Terms from AGTRU MAR in non-metal containers affected by follow on fire**
- **Source Terms from (Retrieved) BGTRU MAR**
- **Source Terms from MAR in storage array of compliant (metal) containers**

#### DBA 3 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF</td>
<td>Dose (rem)</td>
<td>DSF</td>
</tr>
<tr>
<td>Fire</td>
<td>4.56E-01</td>
<td>3.17E+01</td>
<td>1.44E+01</td>
</tr>
</tbody>
</table>

- **Total Public Dose (rem)**: 1.44E+01
- **Total Collocated Worker Dose (rem)**: 1.41E+02

- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412 (closer than the nearest Storage Area to site boundary), with NO plume heating.

---

Chapter 3: Hazard and Accident Analysis
Appendix 3C

3C-18
### DBA 3 - Mitigated Analysis - Non-metal Storage Area MAR Limit of 2,000 PE-Ci applies

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined burning of waste in non-metal containers</td>
<td>C</td>
<td>2000</td>
<td>0.047</td>
<td>1</td>
<td>5.E-04</td>
<td>4.68E-02</td>
<td>1.61E-01</td>
<td>5.10E+00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>2000</td>
<td>0.953</td>
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<td>1.14E-01</td>
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<tr>
<td></td>
<td>NC, ND</td>
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<td>0</td>
<td>1</td>
<td>1.E-06</td>
<td>0.00E+00</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.61E-01</td>
<td>5.10E+00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>1.61E-01</td>
<td>3.17E+01</td>
<td>5.10E+00</td>
</tr>
<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td>5.10E+00</td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
<td>5.00E+01</td>
</tr>
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### DBA 3 - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

**Non-metal Storage Area MAR Limit of 2,000 PE-Ci applies**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>1.61E-01</td>
<td>3.17E+01</td>
<td>5.10E+00</td>
</tr>
<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td>5.10E+00</td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
<td>5.00E+01</td>
</tr>
</tbody>
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### DBA 3 - Mitigated Analysis - Metal container (only) Storage Area MAR Limit of 22,000 PE-Ci applies

<table>
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<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined burning of waste in non-metal containers</td>
<td>C</td>
<td>22000</td>
<td>0.306</td>
<td>0.5</td>
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</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>22000</td>
<td>0.389</td>
<td>0.5</td>
<td>6.E-05</td>
<td>2.57E-02</td>
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</tr>
<tr>
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<td>NC, ND</td>
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<td><strong>Total</strong></td>
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<td></td>
<td></td>
<td>2.04E-01</td>
<td>1.64E+00</td>
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</tbody>
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<table>
<thead>
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<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Fire</td>
<td>2.04E-01</td>
<td>3.17E+01</td>
<td>6.47E+00</td>
</tr>
<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td>6.47E+00</td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
<td>6.34E+01</td>
</tr>
</tbody>
</table>
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.
### DBA 4A - Mitigated Analysis - Doublepack of high MAR drum eliminates ejection and unconfined burning

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.E-02</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.10</td>
<td>5.E-04</td>
<td>2.77E-02</td>
<td>2.77E-02</td>
</tr>
</tbody>
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**MACCS -- 38 cm SR**

<table>
<thead>
<tr>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>1.01E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Total</td>
<td>1.01E+00</td>
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</tr>
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### DBA 4A - SUMMARY OF MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

**Doublepack of high MAR drum**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>0.00E+00</td>
<td>5.33E+01</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>2.77E-02</td>
<td>3.65E+01</td>
<td>1.01E+00</td>
</tr>
</tbody>
</table>

| Total Public Dose (rem) | 1.01E+00 |
| Total Collocated Worker Dose (rem) | 8.57E+00 |
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.
### DBA 4C - Mitigated Analysis - Doublepack of highest single MAR container prevents ejection and unconfined burning and reduces DR

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF *RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Mitigated Dose</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Public Dose</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Dose from fire</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dose from spill</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Collocated Worker Dose</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Dose from fire</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Dose from spill</td>
</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.E-02</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00</td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.10</td>
<td>5.E-04</td>
<td>2.77E-02</td>
<td>2.77E-02</td>
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Total 1.01

### DBA 4C - Mitigated Analysis - Doublepack of 1100 PE-Ci MAR container prevents ejection and unconfined burning and reduces DR

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF *RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Mitigated Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Dose from fire</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dose from spill</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Collocated Worker Dose</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dose from fire</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Dose from spill</td>
</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>1100</td>
<td>1</td>
<td>0.00</td>
<td>1.E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>1100</td>
<td>1</td>
<td>0.00</td>
<td>1.E-02</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00</td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>1100</td>
<td>1</td>
<td>0.10</td>
<td>5.E-04</td>
<td>5.50E-02</td>
<td>5.50E-02</td>
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Total 2.01

Total 17.05
### DBA No. 4D AGTRU-2-030

#### Accident Component

<table>
<thead>
<tr>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.40</td>
<td>1.E-04</td>
<td>2.21E-02</td>
<td>2.21E-02</td>
</tr>
<tr>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.40</td>
<td>1.E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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</tr>
<tr>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.40</td>
<td>7.E-05</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td></td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.02</td>
<td>1.E-02</td>
<td>1.11E-01</td>
<td>1.11E-01</td>
</tr>
<tr>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.02</td>
<td>6.E-05</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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</tr>
<tr>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.02</td>
<td>1.E-06</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td></td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.60</td>
<td>5.E-04</td>
<td>1.66E-01</td>
<td>1.66E-01</td>
</tr>
<tr>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.60</td>
<td>6.E-05</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<tr>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.60</td>
<td>1.E-06</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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</tr>
<tr>
<td>Spilled Material, remainder of truckload</td>
<td>C</td>
<td>547</td>
<td>0.0306</td>
<td>0.10</td>
<td>1.E-04</td>
<td>1.68E-04</td>
<td>3.94E-03</td>
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<td>NC, D</td>
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<td>0.10</td>
<td>1.E-04</td>
<td>2.13E-04</td>
<td>2.10E-01</td>
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<tr>
<td>NC, ND</td>
<td>547</td>
<td>0.9304</td>
<td>0.10</td>
<td>7.E-05</td>
<td>3.56E-03</td>
<td></td>
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</tr>
</tbody>
</table>

### Total

<table>
<thead>
<tr>
<th>Public Dose (rem)</th>
<th>Dose from fire (rem)</th>
<th>Dose from spill (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.18E+00</td>
<td>1.39E+00</td>
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</tbody>
</table>

#### DBA 4D - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated Worker DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>2.61E-02</td>
<td>5.33E+01</td>
<td>1.39E+00</td>
<td>4.50E+02</td>
<td>1.17E+01</td>
</tr>
<tr>
<td>Fire</td>
<td>2.77E-01</td>
<td>3.65E+01</td>
<td>1.01E+01</td>
<td>3.10E+02</td>
<td>8.57E+01</td>
</tr>
</tbody>
</table>

- 53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)
- 36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.
### DBA 4D - Mitigated Analysis - Doublepack containers > 200 PE-Ci, and transport vehicle MAR limit of 1100 PE-Ci

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Source Terms from MAR on Truck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.00</td>
<td>1.0E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.00</td>
<td>1.0E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.00</td>
<td>7.0E-05</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.00</td>
<td>1.0E-02</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<tr>
<td></td>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.00</td>
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<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<tr>
<td></td>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.00</td>
<td>1.0E-06</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>553</td>
<td>1.000</td>
<td>0.10</td>
<td>5.0E-04</td>
<td>2.77E-02</td>
<td>2.77E-02</td>
<td>1.01E+00</td>
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<tr>
<td></td>
<td>NC, D</td>
<td>553</td>
<td>0.000</td>
<td>0.10</td>
<td>6.0E-05</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>1.01E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>553</td>
<td>0.000</td>
<td>0.10</td>
<td>1.0E-06</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>1.01E+00</td>
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<tr>
<td>Spilled Material, remainder of truckload</td>
<td>C</td>
<td>547</td>
<td>0.031</td>
<td>0.10</td>
<td>1.0E-04</td>
<td>1.71E-04</td>
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<td>NC, D</td>
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<td>NC, ND</td>
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<td>7.0E-05</td>
<td>3.44E-03</td>
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**Total** 1.22E+00

### DBA 4D - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

Doublepack containers > 200 PE-Ci, and transport vehicle MAR limit of 1100 PE-Ci

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>4.00E-03</td>
<td>5.33E+01</td>
<td>2.13E-01</td>
<td>4.50E+02</td>
<td>1.80E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>2.77E-02</td>
<td>3.65E+01</td>
<td>1.01E+00</td>
<td>3.10E+02</td>
<td>8.57E+00</td>
</tr>
</tbody>
</table>

**Total Public Dose (rem)** 1.22E+00

**Total Collocated Worker Dose (rem)** 1.04E+01
### DBA No. 4E  BGTRUCSK-2-011

**Source Terms from MAR**

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF^RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>750</td>
<td>1</td>
<td>0.40</td>
<td>1.E-04</td>
<td>3.00E-02</td>
<td>3.00E-02</td>
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<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>750</td>
<td>1</td>
<td>0.02</td>
<td>1.E-02</td>
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<td>C</td>
<td>750</td>
<td>1</td>
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<td>2.25E-01</td>
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**DBA 4E - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
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</thead>
<tbody>
<tr>
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<td>1.40E+01</td>
<td>4.21E-01</td>
<td>4.50E+02</td>
<td>1.35E+01</td>
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</tr>
<tr>
<td>Fire</td>
<td>3.75E-01</td>
<td>9.61E+00</td>
<td>3.60E+00</td>
<td>3.10E+02</td>
<td>1.16E+02</td>
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</tbody>
</table>

- 14.05 rem/PE-Ci = DSF value for spills, using the X/Q value for releases from Trenches A-D
- 9.6 rem/PE-Ci = DSF value for fires, using the X/Q value for releases from Trenches A-D

Total Public Dose (rem) 4.03E+00

Total Collocated Worker Dose (rem) 1.30E+02
### DBA 4E - Mitigated Analysis - Deflagration of highest MAR container excluded from doublepack requirement

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>199</td>
<td>1</td>
<td>0.40</td>
<td>1.E-04</td>
<td>7.96E-03</td>
<td>7.96E-03</td>
<td>1.12E-01</td>
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<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>199</td>
<td>1</td>
<td>0.02</td>
<td>1.E-02</td>
<td>3.98E-02</td>
<td>3.98E-02</td>
<td>3.82E-01</td>
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<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>199</td>
<td>1</td>
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<td>5.E-04</td>
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<td>5.97E-02</td>
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<td><strong>Total</strong></td>
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<td></td>
<td><strong>1.07E+00</strong></td>
<td><strong>1.12E-01</strong></td>
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### DBA 4E - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

Highest MAR container not required to have doublepack

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>7.96E-03</td>
<td>1.40E+01</td>
<td>1.12E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>9.95E-02</td>
<td>9.61E+00</td>
<td>9.56E-01</td>
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<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td><strong>1.07E+00</strong></td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
<td><strong>3.44E+01</strong></td>
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</table>
### DBA No. 4F BGTRUCSK-2-014 UNMITIGATED

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<th>MAR (PE-Ci)</th>
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<th>ARF=RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
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</thead>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Public Dose (rem)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Unmitigated</td>
</tr>
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<td></td>
<td>Dose from fire (rem)</td>
</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>1,500</td>
<td>1.0</td>
<td>0.40</td>
<td>1.E-04</td>
<td>6.00E-02</td>
<td>6.00E-02</td>
<td>8.43E-01</td>
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<tr>
<td>Uncontained burning of expelled waste</td>
<td>C</td>
<td>1,500</td>
<td>1.0</td>
<td>0.02</td>
<td>1.E-02</td>
<td>3.00E-01</td>
<td>3.00E-01</td>
<td>2.88E+00</td>
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<tr>
<td>Contained burning of remaining material</td>
<td>C</td>
<td>1,500</td>
<td>1.0</td>
<td>0.60</td>
<td>5.E-04</td>
<td>4.50E-01</td>
<td>4.50E-01</td>
<td>4.32E+00</td>
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<td>Total</td>
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### DBA 4F - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>6.00E-02</td>
<td>1.40E+01</td>
<td>8.43E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
</tr>
<tr>
<td>Total Public Dose (rem)</td>
<td>8.05E+00</td>
<td></td>
<td>Total Collocated Worker Dose (rem)</td>
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</tbody>
</table>

- 14.05 rem/PE-Ci = DSF value for spills, using the X/Q value for releases from Trenches A-D
- 9.6 rem/PE-Ci = DSF value for fires, using the X/Q value for releases from Trenches A-D
### DBA 4F - Mitigated Analysis - Maximum drum MAR not subject to doublepack (x 2 drums)

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>398</td>
<td>1.0</td>
<td>0.40</td>
<td>1.E-04</td>
<td>1.59E-02</td>
<td>1.59E-02</td>
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<tr>
<td></td>
<td>Flexing of ejected material</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>C</td>
<td>398</td>
<td>1.0</td>
<td>0.02</td>
<td>1.E-02</td>
<td>7.96E-02</td>
<td>7.96E-02</td>
<td>7.65E-01</td>
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<tr>
<td></td>
<td>Uncontained burning of expelled waste</td>
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</tr>
<tr>
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<td>1.15E+00</td>
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</table>

**Total:** 2.14E+00

### DBA 4F - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Public Dose (rem)</th>
<th>Collocated Worker Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>1.59E-02</td>
<td>1.40E+01</td>
<td>2.24E-01</td>
<td>7.16E+00</td>
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<tr>
<td>Fire</td>
<td>1.99E-01</td>
<td>9.61E+00</td>
<td>1.91E+00</td>
<td>6.17E+01</td>
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</table>

**Total Public Dose (rem):** 2.14E+00

**Total Collocated Worker Dose (rem):** 6.89E+01
### DBA No. 5A AGTRU-2-007

#### Basis for Interim Operation, Rev. 3.0
Los Alamos National Laboratory
November 2014

## Chapter 3: Hazard and Accident Analysis

### Appendix 3C

#### DBA No. 5A AGTRU-2-007

**UNMITIGATED**

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF x RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td>Public Dose</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unmitigated</td>
<td>(rem) Unmitigated</td>
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<tr>
<td>Flexing of ejected material</td>
<td>C 609</td>
<td>0.0306</td>
<td>0.40</td>
<td>1.E-04</td>
<td>7.47E-04</td>
<td>1.76E-02</td>
<td>9.37E-01</td>
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</tr>
<tr>
<td></td>
<td>NC, D 609</td>
<td>0.0389</td>
<td>0.40</td>
<td>1.E-04</td>
<td>9.48E-04</td>
<td>3.77E-03</td>
<td>3.86E-01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND 609</td>
<td>0.9304</td>
<td>0.40</td>
<td>7.E-05</td>
<td>1.59E-02</td>
<td>1.13E-05</td>
<td>9.37E-01</td>
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<tr>
<td>Unconfined burning of expelled waste</td>
<td>C 609</td>
<td>0.0306</td>
<td>0.02</td>
<td>1.E-02</td>
<td>3.73E-03</td>
<td>3.77E-03</td>
<td>3.86E-01</td>
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<tr>
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<td>NC, D 609</td>
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<td>0.02</td>
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<tr>
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<td>NC, ND 609</td>
<td>0.9304</td>
<td>0.02</td>
<td>1.E-06</td>
<td>1.13E-05</td>
<td>1.38E-01</td>
<td>9.37E-01</td>
<td></td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C 609</td>
<td>0.0306</td>
<td>0.60</td>
<td>5.E-04</td>
<td>5.60E-03</td>
<td>6.79E-03</td>
<td>2.48E-01</td>
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<tr>
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<td>NC, D 609</td>
<td>0.0389</td>
<td>0.60</td>
<td>6.E-05</td>
<td>8.53E-04</td>
<td>6.79E-03</td>
<td>2.48E-01</td>
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<tr>
<td></td>
<td>NC, ND 609</td>
<td>0.9304</td>
<td>0.60</td>
<td>1.E-06</td>
<td>3.40E-04</td>
<td>6.79E-03</td>
<td>2.48E-01</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.32E+00</strong></td>
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### DBA 5A - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>1.76E-02</td>
<td>5.33E+01</td>
<td>9.37E-01</td>
</tr>
<tr>
<td>Fire</td>
<td>1.06E-02</td>
<td>3.65E+01</td>
<td>3.86E-01</td>
</tr>
<tr>
<td><strong>Total Public Dose (rem)</strong></td>
<td>1.32E+00</td>
<td></td>
<td><strong>Total Collocated Worker Dose (rem)</strong></td>
</tr>
</tbody>
</table>

- 53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)
- 36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.
### DBA 5A - Mitigated Analysis - No stacking eliminates sympathetic deflagration and doublepack of high MAR drum eliminates ejection and unconfined burning

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Public Dose (rem)</td>
<td>Dose from fire (rem)</td>
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<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.0E-04</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.00</td>
<td>1.0E-02</td>
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<td>0.00E+00</td>
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<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>553</td>
<td>1</td>
<td>0.10</td>
<td>5.0E-04</td>
<td>2.77E-02</td>
<td>2.77E-02</td>
<td>1.01E+00</td>
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<td></td>
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<td>1.01E+00</td>
<td>0.00E+00</td>
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### DBA 5A - SUMMARY OF MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

No stacking, plus doublepack of high MAR drum

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>0.00E+00</td>
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<tr>
<td>Fire</td>
<td>2.77E-02</td>
<td>3.65E+01</td>
<td>1.01E+00</td>
</tr>
</tbody>
</table>

Total Public Dose (rem) 1.01E+00  Total Collocated Worker Dose (rem) 8.57E+00
### DBA No. 5B  BGTRUCSK-2-007

#### UNMITIGATED

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Terms from MAR from 2 Statistical Drums</td>
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</tr>
<tr>
<td>Flexing of ejected material</td>
<td>C</td>
<td>1,500</td>
<td>1.0</td>
<td>0.40</td>
<td>1.E-04</td>
<td>6.00E-02</td>
<td>6.00E-02</td>
<td>8.43E-01</td>
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<tr>
<td>Unconfined burning of expelled waste</td>
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<td>1,500</td>
<td>1.0</td>
<td>0.02</td>
<td>1.E-02</td>
<td>3.00E-01</td>
<td>3.00E-01</td>
<td>2.88E+00</td>
</tr>
<tr>
<td>Confined burning of remaining material</td>
<td>C</td>
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<td>1.0</td>
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#### DBA 5B - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

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<th>Collocated Worker</th>
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<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
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<td>Spill</td>
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<tr>
<td>Fire</td>
<td>7.50E-01</td>
<td>9.61E+00</td>
<td>7.21E+00</td>
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</table>

<table>
<thead>
<tr>
<th>Total Public Dose (rem)</th>
<th>Total Collocated Worker Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.05E+00</td>
<td>2.60E+02</td>
</tr>
</tbody>
</table>

- 14.05 rem/PE-Ci = DSF value for spills, using the X/Q value for releases from Trenches A-D
- 9.6 rem/PE-Ci = DSF value for fires, using the X/Q value for releases from Trenches A-D
### DBA 5B - Mitigated Analysis - Overpack of retrieved containers

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexing of ejected material</td>
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<td>1500</td>
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<td>1.E-04</td>
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<td>0.00E+00</td>
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<tr>
<td>Unconfined burning of expelled waste</td>
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<td>0.00</td>
<td>1.E-02</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td></td>
<td>7.21E-01</td>
<td></td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Confined burning of remaining contents</td>
<td>C</td>
<td>1500</td>
<td>1</td>
<td>0.10</td>
<td>5.E-04</td>
<td>7.50E-02</td>
<td>7.50E-02</td>
<td></td>
<td></td>
<td>7.21E-01</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.21E-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source Terms from MAR**

- Flexing of ejected material: Dose from fire (rem) Unmitigated = 0.00E+00
- Unconfined burning of expelled waste: Dose from fire (rem) Unmitigated = 7.21E-01
- Confined burning of remaining contents: Dose from fire (rem) Unmitigated = 7.21E-01

### DBA 5B - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

**Overpack of Retrieved Containers**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>0.00E+00</td>
<td>1.40E+01</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Fire</td>
<td>7.50E-02</td>
<td>9.61E+00</td>
<td>7.21E-01</td>
</tr>
</tbody>
</table>

| Total Public Dose (rem) | 7.21E-01 | Total Collocated Worker Dose (rem) | 2.33E+01 |
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.

**DBA 6 No credited mitigation of dose consequences**
DBA No. 7A AGTRU-3-012

### Source Terms from MAR on Truck

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C 863.8</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.0E-04</td>
<td>2.65E-04</td>
<td><strong>6.23E-03</strong></td>
<td>2.88E-01</td>
</tr>
<tr>
<td></td>
<td>NC, D 863.8</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.0E-04</td>
<td>3.36E-04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND 863.8</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.0E-05</td>
<td>5.63E-03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Source Terms from MAR in non-metal Storage Array

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C 855</td>
<td>0.047</td>
<td>1.0</td>
<td>1.0E-04</td>
<td>4.00E-03</td>
<td><strong>8.55E-02</strong></td>
<td>3.95E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D 855</td>
<td>0.953</td>
<td>1.0</td>
<td>1.0E-04</td>
<td>8.15E-02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND 855</td>
<td>0</td>
<td>1.0</td>
<td>7.0E-05</td>
<td>0.00E+00</td>
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</tbody>
</table>

Total 4.24E+00

### Public and Collocated Worker Dose

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>9.17E-02</td>
<td>4.63E+01</td>
<td>4.24E+00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.50E+02</td>
<td>4.13E+01</td>
</tr>
</tbody>
</table>

- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (closer than the nearest Storage Area to site boundary)
### DBA 7A - Mitigated Analysis - With vehicle barriers, no storage array impact

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS 38 cm SR</th>
<th>Public Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Source Terms from MAR on Truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>863.8</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.E-04</td>
<td>2.65.E-04</td>
<td>6.23E-03</td>
<td>2.88E-01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>863.8</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.E-04</td>
<td>3.36.E-04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>863.8</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.E-05</td>
<td>5.63.E-03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.88E-01</td>
</tr>
</tbody>
</table>

### DBA 7A - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

**Mitigated with vehicle barriers - no storage array impact**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill</td>
<td>6.23E-03</td>
<td>4.63E+01</td>
<td>2.88E-01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.50E+02</td>
<td>2.80E+00</td>
</tr>
</tbody>
</table>
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)
### DBA 7B - Mitigated Analysis - Maximum MAR without critical lift

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS 38 cm SR</th>
<th>Public Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>925</td>
<td>0.0306</td>
<td>1.00</td>
<td>1.E-04</td>
<td>2.83E-03</td>
<td>6.67E-02</td>
<td>3.56E+00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>925</td>
<td>0.0389</td>
<td>1.00</td>
<td>1.E-04</td>
<td>3.60E-03</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>925</td>
<td>0.9304</td>
<td>1.00</td>
<td>7.E-05</td>
<td>6.02E-02</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.56E+00</td>
</tr>
</tbody>
</table>

### DBA 7B - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSES

Mitigated with MAR limit without critical lift

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
</tr>
<tr>
<td>Spill</td>
<td>6.67E-02</td>
<td>5.33E+01</td>
<td>3.56E+00</td>
</tr>
</tbody>
</table>
### DBA No. 8 AGTRU-3-017

#### UNMITIGATED

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS - 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source Terms from drop of suspended payload onto top of another payload, with high energy impact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C 1100</td>
<td>0.0306</td>
<td>0.2</td>
<td>2.00E-03</td>
<td>1.35E-02</td>
<td>1.65E-01</td>
<td>8.82E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>NC, D 1100</td>
<td>0.0389</td>
<td>0.2</td>
<td>1.00E-03</td>
<td>8.56E-03</td>
<td>8.82E+00</td>
<td>7.42E+00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC, ND 1100</td>
<td>0.9304</td>
<td>0.2</td>
<td>7.00E-04</td>
<td>1.43E-01</td>
<td>7.42E+00</td>
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</tr>
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</table>

#### DBA 8 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact/Spill</td>
<td>1.65E-01</td>
<td>5.33E+01</td>
<td>8.82E+00</td>
<td>4.50E+02</td>
<td>7.44E+01</td>
</tr>
</tbody>
</table>

- 53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

### DBA 8 - Mitigated Analysis - Maximum MAR for >12 ft lift

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS - 38 cm SR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source Terms from drop of suspended payload onto top of another payload</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C 925</td>
<td>0.0306</td>
<td>0.2</td>
<td>2.00E-03</td>
<td>1.13E-02</td>
<td>1.39E-01</td>
<td>7.42E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>NC, D 925</td>
<td>0.0389</td>
<td>0.2</td>
<td>1.00E-03</td>
<td>7.20E-03</td>
<td>7.42E+00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC, ND 925</td>
<td>0.9304</td>
<td>0.2</td>
<td>7.00E-04</td>
<td>1.20E-01</td>
<td>7.42E+00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.42E+00
### DBA 8 - Summary Mitigated Public and Collocated Worker Doses

#### Mitigated with MAR limit for > 12 ft lift

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated Worker DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact/ Spill</td>
<td>1.39E-01</td>
<td>5.33E+01</td>
<td>7.42E+00</td>
<td>4.50E+02</td>
<td>6.26E+01</td>
</tr>
</tbody>
</table>

#### DBA 8 - Mitigated Analysis - Lifts > 12 ft are prohibited for payloads with MAR > 925 PE-Ci and < 1,100 PE-Ci (low energy impact, if dropped)

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS - 38 cm SR</th>
<th>Unmitigated Public Dose Unmitigated Dose from Fire Unmitigated Dose from Spill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Terms from drop of suspended payload onto top of another payload - low energy impact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Impact -- Spilled Material</td>
<td>C</td>
<td>1100</td>
<td>0.0306</td>
<td>0.1</td>
<td>1.00E-04</td>
<td>3.37E-04</td>
<td>7.93E-03</td>
<td>4.23E-01</td>
<td>0.00E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>1100</td>
<td>0.0389</td>
<td>0.1</td>
<td>1.00E-04</td>
<td>4.28E-04</td>
<td>7.93E-03</td>
<td>4.23E-01</td>
<td>0.00E+00</td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>1100</td>
<td>0.9304</td>
<td>0.1</td>
<td>7.00E-05</td>
<td>7.16E-03</td>
<td>4.23E-01</td>
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</tr>
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</table>

### DBA 8 - Summary Mitigated Public and Collocated Worker Doses

#### Mitigated with lift < 12 ft (low energy drop height)

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
<th>Collocated Worker DSF (rem/PE-Ci)</th>
<th>Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact/ Spill</td>
<td>7.93E-03</td>
<td>5.33E+01</td>
<td>4.23E-01</td>
<td>4.50E+02</td>
<td>3.57E+00</td>
</tr>
</tbody>
</table>
DBA No. 9 AGTRU-6-001

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS - 38 cm SR</th>
<th>Dose from Spill (rem) Unmitigated</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Dose to Public (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Chapter 3: Hazard and Accident Analysis</strong> Appendix 3C</td>
<td></td>
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</tr>
</tbody>
</table>
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.

**DBA 9 – No credited mitigation of dose consequences for extremely unlikely Aircraft Crash**
### Source Terms from AGTRU MAR in metal containers in storage

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined Burning in compliant (metal) TRU containers due to seal failure</td>
<td>C</td>
<td>49,464</td>
<td>0.0306</td>
<td>0.5</td>
<td>5.E-04</td>
<td>3.79E-01</td>
<td>4.60E-01</td>
<td>1.46E+01</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>49,464</td>
<td>0.0389</td>
<td>0.5</td>
<td>6.E-05</td>
<td>5.78E-02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>49,464</td>
<td>0.9304</td>
<td>0.5</td>
<td>1.E-06</td>
<td>2.30E-02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Source Terms from SSSR processing

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSSR uncontained burning of open container contents</td>
<td>C</td>
<td>18.0</td>
<td>1.000</td>
<td>1.0</td>
<td>1.E-02</td>
<td>1.80E-01</td>
<td>1.80E-01</td>
<td>5.70E+00</td>
</tr>
<tr>
<td></td>
<td>NC, D</td>
<td>18.0</td>
<td>0.0389</td>
<td>0.5</td>
<td>6.E-05</td>
<td>4.67E-03</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>NC, ND</td>
<td>18.0</td>
<td>0.9304</td>
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### Source Terms from SSSR (staged in Area)

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<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
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<tr>
<td>SSSR Area staged, not open, contained burning</td>
<td>C</td>
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### Source Terms from AGTRU MAR in containers undergoing processing

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<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
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### Source Terms from AGTRU MAR in above ground non-metal containers

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<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
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<tbody>
<tr>
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### Source Terms from BGTRU MAR in retrieved non-metal containers

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<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
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<tbody>
<tr>
<td>Non-metal BGTRU TRU containers confined burning</td>
<td>C</td>
<td>1500</td>
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### Source Terms from LLW and Tritium affected by Fire

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<th>MAR (PE-Ci)</th>
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<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCCS ~ 38 cm SR Public Dose (rem) Unmitigated</th>
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<tbody>
<tr>
<td>Confined burning of LLW due to fire</td>
<td>C</td>
<td>100</td>
<td>0.070</td>
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<td>5.E-04</td>
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<tr>
<td>Tritium LLW Release due to fire in LLW Pa*</td>
<td>Tritium</td>
<td>3000</td>
<td>1.000</td>
<td>1.0</td>
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<td>3.00E+03</td>
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<tr>
<td>Stored Tritium Release due to fire</td>
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<td>1.000</td>
<td>1.0</td>
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<td>4.00E+06</td>
<td>5.80E+01</td>
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**Total** | 8.93E+01 |
### DBA 10 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
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<th>Collocated Worker</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
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<tr>
<td>Fire/TRU - metal - storage</td>
<td>4.60E-01</td>
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<td>3.10E+02</td>
<td>1.43E+02</td>
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<tr>
<td>Fire/TRU - metal - processing</td>
<td>3.72E-02</td>
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<td>1.36E+00</td>
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<tr>
<td>SSSR Area (staging + in-process)</td>
<td>1.89E-01</td>
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<td>5.86E+01</td>
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<tr>
<td>Fire/TRU Non-Metal</td>
<td>2.55E-01</td>
<td>3.65E+01</td>
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<tr>
<td>Tritium*</td>
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*Reported in rem/Ci

- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412 (closest SSSR Area, and closer than the nearest Storage Area to site boundary), with NO plume heating.
- 36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33 (closest Defined Area to site boundary), with NO plume heating.
- 1.45E-05 rem/Ci = DSF for tritium release in fires, using the X/Q value for Tritium Sheds, with NO plume heating and 0.0 cm/sec deposition velocity.
## DBA 10 - Mitigated Analysis - Application of Transient Combustible Control SAC limits propagation

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS — 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
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<tr>
<td><strong>Source Terms from AGTRU MAR in complying (metal) containers in storage</strong></td>
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<td>0.00E+00</td>
<td>0.00E+00</td>
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</tr>
<tr>
<td></td>
<td>NC, D</td>
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<td>6.E-05</td>
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<td>0.00E+00</td>
<td>0.00E+00</td>
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<tr>
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<td>NC, ND</td>
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<td>SSSR Area staged, not open, contained burning</td>
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<td>1.000</td>
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<td><strong>Source Terms from AGTRU MAR in containers undergoing processing</strong></td>
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<td>0.031</td>
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<td>0.00E+00</td>
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<td>0.039</td>
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<td>6.E-05</td>
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<td>0.00E+00</td>
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<td>0.070</td>
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## DBA 10 - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

Mitigated with TCC SAC in all Storage, Process, Retrieval Areas

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public Dose</th>
<th>Collocated Worker Dose</th>
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<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
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<td>5.70E+00</td>
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<td>0.00E+00</td>
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<td>3.65E+01</td>
<td>1.27E-01</td>
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<tr>
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<td>4.35E-02</td>
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<tr>
<td><strong>Total Collocated Worker Dose</strong></td>
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### DBA No. 10A  AGTRU-7-002

<table>
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<tr>
<th>Description of Accident Component</th>
<th>Waste Matrix Composition</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflagration Max MAR Drum on Top Pallet, Eject 40% of the waste and Burn 5% of the 40% uncontained, Flexing in air term</td>
<td>C</td>
<td>533</td>
<td>0.0306</td>
<td>0.4</td>
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<tr>
<td>Deflagration Max MAR Drum on Top Pallet, Eject 40% of the waste and Burn 5% of the 40% uncontained, Uncontained burning term</td>
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Total 1.72E+00
53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)

36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33, with NO plume heating.

**DBA 10A** No credited mitigation of dose consequences
### DBA No. 11  AGTRU-7-005

**Basis for Interim Operation, Rev. 3.0**
November 2014

#### DBA No. 11  AGTRU-7-005  UNMITIGATED

<table>
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<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS -- 38 cm SR</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
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<td>Impact of compliant (metal) containers by flying debris</td>
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*Reported in rem/Ci

#### DBA 11 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE

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<th>Collocated Worker</th>
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<td>DSF (rem/PE-Ci)</td>
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- 1.75 rem/PE-Ci = DSF value for spills, using the high wind X/Q value for TA-54-33 (closest Defined Area to site boundary)
- 7.08 rem/PE-Ci = DSF value for fires, using the high wind X/Q value for TA-54-33, with NO plume heating.
### Chapter 3: Hazard and Accident Analysis

#### Appendix 3C

### DBA No. 12 AGTRU-7-007: UNMITIGATED

**Source Terms from Metal Containers MAR affected by spill in earthquake**  
(Total site TRU MAR limit, minus non-metal containers and amount in SSSR Areas)

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<th>MAR (PE-Ci)</th>
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<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
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<td>Unconfined burning of spilled waste</td>
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<td>0.047</td>
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<td>3.16E-02</td>
<td>1.45E-01</td>
<td>4.59E+00</td>
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<tr>
<td>Confined Burning of waste in non-metal containers</td>
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<td>0.047</td>
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<td>1.00E-02</td>
<td>3.16E-02</td>
<td>1.45E-01</td>
<td>4.59E+00</td>
</tr>
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</table>

*ST for tritium is reported in Ci. Dose includes an additional 50% of the inhalation intake to account for skin absorption.*
**DBA 12 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSE**

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF</td>
<td>Dose (rem)</td>
<td>DSF</td>
</tr>
<tr>
<td></td>
<td>(rem/PE-Ci)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact/ AGTRU Compliant Metal Containers (Storage &amp; Process)</td>
<td>1.27E-02</td>
<td>4.63E+01</td>
<td>5.88E-01</td>
</tr>
<tr>
<td>Impact/ retrieved TRU Non-Metal Containers</td>
<td>1.50E-02</td>
<td>4.63E+01</td>
<td>6.94E-01</td>
</tr>
<tr>
<td>Impact/ stored TRU Non-Metal Containers</td>
<td>2.00E-02</td>
<td>4.63E+01</td>
<td>9.25E-01</td>
</tr>
<tr>
<td>Impact/ LLW</td>
<td>6.96E-04</td>
<td>5.33E+01</td>
<td>3.71E-02</td>
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<tr>
<td>Fires/ SSSR Area</td>
<td>1.89E-01</td>
<td>3.17E+01</td>
<td>5.98E+00</td>
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<tr>
<td>Fires/ DVS Process Area, 54-33</td>
<td>1.13E-02</td>
<td>3.65E+01</td>
<td>4.13E-01</td>
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<tr>
<td>Fires/TRU Metal Containers in Storage and Process Areas</td>
<td>2.67E-01</td>
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<td>Fires/retrieved TRU Non-Metal Containers</td>
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<td>5.94E+00</td>
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<tr>
<td>Fire/ stored TRU Non-Metal Containers</td>
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<tr>
<td>Fire/ LLW</td>
<td>3.48E-03</td>
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<td>1.27E-01</td>
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<tr>
<td>Tritium* (fire release from LAA &amp; storage shed)</td>
<td>1.003E+06</td>
<td>1.45E-05</td>
<td>1.45E+01</td>
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</tbody>
</table>

* Tritium DSF Includes additional 50 % of the inhalation intake to be absorbed through the skin per DOE-HDBK-1105-2002.

- 46.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-412 (closer than the nearest Storage Area to site boundary)
- 53.3 rem/PE-Ci = DSF value for spills, using the X/Q value for TA-54-33 (closest Defined Area to site boundary)
- 31.7 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-412 (closest SSSR Area, and closer than the nearest Storage Area to site boundary), with NO plume heating.
- 36.5 rem/PE-Ci = DSF value for fires, using the X/Q value for TA-54-33 (closest Defined Area to site boundary), with NO plume heating.
- 1.45E-05 rem/Ci = DSF for tritium release in fires, using the X/Q value for Tritium Sheds, with NO plume heating and 0.0 cm/sec deposition velocity.
## Chapter 3: Hazard and Accident Analysis

### Appendix 3C

#### DRA 12 - Mitigated Analysis - Transient Combustible Control SAC prevents propagation of a combustible fire (LLW and unconfined SSSR MAR still burn; spill not mitigated)

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF *RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>MACCS - 38 cm SR</th>
<th>Unmitigated Public Dose (rem)</th>
<th>Unmitigated Dose from Fire (rem)</th>
<th>Unmitigated Dose from Spill (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Terms from Metal Containers MAR affected by spill in earthquake</td>
<td>Low Impact - Spilled Material from 3rd tier storage</td>
<td>C</td>
<td>53,464</td>
<td>0.0306</td>
<td>0.0033</td>
<td>1.00E-04</td>
<td>5.41E-04</td>
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<td>1.27E-02</td>
<td>5.88E-01</td>
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<tr>
<td></td>
<td></td>
<td>NC, D</td>
<td>53,464</td>
<td>0.0389</td>
<td>0.0033</td>
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<td>6.87E-04</td>
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<td>1.13E-02</td>
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<td>NC, ND</td>
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<td>0.0033</td>
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<td>1.15E-02</td>
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<tr>
<td>Source Terms from unconfined combustible waste in SSSR Areas affected by post-seismic fire (no credit for stationary fire watch mitigation)</td>
<td>Material in SSSR Process Area involved in unconfined burning</td>
<td>C</td>
<td>18</td>
<td>0.0306</td>
<td>0.0033</td>
<td>1.00E-02</td>
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<td>NC, D</td>
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<td>0.0389</td>
<td>0.0033</td>
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<td>0.00E+00</td>
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<td>0.00E+00</td>
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<td>0.00E+00</td>
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<tr>
<td>Source Terms from Spilled Materials from storage area where there are metal containers that catches on fire from the post seismic fire.</td>
<td>Spilled MAR involved in unconfined burning</td>
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<td>0.0306</td>
<td>0.0033</td>
<td>1.00E-02</td>
<td></td>
<td></td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<td>NC, D</td>
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<td>0.0389</td>
<td>0.0033</td>
<td>6.00E-05</td>
<td>0.00E+00</td>
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<td>0.00E+00</td>
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<td>NC, ND</td>
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<td>0.9304</td>
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<tr>
<td>Source Terms from Spilled Materials from Process Areas where there are containers that catches on fire from the post seismic fire.</td>
<td>Spilled MAR involved in unconfined burning</td>
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<td>0.0033</td>
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<td>0.00E+00</td>
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<td>0.0389</td>
<td>0.0033</td>
<td>6.00E-05</td>
<td>0.00E+00</td>
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<td>0.00E+00</td>
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<td>NC, ND</td>
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<td>1.00E-06</td>
<td>0.00E+00</td>
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<td>0.00E+00</td>
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<tr>
<td>Source Terms from AGTRU MAR in Storage Areas with non-metal containers affected by earthquake</td>
<td>Spilled MAR involved in unconfined burning</td>
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<td>0</td>
<td>0.0306</td>
<td>0.0033</td>
<td>1.00E-02</td>
<td></td>
<td></td>
<td>0.00E+00</td>
<td>0.00E+00</td>
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<td>NC, D</td>
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<td>0.0389</td>
<td>0.0033</td>
<td>6.00E-05</td>
<td>0.00E+00</td>
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<tr>
<td>Source Terms from AGTRU MAR in Storage Areas with non-metal containers affected by follow on fire.</td>
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<td>1.00E-04</td>
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<td>Source Terms from (Retrieved) BGTRU MAR in non-metal containers affected by follow on fire.</td>
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<td>0.047</td>
<td>0.1</td>
<td>1.00E-02</td>
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<td>0.953</td>
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<td>0.000</td>
<td>0.1</td>
<td>1.00E-06</td>
<td>0.00E+00</td>
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<td>Source Terms from LLW and Tritium affected by Earthquake &amp; fire</td>
<td>LLW impacted by ground movement</td>
<td>C</td>
<td>3000</td>
<td>0.11</td>
<td>1</td>
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<td>NC, D</td>
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<td>0.99</td>
<td>1</td>
<td>1.00E-04</td>
<td>3.98E-03</td>
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<td>4.35E-02</td>
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<td>NC, ND</td>
<td>3000</td>
<td>0.00</td>
<td>0.99</td>
<td>1.00E-06</td>
<td>0.00E+00</td>
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<td>0.00E+00</td>
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</tbody>
</table>

* Includes an additional 50% of the inhalation intake to be absorbed through the skin per DOE-HDBK-1105-2002.

Total dose 8.21E+00
### DBA 12 - SUMMARY MITIGATED PUBLIC AND COLLOCATED WORKER DOSE

Mitigated with TCC SAC to limit MAR exposed to post-seismic combustible fire

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Public Dose (rem)</th>
<th>DSF (rem/PE-Ci)</th>
<th>Collocated Worker Dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact/ AGTRU Compliant Metal Containers (Storage &amp; Process)</td>
<td>1.27E-02</td>
<td>4.63E+01</td>
<td>5.88E-01</td>
<td>4.50E+02</td>
<td>5.72E+00</td>
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<tr>
<td>Impact/ stored TRU Non-Metal Containers</td>
<td>2.00E-02</td>
<td>4.63E+01</td>
<td>9.25E-01</td>
<td>4.50E+02</td>
<td>9.00E+00</td>
</tr>
<tr>
<td>Impact/ retrieved TRU Non-Metal Containers</td>
<td>1.50E-02</td>
<td>4.63E+01</td>
<td>6.94E-01</td>
<td>4.50E+02</td>
<td>6.75E+00</td>
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<tr>
<td>Impact/ LLW</td>
<td>1.10E-03</td>
<td>5.33E+01</td>
<td>5.87E-02</td>
<td>4.50E+02</td>
<td>4.95E-01</td>
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<tr>
<td>Fires/unconfined SSSR, in-process</td>
<td>1.80E-01</td>
<td>3.17E+01</td>
<td>5.70E+00</td>
<td>3.10E+02</td>
<td>5.58E+01</td>
</tr>
<tr>
<td>Fire/TRU Metal Containers in Process Areas</td>
<td>0.00E+00</td>
<td>3.65E+01</td>
<td>0.00E+00</td>
<td>3.10E+02</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Fires/TRU Metal Containers in Storage Areas</td>
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<td>3.65E+01</td>
<td>0.00E+00</td>
<td>3.10E+02</td>
<td>0.00E+00</td>
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<tr>
<td>Fires/TRU Non-Metal Containers</td>
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<td>3.65E+01</td>
<td>0.00E+00</td>
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<tr>
<td>Fire/ exposed LLW</td>
<td>5.50E-03</td>
<td>3.65E+01</td>
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<td>3.10E+02</td>
<td>1.71E+00</td>
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<tr>
<td>Tritium*, in LLW</td>
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<td>1.85E-04</td>
<td>5.55E-01</td>
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</table>

* Total Public Dose (rem) = 8.21E+00
* Total Collocated Worker Dose (rem) = 8.00E+01

* Includes an additional 50% of the inhalation intake to be absorbed through the skin per DOE-HDBK-1105-2002.
### DBA No. 13 - AGTRU-2-034a

**UNMITIGATED**

<table>
<thead>
<tr>
<th>Accident Component</th>
<th>Waste Matrix</th>
<th>MAR (PE-Ci)</th>
<th>Waste Matrix Fraction</th>
<th>DR</th>
<th>ARF*RF</th>
<th>ST (PE-Ci)</th>
<th>Total ST (PE-Ci)</th>
<th>Public Dose (rem) Unmitigated</th>
<th>Dose from fire (rem) Unmitigated</th>
<th>Dose from spill (rem) Unmitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexing of material ejected from nearest 10% of waste drums which are subjected to catastrophic impact from explosive overpressure or direct missile impact from shrapnel</td>
<td>C-D</td>
<td>2200</td>
<td>0.0306</td>
<td>1.00</td>
<td>1.00E-03</td>
<td>6.74E-02</td>
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<td>3.23E+01</td>
<td>8.49E+01</td>
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<tr>
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<td>NC, D</td>
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<td>0.0389</td>
<td>1.00</td>
<td>1.00E-03</td>
<td>8.56E-02</td>
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</tr>
<tr>
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<td>NC, ND</td>
<td>2200</td>
<td>0.9304</td>
<td>1.00</td>
<td>7.00E-04</td>
<td>1.43E+00</td>
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<td></td>
<td></td>
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<tr>
<td>Flexing of material ejected from top tier of remaining 90% of drums, due to low energy impact from toppling drums</td>
<td>C-D</td>
<td>6600</td>
<td>0.0306</td>
<td>0.01</td>
<td>1.00E-03</td>
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<tr>
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<td>NC, ND</td>
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<td>0.01</td>
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<tr>
<td>Unconfined burning of expelled waste</td>
<td>C</td>
<td>2266</td>
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<td>0.0389</td>
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<td>Confined burning of unexpelled waste</td>
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<td>19734</td>
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<td>6.70E+00</td>
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<td>NC, D</td>
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<td>2.30E-02</td>
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<td>NC, ND</td>
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<td>0.9304</td>
<td>0.500</td>
<td>1.00E-06</td>
<td>9.18E-03</td>
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<td><strong>Total</strong></td>
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<td></td>
<td></td>
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<td></td>
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<td>1.17E+02</td>
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### DBA 13 - SUMMARY UNMITIGATED PUBLIC AND COLLOCATED WORKER DOSES

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th>Collocated Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
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<tr>
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<td>1.59E+00</td>
<td>5.33E+00</td>
<td>8.49E+01</td>
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<tr>
<td>Fire</td>
<td>8.85E+01</td>
<td>3.65E+01</td>
<td>3.23E+01</td>
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<tr>
<td><strong>Total</strong></td>
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<td>1.17E+02</td>
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</tr>
</tbody>
</table>

MACCS -- 38 cm SR
### DBA 13 - SUMMARY Mitigated PUBLIC AND COLLOCATED WORKER DOSES

No Acetylene used or stored with MAR

<table>
<thead>
<tr>
<th>Component</th>
<th>ST (PE-Ci)</th>
<th>Public</th>
<th></th>
<th>Collocated Worker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
<td>DSF (rem/PE-Ci)</td>
<td>Dose (rem)</td>
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<td>Spill</td>
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<td>0.00E+00</td>
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<td>0.00E+00</td>
</tr>
</tbody>
</table>

Total Public Dose (rem) 0.00E+00
Total Collocated Worker Dose (rem) 0.00E+00
APPENDIX 3D

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APPENDIX 3E

AIRPLANE CRASH FREQUENCY ANALYSIS FOR TRU STORAGE DOMES AT TA-54 AREA G
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Airplane Crash Frequency Analysis for TRU Storage Domes at TA-54 Area G

1. Introduction

Aircraft crash frequencies for Area G facilities are determined using the "four-factor" formula from DOE-STD-3014-96. This formula considers (1) the number of aircraft operations; (2) the probability that an aircraft will crash; (3) the probability that, given a crash, the aircraft crashes into a one square mile area where the facility of interest is located; and (4) the size of the facility. The formula from DOE-STD-3014 is:

\[ F = \sum N_{ijk} \cdot P_{ijk} \cdot f_{ijk}(x,y) \cdot A_{ij} \]

where:

- \( F \) = estimated annual aircraft crash impact frequency for the facility of interest (number/year)
- \( N_{ijk} \) = estimated annual number of site-specific airport operations (takeoffs, landings, in-flights) for each applicable summation parameter
- \( P_{ijk} \) = aircraft crash rate for each applicable summation parameter
- \( f_{ijk}(x,y) \) = aircraft crash location conditional probability (per square mile) given a crash evaluated at the facility location for each applicable summation parameter
- \( A_{ij} \) = site-specific effective area for the facility of interest that includes the skid and fly-in effective area (square miles) for each applicable summation parameter
- \( i \) = index for flight phases, (takeoff, in-flight, and landing)
- \( j \) = index for aircraft category or subcategory
- \( k \) = index for flight source (specific runways)

The results of this analysis and a discussion of how the "four factor" formula was applied to the TA-54 Area G facilities are documented in calculation SBD-CALC-NucFac-13-001, Aircraft Crash Impact Frequency Reevaluations for LANL Nuclear Facilities, dated April 2013. The data for numbers of aircraft operations at the Los Alamos Airport were obtained from the Airport Master Record for the Los Alamos County Airport, increased to be conservative and to bound future foreseeable increases in aircraft operations and documented in that calculation.

This BIO appendix provides a summary of the aircraft crash impact frequency determined by SBD-CALC-NucFac-13-001 for TA-54 Area G.

2. Airplane Crash Impact Frequency

Because there are 12 TRU storage domes and they are scattered within Area G, it is necessary to divide these domes into zones for impact analyses. Table 3E-1 displays which domes are included in which zones and their coordinates respective to the nearby airport.
Tables 3E-2 to 3E-6 present the total annual aircraft crash frequency for both airport and non-airport operations, along with the overall total aircraft crash probability for zones A to E, respectively. Table 3E-7 presents the combined total annual aircraft crash impact frequency for all TRU waste storage domes at Area G.

The crash frequencies presented in Tables 3E-2 to 3E-6 tend to be dominated by general aviation type aircraft. The other types of aircraft can be screened out from further analysis based on the guidance in DOE-STD-3014 because their crash frequencies are less than 1E-6 per yr.

The crash frequency for each zone is between 3.3E-06 and 5.5E-06 per yr, giving an overall frequency for Area G for an aircraft impact into any dome of about 2.1E-05 per yr.

Table 3E-1. TRU Storage Dome Zone Data

<table>
<thead>
<tr>
<th>ZONE</th>
<th>L(ft)*</th>
<th>W (ft)*</th>
<th>H (ft)**</th>
<th>GA (Landing, x)</th>
<th>GA (Landing, y)</th>
<th>GA (Takeoff, x)</th>
<th>GA (Takeoff, y)</th>
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<tbody>
<tr>
<td>Zone A</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>54-232</td>
<td>243</td>
<td>88.5</td>
<td>35.83</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>54-231</td>
<td>243</td>
<td>88.5</td>
<td>35.83</td>
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<tr>
<td>54-230</td>
<td>243</td>
<td>88.5</td>
<td>35.83</td>
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<tr>
<td>54-229</td>
<td>243</td>
<td>88.5</td>
<td>35.83</td>
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<td></td>
</tr>
<tr>
<td>Zone Value</td>
<td>243</td>
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<td>35.83</td>
<td>-1.98</td>
<td>3.44</td>
<td>1.98</td>
<td>-3.44</td>
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</tr>
<tr>
<td>54-48</td>
<td>278</td>
<td>60</td>
<td>26.2</td>
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<tr>
<td>54-226</td>
<td>278</td>
<td>88.5</td>
<td>35.83</td>
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<td>Zone Value</td>
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<td>-1.98</td>
<td>3.35</td>
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<td>Zone C</td>
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<td>54-375</td>
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<td>-1.85</td>
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<td>54-49</td>
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<td>Zone E</td>
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<tr>
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<td>3.27</td>
<td>1.58</td>
<td>-3.27</td>
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* Measured from FMU64-A13001 and from manufacturers' data sheets  
** Maximum heights  
*** Zone E landing and takeoff coordinates are taken to be between 54-283 and 54-153.
### Table 3E-2. Annual Aircraft Impact Frequency for Zone A

<table>
<thead>
<tr>
<th>Aircraft Category</th>
<th>Airport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Nonairport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Destination Overflights Aircraft Crash Impact Frequency /yr</th>
<th>Aircraft Crash Impact Frequency /yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Air Carrier</td>
<td>0.00E+00</td>
<td>7.73E-09</td>
<td>0.00E+00</td>
<td>7.73E-09</td>
</tr>
<tr>
<td>Commercial Air Taxi</td>
<td>5.33E-08</td>
<td>1.07E-07</td>
<td>0.00E+00</td>
<td>1.60E-07</td>
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<tr>
<td>General Aviation</td>
<td>3.04E-06</td>
<td>1.98E-06</td>
<td>1.77E-07</td>
<td>5.20E-06</td>
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<tr>
<td>Large Military</td>
<td>0.00E+00</td>
<td>3.07E-09</td>
<td>N/A</td>
<td>3.07E-09</td>
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<tr>
<td>Small Military</td>
<td>1.46E-08</td>
<td>7.62E-08</td>
<td>N/A</td>
<td>9.09E-08</td>
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<tr>
<td>TOTAL</td>
<td>3.11E-06</td>
<td>2.17E-06</td>
<td>1.77E-07</td>
<td>5.46E-06</td>
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### Table 3E-3. Annual Aircraft Impact Frequency for Zone B

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<th>Airport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Nonairport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Destination Overflights Aircraft Crash Impact Frequency /yr</th>
<th>Aircraft Crash Impact Frequency /yr</th>
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<td>3.19E-06</td>
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<td>TOTAL</td>
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<td>1.08E-07</td>
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### Table 3E-4. Annual Aircraft Impact Frequency for Zone C

<table>
<thead>
<tr>
<th>Aircraft Category</th>
<th>Airport Operations Aircraft Crash Impact Frequency /yr</th>
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<th>Destination Overflights Aircraft Crash Impact Frequency /yr</th>
<th>Aircraft Crash Impact Frequency /yr</th>
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<td>2.25E-06</td>
<td>1.59E-06</td>
<td>1.28E-07</td>
<td>3.97E-06</td>
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Table 3E-5. Annual Aircraft Impact Frequency for Zone D

<table>
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<th>Aircraft Category</th>
<th>Airport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Nonairport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Destination Overflights Aircraft Crash Impact Frequency /yr</th>
<th>Aircraft Crash Impact Frequency /yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Air Carrier</td>
<td>0.00E+00</td>
<td>6.81E-09</td>
<td>0.00E+00</td>
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</tr>
<tr>
<td>Commercial Air Taxi</td>
<td>4.73E-08</td>
<td>9.45E-08</td>
<td>0.00E+00</td>
<td>1.42E-07</td>
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<tr>
<td>General Aviation</td>
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<td>1.06E-07</td>
<td>3.12E-06</td>
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<td>Large Military</td>
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<td>N/A</td>
<td>2.49E-09</td>
</tr>
<tr>
<td>Small Military</td>
<td>1.09E-08</td>
<td>5.26E-08</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>1.34E-06</strong></td>
<td><strong>1.06E-07</strong></td>
<td><strong>3.33E-06</strong></td>
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Table 3E-6. Annual Aircraft Impact Frequency for Zone E

<table>
<thead>
<tr>
<th>Aircraft Category</th>
<th>Airport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Nonairport Operations Aircraft Crash Impact Frequency /yr</th>
<th>Destination Overflights Aircraft Crash Impact Frequency /yr</th>
<th>Aircraft Crash Impact Frequency /yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Air Carrier</td>
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<td>9.49E-09</td>
<td>0.00E+00</td>
<td>9.49E-09</td>
</tr>
<tr>
<td>Commercial Air Taxi</td>
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<td>1.35E-07</td>
<td>0.00E+00</td>
<td>2.02E-07</td>
</tr>
<tr>
<td>General Aviation</td>
<td>2.64E-06</td>
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<td>1.55E-07</td>
<td>4.51E-06</td>
</tr>
<tr>
<td>Large Military</td>
<td>0.00E+00</td>
<td>3.29E-09</td>
<td>N/A</td>
<td>3.29E-09</td>
</tr>
<tr>
<td>Small Military</td>
<td>1.52E-08</td>
<td>7.32E-08</td>
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<td>8.84E-08</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2.72E-06</strong></td>
<td><strong>1.94E-06</strong></td>
<td><strong>1.55E-07</strong></td>
<td><strong>4.82E-06</strong></td>
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</table>

Table 3E-7. Total Annual Aircraft Impact Frequency for TRU Waste Storage Domes at Area G

<table>
<thead>
<tr>
<th>Zone</th>
<th>Aircraft Crash Impact Frequency /yr</th>
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<tr>
<td>A</td>
<td>5.46E-06</td>
</tr>
<tr>
<td>B</td>
<td>3.37E-06</td>
</tr>
<tr>
<td>C</td>
<td>3.97E-06</td>
</tr>
<tr>
<td>D</td>
<td>3.33E-06</td>
</tr>
<tr>
<td>E</td>
<td>4.82E-06</td>
</tr>
<tr>
<td><strong>Area G TOTAL</strong></td>
<td><strong>2.10E-05</strong></td>
</tr>
</tbody>
</table>

3.0 Reference

APPENDIX 3F

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APPENDIX 3G

DOE-STD-5506 PREFERRED AND ALTERNATE CONTROLS ASSESSMENT
### Appendix 3G, DOE-STD-5506 Preferred and Alternate Controls Assessment

<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
<th>Preferred Controls</th>
<th>Alternative Controls</th>
<th>Applicable Events</th>
<th>Preferred/Alternative Control Selection</th>
<th>Compliance Assessment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Pool Fire</td>
<td>Limit fire size (P)</td>
<td>Automatic Fire Suppression System (FSS) OR Vehicle Fuel limit</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>DBA No. 1A DBA No. 1B DBA No. 1C DBA No. 1D</td>
<td>SAC - Metal container storage areas are permitted up to 7 gal of unattended flammable/combustible liquids and up to 93 gal of attended liquid/flammable combustibles for a total of 100 gal. All liquid combustibles with a 100-gal limit in non-metal container storage areas shall be attended.</td>
<td>Preferred Control</td>
<td>For Event 17, external vehicles are not physically plausible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>See Event 9 controls for compliance.</td>
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<td>Fire Detection System (FDS) and FSS exist in some areas, but their performance has never been qualified to meet minimum and sustainable standards due to the outdoor nature of Area G. In addition, neither the FDS nor FSS provide sufficient coverage to address all stored waste within Area G.</td>
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<tr>
<td>External Vehicle Accident with Fire (Combustible or Pool) (Event 17)</td>
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<tr>
<td>If vehicle impact is the initiator of this event, controls from Vehicle/Equipment Impacts Waste/Waste Containers must be added</td>
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<tr>
<td>Separate the MAR from fuel (P)</td>
<td>Grading and sloping; berms; vehicle barriers</td>
<td>Control vehicle route; standoff distance; establish refueling location</td>
<td></td>
<td></td>
<td>FACILITY CONFIGURED WITH RCRA REQUIRED GRADES, SLOPES AND BERMRS. SC VEHICLE BARRIERS AT HIGH RISK LOCATIONS PREVENT ACCIDENTAL ENTRY. SMP REQUIRES VEHICLE BARRIERS TO BE PLACED ALONG ROADWAYS PASSING NEAR DEFINED AREAS. SAC REQUIRES VEHICLES WITH &gt; 100 GALLONS LIQUID COMBUSTIBLES (EXCLUDING LPG) ON BOARD TO BE ESCORTED. THERMAL BARRIER SAC ESTABLISHES SEPARATION REQUIREMENT BETWEEN MAR AND EDGE OF SPILL/POOL DEFINED BY GRADES/SLOPES AND/OR BERMRS. SAC VEHICLE/EQUIPMENT SAFETY CONTROL – REFueling Prohibition Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
<td>Preferred Control Preferred Control Alternate Control Alternate Control Alternate Control</td>
<td>Preferred Control</td>
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<tr>
<td>Accident</td>
<td>Minimum Control Functions</td>
<td>Preferred Controls</td>
<td>Alternative Controls</td>
<td>Applicable Events</td>
<td>Preferred/Alternative Control Selection</td>
<td>Compliance Assessment</td>
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<tr>
<td>Minimize releases (M)</td>
<td>Non-combustible containers AND</td>
<td>Spacing, fire breaks</td>
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<td></td>
<td>Preferred Control</td>
<td>Compliant (metal) containers are used in Area G except for legacy waste containers. Non-metal TRU waste containers (FRPs) are separated from compliant (metal) TRU waste containers and other fuel sources by a thermal separation distance except as permitted.</td>
</tr>
</tbody>
</table>

| Confinement Ventilation System (CVS) | MAR limit and/or vehicle fuel limit | | | | | Preferred Control | |

<p>| Small Fire Characterization | Limit fire size (P) | Closed non-combustible container | Stand off; Fire Barriers | DBA No. 2A | | Preferred Control | The majority of TRU waste containers are closed and constructed of steel. However, legacy FRPs are stored in Area G and will be retrieved from Pit 9. These containers are stored in non-compliant (non-metal) storage areas which limit the MAR that would be involved in an event. Storage area is protected by a thermal barrier. |</p>
<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
<th>Preferred Controls</th>
<th>Alternative Controls</th>
<th>Applicable Events</th>
<th>Preferred/Alternative Control Selection</th>
<th>Compliance Assessment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize releases (M)</td>
<td>CVS</td>
<td>MAR limit and/or flammables and combustible limit</td>
<td>DBA No. 2A DBA No. 2B</td>
<td>• SAC on defined area MAR limits. • SMP limits transient combustibles in defined areas, thereby limiting propagation of fires. • SAC Transient combustible controls within defined areas. Transient fuel packages &gt; 100 lbs are separated from TRU waste or other fuel packages by a minimum of 10 feet in order to reduce fire progression</td>
<td>Alternate Control Alternate Control</td>
<td>Alternate Control</td>
<td>Defined areas limit the MAR available to a fire event.</td>
</tr>
<tr>
<td>Enclosure Fire (e.g. Glovebox, Hot Cell) Waste Repackaging</td>
<td>Minimize fire initiators (P)</td>
<td>Enclosure Design-Electrical wiring designed in accordance with IEEE standards specified in DOE O 420.1B; Glovebox design criteria in accordance with DOE-STD-1066</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>Not Applicable</td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
</tr>
<tr>
<td>Limit fire size (P)</td>
<td>Automatic Fire Suppression System (FSS) OR Inert atmosphere</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>Not Applicable</td>
<td>There are no FSS in Area G</td>
<td>Not Applicable</td>
<td>None</td>
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</tr>
<tr>
<td>Minimize fire initiators (P)</td>
<td>Prohibit hotwork when combustible MAR is present AND Use non-sparking tools OR Inert atmosphere</td>
<td>Protect exposed combustible MAR during hotwork (e.g. fireblankets, non-combustible containers)</td>
<td>Not Applicable</td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Minimize releases (M)</td>
<td>CVS</td>
<td>MAR limit</td>
<td>Not Applicable</td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Enclosure Fire Waste Repackaging Special Treatment Example: Stabilization of pyrophoric material through controlled oxidation</td>
<td>Limit fire size (P)</td>
<td>Automatic FSS OR Inert atmosphere</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>Not Applicable</td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
</tr>
<tr>
<td>Minimize releases (M)</td>
<td>CVS</td>
<td>MAR limit</td>
<td>Not Applicable</td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
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<tr>
<td>Accident</td>
<td>Minimum Control Functions</td>
<td>Preferred Controls</td>
<td>Alternative Controls</td>
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<tr>
<td>Event: Fire from Uncontrolled Chemical Reaction (e.g. pyrophoric)</td>
<td>Minimize uncontrolled reaction (M)</td>
<td>Control oxidation rate</td>
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<td></td>
<td>There are no glovebox operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
</tr>
<tr>
<td>Large Fire</td>
<td>Limit fire propagation (P &amp; M)</td>
<td>Automatic FSS AND</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>DBA No. 3</td>
<td>• SAC Hot work is prohibited without a stationary fire watch within radiological waste defined areas</td>
<td>Alternate Control</td>
<td>See Event 9 controls for compliance. See Event 1 controls for compliance. Emphasis is placed on preventing and mitigating pool and combustible fires thereby preventing fires that could propagate into a large fire. FDS and FSS exist but their performance has never been qualified to meet minimum and sustainable standards due to the outdoor nature of Area G. In addition, neither the FDS nor FSS provide sufficient coverage to address all stored waste within Area G.</td>
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<td>• SAC A thermal distance or equivalent barrier limits heat flux to radiological waste containers • SAC Transient combustible control limits the amount and proximity of combustible fuel packages to limit fire intensity and progression.</td>
<td>Preferred Control</td>
<td>Housekeeping, thermal separation distances between defined areas, non-flammable pallets, and RCRA required aisle spacing serve to minimize the combustible loading of a given area.</td>
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<td>Preferred Control</td>
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</table>

**Chapter 3: Hazard and Accident Analysis**

Appendix 3G
<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
<th>Preferred Controls</th>
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<th>Preferred/Alternative Control Selection</th>
<th>Compliance Assessment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize releases (M)</td>
<td>Non-combustible containers</td>
<td>Fire area MAR limit</td>
<td>SS compliant (metal) containers are non-combustible; SAC on defined area MAR limits.</td>
<td>Preferred Control</td>
<td>Alternate Control</td>
<td>Compliant (metal) containers are used in Area G except for legacy non-metal waste containers. Non-compliant (non-metal) TRU waste containers are separated from compliant TRU waste containers and other fuel sources by a thermal separation distance except as permitted. Non-metal container storage areas have a reduced MAR limit from metal container storage areas.</td>
<td></td>
</tr>
<tr>
<td>CVS</td>
<td>MAR limit</td>
<td>SAC on defined area MAR limits.</td>
<td>Alternate Control</td>
<td>Defined areas limit the MAR available to a fire event.</td>
<td></td>
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</tr>
<tr>
<td>Ignition of Fumes Results in an Explosion, External Explosion</td>
<td>Minimize impact (M)</td>
<td>Separation distance</td>
<td>Limit quantity of potential vapor</td>
<td>DBA No. 13</td>
<td>Preferred Control</td>
<td>Alternate Control</td>
<td>Fume explosion events qualitatively determined to be low risk. For Event 18, external explosions affecting Area G are not physically plausible. Pressurized gas cylinders are not permitted to be stored in defined areas. Handling and use of cylinders within defined areas is restricted to reduce frequency of flammable gas accumulation. Acetylene cylinders are not allowed to be used or stored inside or within 50 ft of a defined area containing MAR.</td>
</tr>
</tbody>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3G

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<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Container Deflagration</td>
<td>Minimize release (M)</td>
<td>Outer container integrity</td>
<td>Apply Minimize worker exposure control set for this event</td>
<td>DBA No. 4A DBA No. 4C DBA No. 4D DBA No. 4E DBA No. 4F</td>
<td>• SS containers are of sound structural integrity. • SAC requires doublepacking of TRU waste containers &gt; 200 PE-Ci. • SAC requires use of lid restraints, blast shields, or separation distance when handling unvented containers. • SAC Equipment/ tool design controls and processes used to penetrate/ breach TRU waste container must minimize frictional sparking • SAC Unvented TRU waste drums ≥ 480 PE-Ci will be doublepacked prior to drum venting. • SAC Above-ground outer TRU waste containers shall be passively vented</td>
<td>Preferred Control</td>
<td>See Event 7 for “Minimize worker exposure” control set. The majority of TRU waste containers are closed and constructed of steel. However, legacy FRPs are stored in Area G and will be retrieved from Pit 9. FRPs have sufficient leakage that buildup of hydrogen and/or VOCs is not plausible. Combinations of blast shielding, distance, restraints and respiratory protection reduce the risk to workers.</td>
</tr>
<tr>
<td>Multiple Waste Container Deflagration, Characterization and Container Handling</td>
<td>Reduce explosive atmosphere (M)</td>
<td>Vent suspect containers</td>
<td></td>
<td>DBA No. 5A</td>
<td>• SAC Above-ground outer TRU waste containers shall be passively vented</td>
<td>Preferred Control</td>
<td>The majority of TRU waste containers are closed and constructed of steel. These containers are either vented or isolated until the container can be vented.</td>
</tr>
<tr>
<td>Minimize worker exposure (M)</td>
<td></td>
<td></td>
<td>Minimize worker contact with suspect container; prevent unnecessary personnel within affected area</td>
<td></td>
<td>• SAC requires use of lid restraints, blast shields, or separation distance when handling unvented containers. • SAC requires container venting or isolation until venting can be performed. • SAC Unvented TRU waste drums are not stacked.</td>
<td>Preferred Control</td>
<td>Impact resistant shielding meeting OSHA requirements during handling of suspect containers. Restraints are placed on containers when possible to reduce the risk to workers when handling/processing unvented containers. Lid restraints, blast shields and/or separation distances may be used to minimize worker risk.</td>
</tr>
<tr>
<td>Accident</td>
<td>Minimum Control Functions</td>
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<td>Alternative Controls</td>
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<tr>
<td>Waste Container Deflagration</td>
<td>Reduce potential sparks and other initiators during venting (P)</td>
<td>Drum Venting System (DVS) with a blast-resistant chamber and containment device (e.g., HEPA filter train)</td>
<td>Tools must be of the type to prevent ignition (e.g., non-sparking tools; use cold drilling, speed drilling, or drum punch); grounding and bonding; control static discharge from personnel</td>
<td>DBA NO. 5A DBA NO. 5B</td>
<td>SAC requires use of lid restraints, blast shields, or separation distance when handling unvented containers. SAC requires use of tools and processes to minimize potential for spark generation.</td>
<td>Preferred Control</td>
<td>Alternative Control</td>
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<tr>
<td>Multiple Waste Container Deflagration During Venting and Hydrogen Abatement Venting and/or Abating/Purging</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
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<tr>
<td>Minimize worker exposure during venting (M)</td>
<td>DVS with a blast-resistant chamber and containment device (e.g., HEPA filter train); prevent unnecessary personnel within affected area</td>
<td>Blast resistant enclosure; prevent unnecessary personnel within affected area OR Remote activation; personnel exclusion area</td>
<td>SAC requires use of lid restraints, blast shields, or separation distance when handling unvented containers. SMP Radiation Protection Program.</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
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<tr>
<td>Reduce potential sparks and other initiators during hydrogen abatement (P)</td>
<td>Isolate/segregate container after venting until hydrogen concentration is below 8%; minimize container movement</td>
<td>SAC requires container isolation until venting can be performed (includes during abatement time following vent installation).</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
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<tr>
<td>Minimize worker exposure during hydrogen abatement (M)</td>
<td>Minimize worker contact with container; prevent unnecessary personnel within affected area</td>
<td>SAC requires container isolation until venting can be performed (includes during abatement time following vent installation).</td>
<td>preferred control preferred control</td>
<td>preferred control preferred control</td>
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See Event 7 controls for compliance. Equipment and processes (e.g., non-sparking tools, cold drilling processes) are used to prevent spark generation. The DVS is designed to incorporate these principles and is the preferred means to vent and sample containers.
<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
<th>Preferred Controls</th>
<th>Alternative Controls</th>
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<th>Preferred/Alternative Control Selection</th>
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</thead>
<tbody>
<tr>
<td>Limit interaction between containers during hydrogen abatement (M)</td>
<td>No stacking containers</td>
<td></td>
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<td>SAC Unvented TRU waste drums are not stacked.</td>
<td>Preferred Control</td>
<td>Upon venting, a gas sample is taken. Based on the sample results, a container that does not indicate vented status, is treated as an unvented container (i.e., isolated and not stacked) until subsequent sample results indicate adequate venting.</td>
</tr>
<tr>
<td>Enclosure Deflagration</td>
<td>Reduce Explosive Atmosphere (P)</td>
<td>Concentrations of hydrogen and VOCs are verified to be less than Lower Flammability Limit prior to opening a container.</td>
<td>Explicit personnel restrictions to opening an unvented drum (e.g., remote contained facility, inert atmosphere, protective shielding, blast resistant enclosure)</td>
<td>None</td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
</tr>
<tr>
<td>Minimize release (M)</td>
<td>Enclosure designed to mitigate deflagration pressure wave</td>
<td></td>
<td></td>
<td></td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
</tr>
<tr>
<td>Minimize ignition sources (P)</td>
<td>Enclosure designed in accordance with IEEE/NFPA standards AND Remove inner operationally restricted waste items from the enclosure upon discovery</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td></td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
<td></td>
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<tr>
<td>Prohibit hotwork when combustible MAR is present</td>
<td>Protect exposed combustible MAR during hotwork (e.g. fireblankets, non-combustible containers)</td>
<td></td>
<td></td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
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<tr>
<td>Use non-sparking tools OR Inert atmosphere</td>
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<tr>
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<tr>
<td>Limit fire size (M)</td>
<td>Automatic FSS OR Inert atmosphere</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimize worker exposure (M)</td>
<td>Minimize worker contact with container; prevent unnecessary personnel within affected area</td>
<td>There are no glovebox or hot cell operations in Area G</td>
<td>Not Applicable</td>
<td>None</td>
<td></td>
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</tr>
<tr>
<td>Vehicle/Equipment Impacts Waste/Waste Containers External Vehicle Accident</td>
<td>Minimize material release (M)</td>
<td>Robust waste container</td>
<td>Waste array MAR limit</td>
<td>DBA No. 7A DBA No. 7B</td>
<td>Preferred Control</td>
<td>Steel containers are used in Area G except for legacy waste containers. Non-metal TRU waste containers (FRPs) are separated from compliant (metal) TRU waste containers by a thermal separation distance except as permitted. MAR limits are imposed based upon waste container construction.</td>
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<tr>
<td></td>
<td>Protect waste arrays with physical barriers</td>
<td>Control vehicle/ equipment access OR Control vehicle/ equipment route</td>
<td></td>
<td>Substantial vehicle barriers at high risk locations prevent accidental entry. SME requires placement of vehicle barriers along roads in proximity to defined areas. SAC Spotter supports forklift and crane operations during elevated lifts (&gt; 4 to &lt; 12 ft) placement/ removal (e.g., stacking/unstacking, loading/unloading) of TRU waste containers</td>
<td>Preferred Control</td>
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<td>Preferred Control</td>
<td>Control vehicle/ equipment access OR Control vehicle/ equipment route.</td>
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<td>Alternate Control</td>
<td>Substantial vehicle barriers at high risk locations and jersey barriers along roadways in proximity to defined areas prevent accidental vehicle entry. High MAR and/or high fuel capacity vehicles (e.g., the water truck) are escorted through the site which helps to limit speed during such vehicle movements.</td>
<td></td>
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<tr>
<td>Accident</td>
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</tbody>
</table>
| Drop/Spill Due to Improperly Handled Container, etc. | Minimize material released (M) | Outer container integrity | Limit container lift height OR Limit MAR handled at one time | DBA No. 8 | • SS compliant (metal) containers are of sound integrity. Legacy non-compliant (non-metal) containers (FRPs) are permitted; however, receipt of new FRPs is not allowed per scope.  
• SAC Doublepack radiological waste drums > 200 PE-Ci  
• SAC Limit effective MAR in a defined areas (e.g., Process, Retrieval, Bldg 54-412, LAA, and Transports)  
• SAC requires use of Critical Lift Plan for lifts > 12 feet. | Preferred Control | Preferred Control | Alternate Control | Alternate Control | Steel containers are used in Area G except for legacy waste containers. The Area G inventory does include non-steel TRU waste containers. Lifts of greater than 12’ require a critical lift plan and spotters are used during container lifts greater than 4 ft to prevent mishaps involving containers. |
| Collapse of Stacked Containers                  | Minimize material released (M) | Outer container integrity AND Pallet structural integrity | Stack limitation (e.g., height limit, weight limit, MAR distribution limit) OR Alternate structural enhancement | Not Applicable | • SS compliant (metal) containers are of sound integrity. Legacy non-compliant (non-metal) containers (FRPs) are permitted; however, receipt of new FRPs is not allowed per scope.  
• Use of metal pallets  
• Compliant (metal) containers are limited in stack height to ≤ 12 feet. | Preferred Control | Preferred Control | Alternate Control | Alternate Control | Compliant (metal) containers are used in Area G except for legacy waste containers. The Area G inventory does include non-metal TRU waste containers. Lifts of greater than 12 ft require a critical lift plan and spotters are used during container movements greater than 4 ft to prevent mishaps involving containers. Retrieval activities require interaction with containers stacked in a pre-existing condition. A tiered retrieval approach will be used to minimize the potential drop heights and minimize the risk of waste face collapse. |
<p>| Waste Container Over-Pressurization             | Minimize release (M) | Outer container integrity | Not Applicable | | • SS containers are of sound integrity. | Preferred Control | Compliant (metal) containers of sound integrity are used in Area G except for legacy waste containers. Legacy containers such as FRPs will not pressurize. |</p>
<table>
<thead>
<tr>
<th>Accident</th>
<th>Minimum Control Functions</th>
<th>Preferred Controls</th>
<th>Alternative Controls</th>
<th>Applicable Events</th>
<th>Preferred/Alternative Control Selection</th>
<th>Compliance Assessment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce over-pressurization (M)</td>
<td>Vent pressurized containers</td>
<td></td>
<td></td>
<td></td>
<td>SAC requires container venting or isolation until venting can be performed. SAC Above-ground outer TRU waste containers shall be passively vented</td>
<td>Preferred Control</td>
<td>The majority of TRU waste containers are closed and constructed of steel. These containers are either vented or isolated until the container can be vented.</td>
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<tr>
<td>Minimize worker exposure (M)</td>
<td>Lid restraints on pressurized containers (e.g., nylon straps, netting, drum overpacks, or other physical restraining devices) OR Impact-resistant shielding meeting OSHA requirements during handling of pressurized containers (29CFR Part 1910.120 Section j)</td>
<td>Minimize worker contact with pressurized container; prevent unnecessary personnel within affected area</td>
<td></td>
<td></td>
<td>SAC requires use of lid restraints, blast shields, or separation distance when handling unvented containers.</td>
<td>Preferred Control</td>
<td>Impact resistant shielding meeting OSHA requirements during handling of suspect containers. Restraints are placed on containers when possible to reduce the risk to workers when handling/processing unvented containers. Lid restraints, blast shields or separation distances may be used to minimize worker risk.</td>
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<tr>
<td>Direct Exposure to Radiation Events</td>
<td>Minimize immediate life-threatening worker exposure (M)</td>
<td>Specific shielding distance, and/or time, requirements in accordance with Radiation Protection Requirements</td>
<td></td>
<td></td>
<td>Not Applicable</td>
<td>SMP on Radiological Protection Program</td>
<td>RPP monitors and establishes applicable radiological areas and controls.</td>
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<tr>
<td>Criticality Events</td>
<td>Minimize potential for criticality event (P)</td>
<td>Specific controls evaluated in accordance with site requirements</td>
<td></td>
<td></td>
<td>Not Applicable</td>
<td>SMP on Nuclear Criticality Program</td>
<td>Nuclear Criticality Program establishes guidance for preventing criticality events.</td>
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<tr>
<td>Aircraft Impact w/ Fire</td>
<td>Minimize material release (M)</td>
<td>Facility designed to withstand aircraft impact event</td>
<td>MAR distribution (e.g. less MAR in impact footprint)</td>
<td>DBA No. 9</td>
<td>SAC on defined area MAR limits. Thermal barrier SAC establishes distance between defined areas.</td>
<td>Alternate Control</td>
<td>MAR is separated into defined areas with thermal separation distances between each area. Therefore, the MAR is distributed which limits the amount of MAR involved in an aircraft crash.</td>
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<td>Alternative Controls</td>
<td>Applicable Events</td>
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<td>External Fire</td>
<td>All controls from Event 4</td>
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<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limit fire growth (M)</td>
<td>Non-combustible facility construction AND Fire breaks (e.g. vegetation control)</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>DBA No. 10</td>
<td>Alternate Control</td>
<td>Housekeeping, including vegetation control, and thermal separation distances between defined areas limit the potential for fire propagation.</td>
</tr>
<tr>
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<td></td>
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<td>Lightning</td>
<td>All controls from Event 4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimize impact of lightning (M)</td>
<td>Facility designed to withstand lightning</td>
<td>Alternate fire protection controls approved by qualified fire protection engineer (e.g., flammables and combustibles limit)</td>
<td>DBA-10a</td>
<td>Alternate Control</td>
<td>See Event 4 controls for compliance.</td>
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<tr>
<td>High Wind</td>
<td>Minimize impact of NPH event (M)</td>
<td>Facility designed to withstand NPH event</td>
<td>Specific engineered protective enclosures</td>
<td>DBA No. 11</td>
<td>SAC Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Alternate Control</td>
<td>Facility is primarily outdoors with some fabric covered structures. MAR is separated into defined areas with thermal separation distances between each area. Therefore, the MAR is distributed which limits the amount of MAR involved in high wind events. Tornadoes are not plausible at Area G.</td>
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<tr>
<td>Accident</td>
<td>Minimum Control Functions</td>
<td>Preferred Controls</td>
<td>Alternative Controls</td>
<td>Applicable Events</td>
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<tr>
<td>Snow/Ice/Volcanic Ash Build-up</td>
<td></td>
<td>Operational restrictions during inclement weather</td>
<td>Not Applicable</td>
<td></td>
<td>• SMP limiting operations during inclement weather.</td>
<td>Preferred Control</td>
<td>Outdoor activities are suspended during inclement weather. Activities within domes are suspended for inclement weather of a certain nature (e.g., very high wind).</td>
</tr>
<tr>
<td>Seismic Event (Impact Only)</td>
<td>Minimize impact of seismic (M)</td>
<td>Facility and SSC designed to withstand seismic event</td>
<td>Specific engineered protective enclosures/controls</td>
<td>Not Applicable</td>
<td>• SAC on defined area MAR limits. • SMP-Drum Banding • Compliant (metal) containers are limited in stack height to ≤ 12 ft.</td>
<td>Alternate Control Alternate Control Alternate Control</td>
<td>Facility is primarily outdoors with some fabric covered structures. MAR is separated into defined areas with thermal separation distances between each area. Therefore, the MAR is distributed which limits the effects of a seismic event.</td>
</tr>
<tr>
<td>Seismic Event w/ Fire</td>
<td>All controls from Event 4</td>
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<td>DBA No. 12</td>
<td></td>
<td>• The SC-SAC, Combustible Loading, minimizes the combustible loading in the Defined. • SC-SAC, protects the presumption that TRU waste defined areas are a sufficient distance from pole mounted transformers to prevent the pole mounted transformer from falling on top of the non-metal storage area during a seismic event, or any fuel pool fire from • SMP-Drum Banding • SAC limits the transient combustibles within the thermal separation distance between defined areas.</td>
<td>Preferred Control Alternate Control Preferred Control</td>
<td>Facility is primarily outdoors with some fabric covered structures. MAR is separated into defined areas with thermal separation distances between each area. Therefore, the MAR is distributed which limits the effects of a seismic event.</td>
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<tr>
<td>Minimize impact of seismic</td>
<td>Facility and SSC designed to withstand seismic event</td>
<td>Specific engineered protective enclosures/controls</td>
<td></td>
<td></td>
<td>• SAC on defined area MAR limits.</td>
<td>Alternate Control</td>
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APPENDIX 3H

CONSOLIDATED HAZARD ANALYSIS
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<td>Administrative Controls</td>
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<td>AGTRU</td>
<td>above-ground TRU</td>
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<tr>
<td>ALARA</td>
<td>as low as reasonably achievable</td>
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<td>ANSI</td>
<td>American National Standards Institute</td>
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<td>BGTRU</td>
<td>Below-ground TRU</td>
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<td>BGTRUCMP</td>
<td>Below-ground TRU Corrugated Metal Pipe Area (Pit 29 Attic)</td>
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<td>BGTRUCSK</td>
<td>Below-ground TRU Cask (Trenches A through D)</td>
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<td>BGTRUPIT</td>
<td>Below-ground TRU Pit (Pit 9)</td>
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<td>Basis for Interim Operation</td>
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<td>Code of Federal Regulations</td>
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<td>collocated worker</td>
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<td>design basis accident</td>
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<td>design feature</td>
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<td>defense-in-depth</td>
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<td>damage ratio</td>
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<td>LCO</td>
<td>limiting condition for operation</td>
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<td>LLW</td>
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<td>MAR</td>
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<td>MEOI</td>
<td>maximally exposed offsite individual</td>
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<td>Mobile Loading Unit</td>
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<td>natural phenomena hazard</td>
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<td>PCB</td>
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<td>structure, system, and component</td>
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<td>Sort, Segregate, Size Reduction, and Repackaging</td>
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<td>standard waste box</td>
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<td>worker</td>
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<td>WAC</td>
<td>Waste Acceptance Criteria</td>
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<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
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EXECUTIVE SUMMARY

This report documents the Consolidated Hazard Analysis (CHA) conducted for the Technical Area 54 (TA-54), Area G facility at Los Alamos National Laboratory (LANL). The CHA was performed to support the development of a Basis for Interim Operations (BIO) to replace the current TA-54, Area G Documented Safety Analysis (DSA) [Ref. 1] and Technical Safety Requirements (TSR) [Ref. 2] in accordance with the U.S. Code of Federal Regulations (CFR), Title 10, Part 830 [Ref. 3] and the U.S. Department of Energy (DOE) Standard (STD) 3009 (DOE-STD-3009-94) (Ref. 4). This CHA was conducted for the TA-54, Area G facility utilizing a CHA Process (CHAP), which was developed using methodologies and guidance from 10 CFR 830 [Ref. 3], DOE-STD-3009-94 [Ref. 4], DOE-STD-3011-2002 [Ref. 5], DOE-STD-1027-92 [Ref. 6], 29 CFR 1910.119 [Ref. 7], and 40 CFR 68 [Ref. 8], and modified to address the requirements of DOE-STD-5506-2007 [Ref. 9].

The CHA was used to identify and evaluate potential process hazards and accident conditions that could cause or contribute to the uncontrolled release of radiological material from the TA-54, Area G facility. The CHA was evaluated for the selection of candidate Design Basis Accidents (DBAs). The CHAP consists of multiple elements that utilize specific, proven techniques and a team approach to identify potential safety controls (preventive and mitigative); potential safety-significant structures, systems, and components (SSCs), Specific Administrative Controls (SACs), Safety Management Programs (SMPs), and defense-in-depth (DID) controls where applicable. This systematic, team-based approach to develop the CHA utilizes the concepts of Integrated Safety Management [Ref. 10].

The results of the CHA include event scenarios with qualitative assessment of frequency, consequences, associated preventative or mitigative safety controls, and a summary of event scenarios to be evaluated quantitatively in the Accident Analysis (AA). The methodology used to identify and evaluate hazards is documented in Sections 9.3 and 5.0 of this report. DOE-STD-1027-92 [Ref. 6] and DOE-STD-3009-94 [Ref. 4] provide guidance for grading the Hazard Analysis (HA) and AA. A graded approach dictates that complex, high-hazard facilities be assessed more rigorously and that this assessment be documented more thoroughly than that for simple, low-hazard facilities, since grading is a function of both hazard potential and complexity. Consistent with this approach, if a hazard poses a significant threat (i.e., health consequences), a more detailed analysis is performed. The event scenarios presented in this report were graded in accordance with these DOE standards. The CHA considers the consequences from the material-at-risk (MAR) limits associated with TA-54, Area G operations. This examination results in bounding hazards for all TA-54, Area G operations.

This CHA Report lists the inputs and assumptions identified during the HA in Section 4.0. The event scenarios listed in Section 6.4 of this report were determined to be unique and/or representative of the identified event types. These event scenarios were submitted to the AA for further consideration, quantitative review, and analysis. All postulated events for transuranic (TRU) and non-TRU facility operations are documented in the Hazard Evaluation (HE) tables in Section 9.4.
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1.0 INTRODUCTION

TA-54, Area G is the primary site for the disposal of low-level waste (LLW) and tritium- (H3) contaminated waste. In addition, TA-54, Area G is used for storage of mixed low-level waste (MLLW), hazardous waste (HW), H3 contaminated waste, and TRU waste generated at the Laboratory. The TA-54, Area G facilities are situated in the middle of TA-54 on Mesita del Buey. The LLW to be disposed of includes radiologically contaminated asbestos, bio-organics, beryllium, and small amounts of polychlorinated biphenyls (PCBs). The HW and MLLW are stored in arrays that are easily inspected in a Resource Conservation and Recovery Act (RCRA)-permitted storage area. Small amounts of H3-contaminated LLW and MLLW are also stored in specific, commercially-constructed steel chemical storage units on a RCRA-permitted pad. The TRU waste destined for the Carlsbad, NM Waste Isolation Pilot Plant (WIPP) is also stored in easily inspected arrays that allow for container integrity as well as RCRA inspections. Radiological wastes with significantly high dose rates that pose an unacceptably high exposure hazard to workers are placed in shafts for storage and/or disposal to meet as low as reasonably achievable (ALARA) requirements.

The LLW, MLLW, HW, H3-contaminated, and TRU waste are managed according to applicable regulations. In accordance with RCRA, all mixed waste received is stored within RCRA permitted storage areas. Retrievably stored TRU wastes at TA-54, Area G, if acceptable under the WIPP Waste Acceptance Criteria (WAC), will be prepared for eventual shipment to WIPP. Any TRU waste not meeting the WIPP WAC, and MLLW with no treatment path, will be held in storage at LANL until process activities are developed to treat and/or prepare this waste for acceptance at WIPP or another treatment, storage, and disposal facility.

The purpose of this report is to document the CHA conducted for the TA-54, Area G facility. The CHA qualitatively evaluated unmitigated event scenarios for TA-54, Area G, according to risk.

The scope of the HE includes identifying hazardous events or conditions associated with the following:

- Activities in areas involving TA-54, Area G operations
- Transport of TRU waste between the Radioassay and Nondestructive Testing (RANT) facility entrance gate and TA-54, Area G
- External events, both natural and man-made

A CHAP team consisting of recognized experts in a variety of operations-related disciplines and design areas (e.g., facility engineering, AA, fire and criticality), including individuals experienced in safety and hazard analysis development, was assembled to perform the CHA. The integrated multi-disciplined team consisted of personnel from URS Safety Management Solutions, Los Alamos National Security (LANS), and Bechtel Babcock and Wilcox Idaho, LLC. These individuals were selected to provide complete coverage of the various functional areas and the expertise to perform a thorough analysis.
The CHAP team was composed of the following core team members:

**URS Safety Management Solutions**
- Corey Campbell
- Scott Church
- Jackie East
- Richard Haddock
- Jennifer Long
- Srikant Mehta
- April Price
- Barbara Scherpenberg
- Cheryl Smith
- Steve Sommer

**LANS**
- Jason Apperson
- Luke Bartlein
- James Blankenhorn
- Davis Christensen
- Steve Clemmons
- Sean French
- Karen McHugh
- Shean Monahan
- Lisa Pansoy-Hjelvik
- D. Palmer Smitherman

**Bechtel Babcock and Wilcox Idaho**
- Tim Finup
2.0 FACILITY DESCRIPTION

2.1 TA-54, AREA G DEFINED AREAS AND OPERATIONS

The TA-54, Area G process operations related to waste processing and handling, and storage of all types of hazardous, radiological, and mixed radiological wastes, are conducted in several defined areas. The major structures, facilities, and nuclear waste operation descriptions, including TRU (above-ground TRU [AGTRU] and below-ground TRU [BGTRU]) and non-TRU (LLW, MLLW, HW, and H3-contaminated) waste handling and storage, are discussed or presented in Chapter 2 of the BIO.

3.0 OPEN ITEMS

None

4.0 INPUTS AND ASSUMPTIONS

The inputs and assumptions established a baseline upon which this CHA was performed. The input data and assumptions for the TA-54, Area G facility used in this CHA were obtained from TA-54, Area G facility personnel and URS SMS team members. During the CHA process, some developed inputs and assumptions common to both the TRU HA and the non-TRU HA were used where applicable. The following inputs and assumptions form the basis for the conclusions or recommendations of this CHA. The justification for the inputs and assumptions is shown in parentheses following the input/assumption.

Additional inputs and assumptions that were developed during the HA are listed in Section 4.1.3 and 4.1.4 of this report. These inputs and assumptions are taken directly from specific event scenarios in the HE Tables located in Section 9.4.

4.1 INPUTS AND ASSUMPTIONS

4.1.1 AGTRU/BGTRU Base Assumptions

The following base assumptions were defined before starting the CHAP for AGTRU and BGTRU:

1. The risk of 1,100 plutonium equivalent curies (PE-Ci) involved in a worst-case event scenario (i.e., impact with pool fire) is acceptable. (Justification: This MAR value, in the currently approved TA-54, Area G Safety Basis, is the maximum for a single vehicle on-site transportation activity. The radiological release from this event scenario was an accepted risk by the DOE and will be further justified in the AA.)

2. The Emergency Preparedness Program reduces the risk to workers. (Justification: Waste Disposition Projects and Laboratory guidance requires that site workers with unrestricted access have appropriate facility training to react to adverse conditions. Workers recognize adverse conditions and report those conditions to the Operations Center, which notifies facility and site personnel and directs the response to reduce radiological consequences to workers by limiting exposure [i.e., worker evacuation].)

3. The maximum AGTRU waste inventory is 57,000 PE-Ci. (Justification: This MAR value, based on the projected above ground inventory as of July 31 2013, is significantly less than that provided in the currently approved TA-54, Area G Safety Basis as the site above-ground TRU
maximum. With the scheduled facility closure, current waste shipments to WIPP, and scheduled retrieval activities, this maximum MAR value provides sufficient margin for continued operations. The MAR value will be further justified in the AA.)

4. Low speed (< 10 mph) vehicle event scenarios with fire are considered Unlikely. (Justification: The methodology to assign this frequency was developed using U.S. Department of Transportation (DOT) accident statistics. A vehicle fire requires two separate events: (1) an accident, and (2) ignition of combustible materials.)

5. Moderate speed (> 10 mph, < 35 mph) vehicle event scenarios with pool fire are considered Extremely Unlikely. (Justification: The methodology to assign this frequency was developed using DOT accident statistics. A vehicle accident with pool fire requires three separate events: (1) an accident, (2) rupture of the fuel tank, and (3) ignition of the fuel.)

6. Fires will not propagate across non-flammable, closed TRU waste containers. (Justification: Non-flammable TRU waste containers that are involved in fire events do not burn, nor do they support propagation to other non-flammable closed containers. A reduction in unmitigated frequency was applied to applicable event scenarios, since closed non-flammable TRU waste containers reduce the likelihood for the propagation of small fires that begin inside the container to larger fires within a TRU waste storage array.)

7. Double-packing of TRU waste containers reduces the amount of MAR released by 90% for accidents involving mechanical insults. (Justification: According to DOE-STD-5506-2007 [Ref. 9], a Damage Ratio (DR) of 0.1 is assumed for overpacked drums of sound integrity (vented or unvented), whether overpacked in a larger drum, a standard waste box (SWB), or a ten-drum overpack (TDOP). Therefore, a reduction in released MAR was assumed and applied to reduce the radiological consequences of the doublepacked container. Doublepacking is placing a TRU waste container of good and unimpaired condition into a larger container of good and unimpaired condition, and then placing that container into a larger container of good and unimpaired condition. Doublepacking does not provide a similar reduction in consequences for deflagrations or fire event scenarios. Note that the credit for doublepacking is not applicable to storage area MAR limits and the Area G total above-ground limit.)

8. Overpacking TRU waste containers is placing a TRU waste container of good and unimpaired condition (vented or unvented), or of suspect condition, into a larger container of good and unimpaired condition.

9. The Employee Health and Safety Program ensures that employees are fit for duty. (Justification: The Employee Health and Safety Program guides workers with unrestricted site access to be fit for duty, to conduct work safely, and to be able to react to adverse conditions. In addition, the Program guides management personnel to ensure a safe and competent work force, and criteria for self-reporting employee health conditions that might affect performance.)

10. For single-container event scenarios, the highest MAR container is assumed in the facility activities (Characterization, Drum Venting). (Justification: For event scenarios where only a single container was involved, the CHA team assumed that a TRU waste container with the highest known MAR was in the activity at the time the event scenario occurred. The consequences of the event would then provide conservative release values.)

11. Handling TRU waste is defined as the moving, lifting, relocating, double-packing, and/or overpacking of containers within a defined area. (Justification: The definition of handling was
taken from DOE-STD-5506-2007 [Ref. 9] and expanded to define and include locations in TA-54, Area G where handling occurs. The processing of TRU waste containers is not considered handling (e.g., Sort, Segregate, Size Reduction, and Repackaging [SSSR], drum venting activity, and characterization.)

12. Non-combustible pallets are used for container storage. (Justification: In the current TA-54, Area G Safety Basis, only non-flammable pallets are used in the facility for container storage. Continued use of non-combustible pallets is also captured in Chapter 2 of the BIO. Pallets of non-combustible construction that are involved in fire events do not burn, nor do they support fire propagation. Use of non-combustible pallets is an element of the Fire Protection Program, but is not credited with accident frequency or consequence reduction.)

13. Training and qualification of unrestricted TA-54, Area G personnel reduces the worker risk. (Justification: Waste Disposition Projects and Laboratory guidance requires that site workers with unrestricted access be specifically trained and qualified to conduct work safely and be able to react to adverse conditions. Authorized personnel who operate equipment and processes, and handle radiological waste, have been trained on facility hazards, identification of adverse (abnormal) events, response to adverse conditions, and use of approved procedures.)

14. Remote-handled waste shafts contain $\leq$ 150 PE-Ci. (Justification: Based on TA-54, Area G Material Inventory records, this is the worst-case inventory in a remote-handled shaft.)

15. TA-54, Area G roadways are maintained to reduce the likelihood of road-hazard-induced vehicle accidents. (Justification: Asphalt or densely packed soil/gravel roadways are constructed and maintained in accordance with Waste Disposition Projects and Laboratory guidance.)

16. Releases from American National Standards Institute (ANSI)-certified sealed sources are excluded from event scenarios if the sources are packaged in pipe overpack containers. (Justification: In accordance with DOE-STD-5506 [Ref. 9], ANSI-certified sealed sources packaged in pipe overpack containers [POCs] have a DR of 0 for all postulated event scenarios. Therefore, the PE-Ci values for the certified sealed sources in POCs are not counted toward the above-ground TRU site inventory.)

17. It must be noted that some sealed sources cannot be verified as being certified to 49 CFR 173.469 [Ref. 11] and ANSI N43.6 [Ref. 12] requirements. Sealed sources that are not packaged in POCs are counted toward the above-ground TRU site inventory.

18. Only 10% of the MAR in a WIPP-approved POC is counted toward Area G MAR limits. (Justification: POCs provide assurance that radiological material contained within a sealed metal pipe and packaged within a structurally sound container are not readily releasable. Retaining radiological waste within POCs assures that the consequences of any given event are negligible. DOE-STD-5506, Table 4.4.4-1 [Ref. 4] indicates that, for the majority of accident stresses, a DR=0 is applied to MAR stored within POCs. The accident stress involving a forklift tine puncture of a waste container with contaminated solids results in a DR=0.05; forklift tine puncture of a waste container with sand-like materials results in a DR=0.1. Therefore, for waste material that is stored within a POC at Area G, a DR=0.1 is conservatively applied. The POC is credited in the Area G TSRs as a safety-class design feature [DF] to protect the initial condition that its performance criteria and an in-service inspection [ISI] meet WIPP criteria.)
19. Extended exposure to high heat is required to release H3 from a matrix. (Justification: Release mechanisms, other than a large fire, do not release H3 from the matrix. Potential mechanisms to release H3 from a binding matrix do not exist within TA-54, Area G, other than large liquid fuel spills. Therefore, only fire event scenarios with large liquid fuel spills that postulated releases of H3 were considered.)

20. Transporting TRU waste is defined as the relocation of containers from one defined area to another defined area. (Justification: The definition of transporting TRU waste was defined by the CHA team as the movement of waste between defined areas in TA-54, Area G, to distinguish transporting from handling of TRU waste containers within a defined area.)

21. Hazardous waste contents in newly generated waste are within approved limits. (Justification: Waste generators package known quantities of hazardous and/or radiological waste in approved containers using approved procedures. The contents and quantity of newly generated waste are required by the LANL WAC to be within approved limits. Receipt inspections and verification of content are conducted before acceptance of the waste containers in accordance with approved procedures.)

22. Pole-mounted transformers with liquid fuel are of sufficient distance from TRU waste storage areas that the sum of the height of the pole transformer, and the radius of the spilled fuel pool, are at a thermal separation distance that will prevent ignition of TRU waste. (Justification: Pole transformers with liquid fuel will not fall on top of TRU waste storage areas. This is a presumption of the seismic and post-seismic fire analysis that only considers a post-seismic fire involving ordinary combustibles, not one that results from a post-seismic fuel pool fire caused by a downed transformer pole).

23. The statistical above-ground analysis of MAR in containers and the waste matrix composition will not change significantly as retrieval efforts progress. (Justification: Significant variations in the statistical analysis of the above-ground inventory may not be bounded by the Area G BIO analysis. This is true especially because high-MAR drums (up to 620 PE-Ci) retrieved from Trenches A through D with a 100% combustible waste matrix may result in an above-ground inventory that is not bounded, without controls. Therefore, an SAC is required to ensure that, before retrieving drums from Trenches A through D, the above-ground inventory will not be impacted without controls. In addition, a yearly evaluation of the statistical values is also required as a commitment in the Area G BIO.)

24. The MAR in closed Type B containers, such as transuranic package transporter (TRUPACT) II or HalfPACT containers, is excluded from the payload process inventory. (Justification: Due to the inherently robust design of the TRUPACT, when waste is loaded into the TRUPACT and the external enclosure is installed, the MAR does not become involved in accident scenarios. A closed TRUPACT that has not yet been certified is considered to be sufficiently isolated from Mobile Loading Unit [MLU] activities. No TRUPACT activities are of sufficient energy to overturn a TRUPACT, dislodge its lid, and expose its contents to adverse conditions. Certification of closure is performed before highway transport. The event does not induce the consequences during these TRUPACT insults; therefore, the MAR is excluded during those postulated event scenarios. Type B containers are protected in the TSRs as a safety-class DF to protect the initial condition for a DR=0 if the containers meet 49 CFR 173.469 [Ref. 11] testing requirements, as per WIPP certification.)
25. The FRPs have no pedigree established for response to impacts or drops. The FRPs are not expected to survive even low to moderate impacts or drops without expelling all or most of their contents. A high impact or drop of a FRP with 150 PE-Ci results in just under 1 rem to the maximally exposed offsite individual (MEOI). For this reason, lifts greater than 4 ft involving FRPs with > 150 PE-Ci are to be protected by a critical lift plan in order to reduce the likelihood of a load drop.

Specific assumptions that were made for individual event scenarios are documented in the HE Tables, Section 9.4, under the specific event scenario, and are collectively shown in Section 4.1.3 and 4.1.4.

4.1.2 Non-TRU Base Assumptions (LLW/H3)

The following base assumptions were defined before starting the CHAP for LLW/H3:

1. The Emergency Preparedness Program reduces the risk to workers. (Justification: Waste Disposition Projects and Laboratory guidance requires that site workers with unrestricted access have appropriate facility training to react to adverse conditions. Workers recognize adverse conditions and report those conditions to the Operations Center, which notifies facility and site personnel and directs the response to reduce radiological consequences to workers by limiting exposure [i.e., worker evacuation]).

2. Hazardous waste contents in newly generated waste are within approved limits. (Justification: Waste generators package known quantities of hazardous and/or radiological waste in approved containers using approved procedures. The contents and quantity of newly generated waste are required by the LANL WAC to be within approved limits. Receipt inspections and verification of content are conducted before acceptance of the waste containers in accordance with approved procedures.)

3. The MLLW does not undergo disposal or compaction processes. (Justification: RCRA requirements and the LANL WAC prohibit the disposal or compaction of MLLW. Newly generated MLLW at the Laboratory is required to be stored above ground until a qualified treatment, storage, or disposal facility is acquired to accept MLLW.)

4. Training and qualification of unrestricted TA-54, Area G personnel reduces the worker risk. (Justification: Waste Disposition Projects and Laboratory guidance requires that site workers with unrestricted access be specifically trained and qualified to conduct work safely and be able to react to adverse conditions. Authorized personnel who operate equipment and processes, and handle radiological waste, have been trained on facility hazards, identification of adverse (abnormal) events, response to adverse conditions, and the use of approved procedures.)

5. Extended exposure to high heat is required to release H3 from a matrix. (Justification: Release mechanisms, other than a large fire, do not release H3 from the matrix. Potential mechanisms to release H3 from a binding matrix do not exist within TA-54, Area G, other than large liquid fuel spills. Therefore, only fire event scenarios with large liquid fuel spills that could cause releases of H3 were considered.

6. Specific assumptions that were made for individual event scenarios are documented in the HE Tables, Section 9.4, under the specific event scenario, and are collectively shown in Sections 4.1.4 and 4.1.5.
4.1.3 Specific AGTRU/BGTRU Event scenario assumptions

The following inputs or assumptions were defined during the development of CHA event-specific scenarios for AGTRU and BGTRU:

1. A container with an internal flammable atmosphere will not deflagrate without an interaction with an external force (e.g., human or natural activity). (Justification: A fire requires fuel, oxygen, and an ignition source. Some action [e.g., violent shaking, spark, heat source] in the drum must occur to generate or induce an ignition source that would cause a deflagration.)

2. Fire will not propagate from one Thermal Equilibration Unit (TEU) to another TEU. (Justification: The TEUs are all-metal, SeaLand-type structures. These structures cannot support or propagate a fire. If a fire is internal to one of these structures, the fire cannot propagate outside the TEU.)

3. The effect of a sympathetic drum deflagration is vertical. (Justification: DOE-STD-5506-2007 [Ref. 9] defines a sympathetic deflagration as affecting a drum on top [vertical] of the initial deflagration. A horizontal [radial] sympathetic deflagration has not been observed.)

4. Fiberglass-reinforced plywood (FRP), cargo containers (SeaLand), and other miscellaneous non-metal containers do not accumulate hydrogen or volatile organic compounds. (Justification: FRP and SeaLand containers are constructed so that hydrogen or volatile organic compounds cannot accumulate, as these containers or structures are not sealed units. Either the concentration of any accumulated flammable gases is insufficient to sustain a fire or deflagration, or the influx of air dilutes any potential buildup.)

5. Fuel spilled near storage casks located in Trenches A through D will not flow into the cask. (Justification: The engineered cask design includes a raised concrete collar that surrounds the cask opening. This design and construction inherently routes rainwater or a flammable/combustible liquid spill external to the cask opening away from the stored waste.)

6. The TRU waste container inner liners will be accessed only during SSSR. (Justification: RCRA requirements and the LANL WAC prohibit the opening of TRU waste containers in areas not designed for SSSR. Inner liners are secondary containment inside TRU waste drums, and restrictions are currently in place prohibiting opening inner liners.)

7. The quantity of fuel in the large refueling vehicle is restricted to 5,000 gal. (Justification: For these fire events, a large refueling vehicle is involved in the postulated event. The General Services Administration refueling vehicles that are used at the Laboratory could contain up to 5,000 gal; therefore, the CHA team concluded that 5,000 gal would be the fuel maximum for postulated event scenarios.)

8. The TRU waste contained within a Corrugated Metal Pipe (CMP) was processed into a concrete matrix. (Justification: For these fire and impact events, the waste matrix is contained and protected by the inherent design of the CMP. As a result, the consequences to all receptors are significantly reduced.)
4.1.4 Specific non-TRU Event scenario assumptions

The following inputs or assumptions were defined during the development of CHA event-specific scenarios for LLW and H3:

1. Fuel spilled near LLW disposal shafts will not flow into the shaft. (Justification: The engineered shaft design includes a raised concrete collar that surrounds the shaft opening. This design and construction inherently routes rainwater, or a flammable/combustible liquid spill external to the shaft opening, away from the disposed waste.)

2. Once covered with dirt, the pit or shaft inventory is no longer included in the above ground MAR. (Justification: When greater than 3 in. of a soil barrier/overburden covers the waste, the waste material is assumed to be buried and the disposed MAR becomes below-ground inventory. The soil barrier/overburden acts as a fire barrier so that postulated fires do not propagate to the buried waste.)

The control is not credited for mitigation of an airplane crash with fire, as the depth of soil is insufficient to ensure that the buried waste is protected from the impact. A quantitative analysis of the control’s mitigative importance for an airplane impact is presented here so that the HE credits the control appropriately. According to DOE-STD-3014-96 [Ref. 14], the general aircraft crash at Area G utilizes a plane with a 50-ft (15.24 m) wing span. Based on the crash angle, a 60-ft (18.3-m) skid is considered possible. Upon impact, only the engines are normally used as an impact concern. For conservatism, 50% of the 50-ft wing span is considered as the engine width. This means that a skid area of approximately 140 m² is affected by the impact zone. For a 1-m-deep impact, a total of 140 m³ of soil/waste is displaced and considered to burn unconfined.

The LLW in the PIT has a maximum content of 99 nanocuries/g. Utilizing 100% soil weight content, the affected area has a density of approximately 1,700 kg/m³. This maximizes the amount of MAR that could be in any cubic meter, as the density of the compacted waste is much less. The LLW component is then 0.17 Ci per m³. The 140 m³ displaced and/or burned, assuming that all the material is waste, equals 24 PE-Ci. Burning 35 PE-Ci uncontained in the PIT amounts to just under 20 rem to the MEOI. Based on this analysis, the dose to the MEOI from the airplane impact and fire is 13.7 rem to the MEOI. Conservatively assuming a 30/70 soil/waste mix by weight, the dose is under 10 rem. This means that the soil overburden can be relegated to a DID control for protection of the public from the airplane impact with fire.

5.0 METHODOLOGY

5.1 CONSOLIDATED HAZARDS ANALYSIS PROCESS

The CHAP was used to identify potential hazards and accident events applicable to the TA-54, Area G facility and to identify preventative and mitigative safety control strategies that eliminate the hazards and resultant hazardous situations, reduce the likelihood of occurrence of the event, or mitigate the consequences of the event.

The CHAP began with team members becoming familiar with the facility. Facility familiarization included a physical site walkdown and reviews of documented information to identify actual hazardous materials, energy sources, and procedure processes for each operation and activity that occurs within a defined area. Physical walkdowns allow for first-hand familiarization with actual facility systems, processes, practices, equipment, and inventory. Following the facility walkdown, the CHA team
convened and completed a Hazard Identification Checklist to review and document the facility hazards associated with the buildings, processes, and site area. The results of the hazard identification are documented in Section 9.1. The review of documented information included all available documents such as the material inventory, existing safety documentation (e.g., current DSA/TSR and Fire Hazards Analyses). In addition, consultations with facility system and process engineers or subject matter experts (SMEs) on facility processes and documents were conducted. Section 9.2 details the radiological inventories, along with background information on the various types and forms of LLW, MLLW, H3, and TRU used during the CHA. In addition, Table 9.2-2 of Section 9.2 provides a summary of the waste container MAR values used during the CHA for TRU and non-TRU event scenarios. TA-54, Area G line management and operations personnel also provided descriptions of the major operations and specifics of the activities occurring within an activity.

Standard industrial hazards (SIHs) are not addressed in this CHA. SIHs are defined as hazard sources (material or energy) or event scenarios that involve hazards that are routinely encountered by the general public or in general industry and construction. National consensus codes or standards exist for SIHs to govern handling or use without the need for special analysis to define safety design and operational parameters. The scope of the CHA did not include hazards screened as SIHs, or willful acts such as sabotage. However, if an SIH resulted in a radiological release, the event scenario was carried forward into hazardous event scenario development.

The TA-54, Area G CHA team consisted of personnel with backgrounds in fire protection, nuclear operations and engineering, health physics, criticality, mechanical engineering, and related technical disciplines. The CHA team members that participated in this analysis and contributed to the preparation of this report are shown in Section 1.
5.2 HAZARD ANALYSIS

The objective of the CHA is to perform a systematic evaluation of potential event scenarios that could involve hazards based on the event types contained in DOE-STD-5506-2007 [Ref. 9]. The Standard provides detailed guidance for consistently analyzing hazards and selecting controls for TRU waste activities. The HA and controls for TRU waste activities must be integrated into the overall Safety Basis documents for nuclear facilities in accordance with 10 CFR 830, Subpart B requirements [Ref. 3]. In addition, the CHAP identifies safety controls and qualitatively establishes their adequacy. Non-TRU waste HA and controls for non-TRU waste activities are likewise integrated into the Safety Basis document. This methodology was used to present a comprehensive evaluation of facility hazards and to focus attention on those event scenarios that pose the greatest risk to the public, collocated onsite workers, and workers. The term MEOI or public means an individual at the closest site boundary to TA-54, Area G who would receive a radiological dose from a potential on-site release. The collocated worker is an individual who is within the site boundary and is located 100 m from the potential event release. The worker is normally an individual in direct contact with the material at the time of release. When the collocated worker has a High consequence based on calculated doses, the worker is assumed to have a high consequence. When the collocated worker has a Moderate or Low consequence, the worker is assumed to experience up to one-bin-higher consequence due to their closer proximity. Some initiating events themselves have the potential to directly inflict significant physical and radiological worker consequences. Such events include a building structural failure due to a natural phenomena hazard (NPH) event, airplane crash, lightning strike, etc. For events of this type, worker physical and dose consequences would be estimated to be higher than those for collocated workers. Some slowly-progressing events, such as a low energy spill or a gradually spreading fire, would allow the trained facility worker adequate time to recognize the hazard and safely exit the area well before experiencing significant or life-threatening consequences. For such events, the worker consequence bin is estimated to be equal to that for the collocated worker. Worker consequences are applied in this manner with no supporting dose calculations.

As part of the unmitigated hazards evaluation, a set of unique and representative event scenarios requiring further quantitative AA are identified.

5.2.1 Hazard Analysis Method

Several HA techniques may be used depending on the situation. The Hazard and Operability Study (HAZOP) and What-If techniques were used during this CHA. The CHAP team examined actual facility design configurations and operations. Guide words were used to provide structure to the CHA and stimulate the identification of hazards and hazardous situations. The team examined the major process steps or nodes and analyzed each one to postulate hazardous situations or events.

The scope of the CHA included the following:

- All major aspects of TA-54, Area G operations.
- Natural phenomena (e.g., earthquakes, tornadoes, and high-velocity straight winds), and external events (e.g., aircraft and vehicular impact).
- Consideration of possible event scenarios for a given hazard in terms of both frequency and consequence levels.
- Facility activities or systems that pose no hazards or pose only common/SIHs addressed by other programs or regulations (e.g., Occupational Safety and Health Administration [OSHA], DOT) were examined to determine if a loss of control of the activity or system could result in a release.
• The mitigated consequences specified for all the postulated CHA event scenarios are conservative estimates with respect to the AA. The actual mitigation results are finalized during the AA.

In accordance with DOE-STD-3009-94 [Ref. 4], SIHs are not typically evaluated, and are evaluated only to the extent that they could act as initiators and contributors to event scenarios that result in a radiological or chemical release.

5.2.1.1 Radiological Hazards and Potential Consequences

Radiological hazards and their potential consequences have been evaluated and are documented in Section 9.4. These postulated event scenarios represent qualitative (estimated) unmitigated consequences due to specific upset conditions. The consequences are evaluated against the LANL and DOE criteria for selection of design basis accidents.

5.2.1.2 Chemical Hazard

The hazards from chemicals contained in the waste have been determined as being low at TA-54, Area G, and are therefore not considered in this CHA. An evaluation was performed [Ref. 15] on the chemical information obtained from 2,890 drums of MLLW and hazardous chemicals stored in TA-54, Area G. Through the sorting process, 179 hazardous chemicals were identified. Their inventories were compared with the 40 CFR 302.4 reportable quantities (RQs) and the LANL 30 m threshold quantities (TQs) (Refs. 16 and 17). Based on the comparison, 58% of the chemicals were screened out. The remaining 42% (58 chemicals) have no values of RQs and TQs at 30 m for comparison. However, they were also screened out because their quantities were either small (< 40-lb exemption under 40 CFR 355 [Ref. 17] total planning quantity), or by comparison with other chemicals with large quantities with similar properties that were also screened out. From this study, chemical hazards in the hazard identification have been screened as a SIH. The MLLW, due to the waste streams, bounds all chemical constituents anticipated in TRU waste.

A large number of different radionuclides are present in the waste materials, with the primary concern being the transuranics (represented by $^{239}\text{Pu}$-) and H3. The chemical toxicity of the $^{239}\text{Pu}$ analyzed by this CHA would bound all the chemicals studied above. Therefore, the chemical hazards associated with TRU waste are screened as SIHs, as the controls associated with protecting all receptors from radiological hazards also protect from chemical hazards.

5.2.2 Unmitigated Hazard Analysis

The unmitigated HA documents the hazards of the facility, identifies and documents common SIHs, identifies and groups unmitigated event scenarios, and bins these event scenarios according to risk without regard for any safety controls or safety management programs. DOE-STD-5506-2007 [Ref. 9] provides a list of the minimum set of event scenarios related to TRU waste operations that must be addressed in the HE. DOE-STD-3009-94 [Ref. 4] provides guidance for hazard and event scenarios related to non-TRU waste operations that must be addressed in the HE. The results of the CHA are documented in the HE Tables in Section 9.4. Information contained in these tables and obtained during this HA includes the following:

- Event Scenario Number
- Description
  - Locations
- MAR
- Release mechanisms
- Assumptions
- Causes
- Unmitigated system effects
- Methods of detection

- Unmitigated event evaluation
  - Risk
  - Unmitigated event frequency
  - Unmitigated event consequences
  - Unmitigated risk rank

- Preventive and mitigative features
  - Engineered
  - Administrative

- Qualitative mitigated risk ranks

- Notes, references, and reminders

5.2.2.1 Event Scenario Number

Event scenario numbers were assigned according to applicable TA-54, Area G Operations/Activities within an event category, and finally to a number within that specific event category. For example, the first scenario (001) is a fire event (event category E-1) for RANTTOG activities (e.g., movement of TRU waste between TA-54, Area G and RANT) and would, therefore, be numbered RANTTOG-1-001. All CHA results are documented in the HE Tables in Section 9.4.

TA-54, AREA G OPERATIONS/ACTIVITIES:

TRU waste

- AGTRU – All above-ground TRU waste activities
- BGTRUCMP – Below-ground CMP waste retrieval activities
- BGTRUCSK – Below-ground Trenches A through D waste retrieval activities
- BGTRUPIT – Below-ground Pit 9 waste retrieval activities
- BLDG412 – Activities associated within Building 54 – 412
- RANTTOG – Activities associated with TA-54, Area G to RANT, to TA-54, Area G transportation activities
- TRU H3 – Activities that reflect TRU waste/H3 contaminated waste activities/interaction
- TRU LLW - Activities that reflect TRU waste/LLW waste activities/interaction
Non-TRU waste

- H3 – H3 contaminated waste activities
- LLW – Low-level waste activities

EVENT CATEGORY:

- E-1 Fire
- E-2 Deflagration (Explosion)
- E-3 Loss of Confinement/Containment/Spill
- E-4 Direct Exposure (Radiological)
- E-5 Criticality (Nuclear)
- E-6 External Hazards
- E-7 Natural Phenomena Hazard (NPH)

5.2.2.2 Description

This field gives a brief description of a postulated scenario that defines the event. The event scenario description details the upset process condition and the physical consequences of the upset. The description includes the event, the location, the release mechanism or other exposure mechanism, and the hazardous material or radiological MAR that may be affected by the event. Event scenarios may include a release of hazardous energy and/or material, personnel injuries, and loss of equipment or facilities. The scenarios cover possible events for a given hazard; from small-consequence events to reasonable worst-case conditions. Unlike “worst-case,” “reasonable worst-case” does not necessarily consider every parameter in its most unfavorable state.

The Cause field states the failure, error, and operational and/or environmental condition that initiated the release event. Causes may be hardware failures, human errors, unanticipated process states (e.g., change of composition), external disruptions (e.g., loss of power), etc. By identifying the causes of the postulated event, the CHAP team was able to better determine the initiating frequency and achieve a better understanding of potential preventive and mitigative features necessary for that event scenario.

The Unmitigated System Effects field describes the overall result to the system if the event were to occur in the absence of any attempt to prevent it. Since TA-54, Area G is an existing facility, this field was not used for the CHA.

The Method of Detection field indicates how the event occurrence would be detected, which could include worker sensory perception, alarms, vessel instrumentation, etc.

5.2.2.3 Unmitigated Event Evaluation

Unmitigated consequences include the estimated (qualitative) radiological and physical consequences to receptor groups from that event scenario. These two factors are combined to produce an unmitigated risk ranking that permitted the CHAP team to focus on those event scenarios that present the greatest risks to receptors:
1. **Risk** – Risk is a qualitative measure of the likelihood of event occurrence in combination with the potential consequences of the event. Risk can be estimated for each hazard type and receptor combination.

2. **Unmitigated Event Frequency** – Unmitigated event frequency is determined through a qualitative and/or semi-quantitative process that involved assigning a frequency level to each event identified that could result in a release of hazardous energy and/or material, personnel injuries, loss of equipment or facilities, or loss of production. Frequency levels and descriptions are outlined in Table 9.3-1, Section 9.3.

   The CHAP team qualitatively determined which frequency level was appropriate for a particular event scenario based on the event’s causes. Sources of frequency information included generic initiator frequency data, existing safety documentation, engineering calculations, generic failure rate data, and facility SME opinion. The existence of regulatory and/or Laboratory-required SMPs is acknowledged, but these SMPs were not used as a basis for lowering the unmitigated frequency estimates. The frequency level was recorded in the Unmitigated Frequency field of the HE Tables.

3. **Qualitative Event Consequences** – Qualitative event consequences are documented by specifying the effect on the receptors (described below). For CHA purposes, unmitigated consequences are defined as the dose or exposure at specified receptor locations that has been determined without taking credit for barriers or controls that could reduce the consequences. Consequences are a function of the type and characteristics of the hazard, the quantity released, the release mechanism, the relative location of the release, and any relevant transport characteristics. Laws of physics (e.g., ambient conditions, buoyancy, or gravity), or inherent features (e.g., physical properties, location, or elevation), operating individually or in combination, can contribute to the reduction of risk.

   Consequences can be determined from:
   
   a. Simple source term calculations
   b. Existing safety documentation
   c. Qualitative assessment supported by simple calculations

   The CHAP team utilized discretion, expertise, and knowledge of facility hazards to select one or more of the above methods appropriate for consequence determination.

   Consequence evaluation is the process of determining which of the consequence levels in Table 9.2-2 is relevant to the three receptors for a particular release event. Section 9.3, Table 9.3-2 gives the radiological consequence levels for the specified receptor locations. Receptors are as follows:

   - **Public**
     
     Public receptors are all the individuals outside the DOE site boundary. Table 9.3-2 in Section 9.3 identifies the consequence categories for the public that were used to assess the various consequence categories for the postulated event scenarios, consistent with LANL requirements.

   - **Collocated Worker**
     
     Collocated workers (CW) are workers outside the occupied area of the hazard. If there is no defined physical means of controlling the hazard or controlling access to the hazard, the location is assumed to be at the worst possible location, but no closer than 100 m to the hazard.

   - **Worker**
     
     Workers (W) are workers in the facility immediately adjacent to or in the occupied area of the hazard. “Occupied area of the hazard” refers to the...
area within the last possible means of physically controlling the hazard or controlling access to the hazard (i.e., building, fence, permanent chain with multiple warning signs, etc.).

For some event scenarios, it is expected that the quantitative AA in Section 3.4 of the TA-54, Area G BIO will result in calculated doses that are less than the consequences assigned in this CHA. These differences are a result of simplifying and conservative assumptions used herein. These situations are expected and will not invalidate the results of the CHA.

4. *Unmitigated Risk Rank* – After developing frequency and consequence estimates, the risk rank of each scenario is determined using the matrices given in Tables 9.3-1 and 9.3-2 of Section 9.3, and then listed in the HE Tables in Section 9.4. The risk ranking complies with the risk ranking methodology in DOE-STD-3009-94 [Ref. 4]. In addition, DOE-STD-5506-2007 [Ref. 9] provides a risk ranking process and associated control selection guidelines that provide a qualitative tool to facilitate discussion between cognizant SMEs, including facility and operational staff, to enhance the judgment process inherent in the selection of hazard controls. The numerical guidelines from the Standard are followed, but, as required, dose and frequency thresholds are not construed as risk acceptance criteria.

The risk ranking process bins the results of unmitigated hazards and AA for the Public, CW, and W. Table 9.3-2 of Section 9.3 identifies consequence levels and the risk evaluation guideline for each of these receptors.

Table 9.3-1 of Section 9.3 identifies risk ranking bins that consider the consequence rankings from Table 9.3-2, together with the postulated accident frequency. Based on these factors, an event scenario is ranked as Risk Rank I, II, III, or IV as described in Table 5.2-1 below.

<table>
<thead>
<tr>
<th>Risk Evaluation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>High Consequences and Anticipated or Unlikely Frequency</td>
</tr>
<tr>
<td>II</td>
<td>High Consequences and Extremely Unlikely Frequency. Moderate Consequences and Anticipated or Unlikely Frequency</td>
</tr>
<tr>
<td>III</td>
<td>High Consequences and Beyond Extremely Unlikely Frequency. Moderate Consequences and Extremely Unlikely Frequency. Low Consequences and Anticipated or Unlikely Frequency</td>
</tr>
<tr>
<td>IV</td>
<td>Moderate Consequences and Beyond Extremely Unlikely Frequency. Low Consequences and Extremely Unlikely and Beyond Extremely Unlikely Frequency</td>
</tr>
</tbody>
</table>

5.2.2.4 *Preventive and Mitigative Safety Features*

Preventive features reduce the frequency of an event scenario, prevent the release of hazardous material, or eliminate the hazard. Mitigative features reduce the consequence of an event scenario. Preventers and mitigators might include engineered features (e.g., SSCs), or ACs (e.g., procedures, policies, or
programs). Preventive and mitigative features, engineered features, and administrative features are listed in the HE Tables (Section 9.4) so that a distinction can be made between them.

Control selection methodology is based on DOE-STD-5506-2007 [Ref. 9] criteria as shown in the Controls Selection Criteria (see Table 9.3-1):

- Unmitigated Risk Rank IV event scenarios to all receptors do not require safety controls.
- Unmitigated Risk Rank III event scenarios to all receptors are generally protected by SMPs.
- Unmitigated Risk Rank I and II event scenarios to all receptors require at least safety-significant SSCs and/or Administrative Controls (ACs). Event scenarios that are High to the Public require safety-class SSCs, SACs, and/or ACs that perform a safety function that would be safety-class or safety-significant if the function were provided by an SSC.

Controls not specifically credited for a safety function are reviewed for significant contribution as DID, and may be elevated to a safety control.

Initial Conditions (ICs) were identified to prevent or mitigate an event scenario, where applicable. These ICs may warrant some level of safety designation to ensure that the inputs and assumptions or analyses performed remain valid.

5.2.2.5 Qualitative Mitigated Risk Ranks

Mitigated risk includes the estimated frequency of event scenario occurrence, as well as the estimated radiological and physical consequences to receptor groups from that event scenario after controls are identified and credited. The effectiveness of a control to either reduce the frequency of an event scenario or to mitigate the consequences of that event scenario are combined to produce a qualitative mitigated risk ranking that permitted the CHAP team to evaluate the effectiveness of the proposed control suite and make adjustments where necessary to achieve the risk reduction objectives.

The initiating frequency level of the event scenario is modified with the reductions due to credited preventive features. The amount of frequency reduction is dependent on the estimated effectiveness of the selected controls. Typically, preventive SSCs are credited with a greater frequency reduction than preventive ACs. In those event scenarios where a robust preventive control can be selected, thereby preventing a radiological release, then the mitigated frequency is shown as Prevented.

The unmitigated consequence level of the event scenario is modified with the reductions due to credited mitigative features. The amount of consequence reduction is dependent on the estimated effectiveness of the selected controls. Typically, mitigative SSCs are credited with a greater consequence reduction than mitigative ACs.

Based on the combination of estimated prevented frequency levels and mitigated consequence levels, the event scenarios are binned in the same manner as during the unmitigated analysis. The mitigated risk bin determined in this manner was used by the CHAP team to estimate the effects of the preventive and mitigative controls.

5.2.2.6 Notes, References, and Reminders

These three optional fields are provided at the bottom of the HE Table (Section 9.4), and allowed the CHAP team to record information regarding the development of the event scenario, provide clarification.
of the material released, identify any action items that require follow-up, etc. This information was useful in preparing this final CHA report and for preparing the BIO.

5.2.3 Mitigated Hazard Analysis/Control Strategy Development

The control selection process identifies the engineered and administrative controls that are specifically credited with reducing the risk of the analyzed event scenarios determined to be Risk Rank I, II, or III. The selected controls are consistent with the preferred or alternate control selection in DOE-STD-5506-2007 [Ref. 9] for each event scenario. In some cases, control selection was based on implementation and effectiveness balanced against the limited lifetime of the facility. Any selected control (e.g., SSC, SAC, AC, or SMP) is considered to have at least a safety-significant function and is addressed by a TSR. Safety-significant controls are identified in Chapter 3.

As a general philosophy, controls were credited to reduce frequency or consequence when required to do so to meet risk ranking goals. However, the risk ranking was not used as a limit to preclude further control selection if an available control could significantly reduce risk further. These additional controls are identified in the HE Tables (Section 9.4) as significant risk reducers with the identifier DID, but may not be explicitly credited with a reduction in frequency or consequence. This approach is consistent with the DID philosophy and results in a robust set of controls.

In general, in determining the amount of credit given to a control, the following criteria were used:

- Engineered SC features are considered to reduce the consequence by a maximum factor of 1.0. Engineered SS or DiD features are considered to reduce the consequence by a maximum of 1.0 risk bin when used in conjunction with an AC or SAC that specifically supports the ability of the design feature to perform its function.

- A single SAC may reduce the scenario frequency/consequence by a maximum factor of 1.0 risk bin. Depending on the effectiveness of the SAC in relation to the accident scenario, a factor of 0.50 may be applied in some cases to be conservative. Depending on the frequency and/or consequences of an event, several SACs controls working together may be judged as sufficient to prevent or mitigate the event.

- The SMPs provide for event scenario risk reduction. These SMPs are significant contributors to the defense-in-depth strategy for all TRU and non-TRU event scenarios and contribute to the overall risk reduction for the facility. Therefore, they are significant contributors to DID risk reduction.

5.2.4 Available Area G Safety Management Programs (SMPs)

5.2.4.1 Unreviewed Safety Question Program

The Unreviewed Safety Question (USQ) program shall be implemented and maintained in accordance with the approved LANL Unreviewed Safety Question procedure [Ref. 18]. Annually, as required by 10 CFR 830.203 [Ref. 19], a summary of all USQ determinations for changes that have been implemented since the last submittal shall be submitted to DOE. Additionally, all approved USQs will become part of the safety basis and will be incorporated during the Area G BIO update process.

5.2.4.2 Emergency Preparedness Program
An emergency preparedness program is established, implemented and maintained at TA-54, Area G in accordance with LANL requirements. The program addresses emergency preparedness planning, including activation of emergency organizations, assessment actions, notification processes, emergency facilities and equipment, protective actions, training and exercises, and recovery actions. The program also relies on adverse conditions being recognized by workers and reported to the Operations Center, which notifies facility and site personnel and helps to direct the response.

5.2.4.3 Nuclear Criticality Safety Program

The Nuclear Criticality Safety Program is implemented to preclude inadvertent nuclear criticality at TA-54, Area G. General limits and controls are applied to fissionable material operations to ensure subcritical configurations under all normal and credible abnormal conditions. The LANL Nuclear Criticality Safety Program is established, implemented, and maintained for TA-54, Area G operations in accordance with LANL requirements. The Nuclear Criticality Safety Program establishes requirements for process-specific criticality safety evaluations and emergent nuclear criticality safety issues (e.g., special disposal conditions, safety evaluations, limits, repackaging, or SSSR activities that combine drum contents).

5.2.4.4 Fire Protection Program

A Fire Protection Program is established, implemented, and maintained in accordance with LANL requirements. This program develops and maintains fire protection (e.g., proper housekeeping; control of combustibles; control of ignition sources; control of cutting, welding, and other hot work) and fire control measures (e.g., detection and alarm systems as available, fire watches, fire-fighting equipment, fire-fighting personnel and responsibilities) for the protection of personnel and structures within TA-54, Area G. The Fire Protection Program provides information on the interface relationships between the Laboratory, the Los Alamos County Fire Department, and the National Nuclear Security Administration (NNSA).

The objective and purpose of the LANL fire protection program is to minimize the potential for the occurrence of a fire or fire-related event; injury or loss of life from fire or a fire-related event; fires that cause an unacceptable onsite or offsite release of hazardous or radiological material that could impact the safety and health of employees, the public, or the environment; unacceptable interruption of a DOE and/or NNSA-designated vital program, or loss of a LANL-designated mission-critical program or activity, as a result of a fire or fire-related event; property loss from a fire or fire-related event exceeding the defined limits established by LANL; and fire damage to critical processes, safety controls, and SSCs as established by the safety analysis. The program also ensures a yearly review of the TA-54, Area G facility, at a minimum, by the fire protection engineer (FPE). The following are elements of the Fire Protection Program:

- Ignition source controls are established within defined areas.
- When used for maintenance activities, acetylene gas cylinders are equipped with flashback arrestors.
- Non-combustible pallets are used for TRU metal container storage.
- Solid transient combustible controls are established (e.g., periodic inspections for housekeeping to minimize solid transient combustibles, vegetation control).

5.2.4.5 Radiation Protection Program
A Radiation Protection Program is established, implemented, and maintained in accordance with LANL requirements. These documents comply with the requirements of 10 CFR 835, *Occupational Radiation Protection* [Ref. 20]. The Radiation Protection Program evaluates radiological conditions and processes for worker protection. Radiation protection training helps ensure that radiation doses are maintained ALARA at the TA-54, Area G site. The following element of the Radiation Protection Program is implemented by procedures:

- Venting of unvented drums will be performed within a contamination-controlled environment.

### 5.2.4.6 Maintenance Program

A program shall be implemented to ensure that SSCs are maintained to meet the performance criteria, functional requirements, and the safety functions established in the approved safety basis and associated engineering documentation.

The maintenance program is implemented to ensure that facility SSCs are maintained and controlled so they continue to provide the safety functions, functional requirements, and performance criteria credited in the BIO. In-service inspections (ISIs) are covered under the maintenance program and are implemented to provide reasonable assurance that the DFs are inspected at a frequency sufficient to demonstrate that they continue to meet the credited safety functions, functional requirements, and performance criteria of the BIO. Section 6 of the TSRs describes the required ISIs and their frequency for each DF. Facility procedures may determine additional inspections and/or the respective frequencies at which they need to be performed. The maintenance program ensures that structural or functional degradation is detected to permit corrective action before the function of the SSC is compromised. The maintenance program may be implemented, as appropriate, by LANL-wide methods such as the system health reporting process (AP-341-802, or successor documents [Ref. 21]).

The TA-54, Area G Maintenance Program is established and maintained in compliance with the DOE-approved Laboratory Procedure P950, *Conduct of Maintenance*, or successor document, which asserts compliance with DOE Order 433.1B, *Maintenance Management Programs for DOE Nuclear Facilities* and provides details of the program and its implementation. A graded approach is applied towards implementing the requirements of the Order. Maintenance activities include all necessary supporting functions for ensuring that the facility continues to operate normally. Maintenance is a critical function to ensure reliability.

1. Periodic inspection and maintenance of LANL vehicles and equipment (e.g., forklift and transportation truck).

### 5.2.4.7 Configuration Management Program

The Configuration Management Program is established, implemented and maintained for TA-54, Area G in accordance with Laboratory requirements. The purpose of this program is to identify and document the technical baseline of configuration control items and to protect equipment integrity. Laboratory requirements ensure that changes to the technical baseline are properly identified, developed, assessed (technically reviewed and validated), approved, scheduled, implemented, and documented.

### 5.2.4.8 Quality Assurance Program
A Quality Assurance (QA) Program is established, implemented, and maintained at TA-54, Area G in accordance with LANL requirements. The QA Program establishes the process for procurement and maintenance to control the integrity and reliability of safety-class and safety-significant SSCs and implementation of SACs and other safety management programs.

5.2.4.9 Vehicle/Equipment Safety Controls

Vehicle/equipment safety controls shall be established, implemented, and maintained to ensure that defined areas are protected and that vehicles/equipment are maintained and operated in an effective but safe manner. The following are elements of the Vehicle/Equipment Safety Controls:

- Posted speed limit within TA-54, Area G is \( \leq 15 \) mph.
- Electric-powered vehicles/equipment are charged in locations where hydrogen gas does not accumulate (e.g., domes, ventilated enclosures, outdoors).
- Vehicles/equipment transporting MAR are not to be refueled. The change-out of a propane cylinder is not considered refueling.
- Vehicle crash barrier are placed around areas that are non-high risk locations where TRU waste is stored.

5.2.4.10 Conduct of Operations

A Conduct of Operations program is established, implemented, and maintained in accordance with LANL requirements (P315 [Ref. 1], or successor document). The Conduct of Operations program addresses areas such as operations organization; shift operating practices including training, turnover, and log-keeping; communications; investigations of abnormal events and notifications; lockout and tagout; and independent verification. Conduct of Operations addresses developing and implementing the controls needed to perform the work safely and securely.

5.2.4.11 Hazardous Material and Waste Management Program

Hazardous material and waste management controls shall be established, implemented, and maintained in accordance with LANL requirements, (PD 400 or successor documents). The program’s purpose is to control personnel exposure to hazardous materials by identifying and limiting contact with hazardous materials, adhering to established occupational exposure limits, implementing administrative and engineered controls (e.g., securing TRU waste containers during transport), and using personal protective equipment.

The following are elements of the hazardous material and waste management controls:

OVERPACK Control

1. TRU WASTE drums in degraded, suspect degraded, or damaged condition (i.e., not in a good and unimpaired condition) are overpacked.

TRU WASTE CONTAINER Inspection

2. TRU waste is packaged in structurally sound, noncombustible containers except as permitted in SSSR Areas or legacy waste (e.g., packaged in FRPs). The Facility implements procedures that
require operators to visually inspect TRU waste containers for integrity and/or vents when handling or transporting containers. These procedures require the identification of deficiencies and the implementation of appropriate corrective actions.

5.3 PRELIMINARY STRUCTURE, SYSTEM, AND COMPONENT CLASSIFICATION

The purpose for preliminary classification of SSC and administrative controls is to identify those controls that could be credited for risk reduction. The SSCs and administrative controls identified for the reduction of high consequences to the public are identified as SS and potential SACs (PSAC), respectively, in the Hazard Evaluation Tables in Section 9.4 of this Appendix. The AA will determine which SSCs or SACs are required to be credited as safety-class or safety-significant for public risk reduction.

The SSCs identified for worker protection are identified as safety-significant. The ACs identified for worker protection are identified as PSACs or SMPs, as appropriate. Safety-significant controls (SS or PSAC) that are specifically credited for worker protection are identified in the credited controls portion of each Hazard Evaluation Table.
6.0 RESULTS

6.1 HAZARD BASELINE DETERMINATION

Hazardous Material Inventory data is tabulated in Table 6.1-1 below. Based on the TQs established in DOE-STD-1027-92, Table a.1 [Ref. 6], the bounding Hazard Category (HC) for TA-54, Area G is a Nonreactor Nuclear Facility, HC-2.

<table>
<thead>
<tr>
<th>Building/Area/Location</th>
<th>Maximum TRU Waste Inventory</th>
<th>DOE-STD-1027-92 HC-2 TQ</th>
<th>DOE-STD-1027-92 HC-3 TQ</th>
<th>HC (DOE-STD-1027-92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-54, Area G Site (AGTRU)</td>
<td>≤ 57,000 PE-Ci</td>
<td>900 grams of Pu-239 or 56 PE-Ci</td>
<td>8.4 grams of Pu-239 or 0.52 PE-Ci</td>
<td>TA-54, Area G is considered a HC-2 facility</td>
</tr>
<tr>
<td>Below Grade Storage-(BGTRU)</td>
<td>≤ 115,000 PE-Ci</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA-54, Area G to RANT onsite transportation routes</td>
<td>≤ 1,100 PE-Ci</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 412</td>
<td>≤ 56 PE-Ci</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.2 HAZARD ANALYSIS

The CHAP was used to identify potential event scenarios applicable to the TA-54, Area G facility and to select potential control strategies that eliminate the hazards and resultant hazardous situations, reduce the likelihood of occurrence of the event, or mitigate the consequences of the event.

Based on the operations of the TA-54, Area G facility, event scenarios were analyzed for the following activities:

- AGTRU operations
- LLW/MLLW/H3 activities
- BGTRU operations (BGTRUCMP, BGTRUCSK, BGTRUPIT)
- BLDG 412
- Movement of TRU waste between TA-54, Area G and RANT (RANTTOG)

The CHA results are documented in the HE Tables in Section 9.4.

6.2.1 Results of Unmitigated Hazard Analysis

Based on the unmitigated frequency and consequence levels determined, each event scenario was binned in frequency-consequence space to assess relative risk according to Tables 9.3-1 and 9.3-2 in Section 9.3, and then listed in the HE Tables in Section 9.4. The risk ranking methodology is comparable to the risk ranking methodologies in DOE-STD-3009-94 [Ref. 4] and in DOE-STD-5506-2007 [Ref. 9]. The risk
rank is listed for the Public, CW, and W, and is used to determine risk ranking in both unmitigated and mitigated HE.

The CHAP team evaluated the bounding MAR for each applicable defined area, numbered and grouped the event scenarios, and assessed the existing control adequacy. Unique and representative event scenarios were chosen based on accident initiators, MAR values, and event frequency and consequences. Event scenarios with low consequences and low or minimal unmitigated risk (Risk Rank III or IV) were not evaluated further. Event scenarios with the highest consequences and risk to the public and workers (Risk Rank I or II) were evaluated. This information is provided in the HE Tables in Section 9.4.

### 6.2.1.1 Public (P) Risk Bins

Table 6.2-1 below summarizes the results of unmitigated risk binning for the Public. The risk bins in this table represent the bounding risk from the radiological or physical consequences for the TRU and non-TRU event scenarios taken from the HE Tables in Section 9.4. SIHs are not part of this table.

<table>
<thead>
<tr>
<th>Public Events - Physical</th>
<th>None</th>
</tr>
</thead>
</table>

### Public (I) Events - Radiological

<table>
<thead>
<tr>
<th>Public (II) Events - Radiological</th>
</tr>
</thead>
</table>
### Table 6.2-1 Public (P) Risk Bins

<table>
<thead>
<tr>
<th>Public (III) Events - Radiological</th>
<th>Public (IV) Events - Radiological</th>
<th>Public (NA) Events - Radiological</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGTRU-1-003, AGTRU-1-012, AGTRU-1-020, AGTRU-1-047, AGTRU-1-049, AGTRU-2-014, AGTRU-2-020, AGTRU-2-023, AGTRU-3-005, AGTRU-3-006, AGTRU-3-009, AGTRU-3-010, AGTRU-3-013, AGTRU-3-014, AGTRU-3-020, AGTRU-3-022, AGTRU-3-023, AGTRU-3-025, AGTRU-3-026, AGTRU-3-030, AGTRU-3-031, AGTRU-3-032, AGTRU-5-012, AGTRU-7-005, BGTRUCSK-2-001a, BGTRUCSK-2-006, BGTRUCSK-2-007, BGTRUCSK-2-008, BGTRUCSK-2-010, BGTRUCSK-3-019, BGTRUCSK-3-001, BGTRUCSK-3-002, BGTRUCSK-3-003, BGTRUCSK-3-004, BGTRUCSK-3-005, BGTRUCSK-3-007, BGTRUCSK-3-008, BGTRUCSK-3-009, BGTRUCSK-3-010, BGTRUCSK-3-011, BGTRUCSK-3-012, BGTRUCSK-3-013, BGTRUCSK-3-017, BGTRUCSK-6-001, BGTRUPIT-1-003, BGTRUPIT-1-004, BGTRUPIT-1-006, BGTRUPIT-1-007, BGTRUPIT-1-008, BGTRUPIT-1-009, BGTRUPIT-1-010, BGTRUPIT-1-011, BGTRUPIT-1-012, BGTRUPIT-1-013, BGTRUPIT-1-014, BGTRUPIT-1-018, BGTRUPIT-1-019, BGTRUPIT-1-022, BGTRUPIT-1-028, BGTRUPIT-1-029, BGTRUPIT-1-031, BGTRUPIT-1-032, BGTRUPIT-1-034, BGTRUPIT-1-036, BGTRUPIT-1-039, BGTRUPIT-1-040, BGTRUPIT-2-001, BGTRUPIT-2-004, BGTRUPIT-2-006, BGTRUPIT-2-009, BGTRUPIT-2-011, BGTRUPIT-2-012, BGTRUPIT-3-001, BGTRUPIT-3-014, BGTRUPIT-3-015, BGTRUPIT-3-018, BGTRUPIT-3-019, BGTRUPIT-3-022, BGTRUPIT-3-023, BGTRUPIT-3-024, BGTRUPIT-3-025, BGTRUPIT-3-027, BGTRUPIT-3-028, BGTRUPIT-3-029, BGTRUPIT-3-034, BGTRUPIT-3-038, BLDG412-1-003, BLDG412-1-005, BLDG412-1-006, BLDG412-1-008, BLDG412-1-010, BLDG412-1-012, BLDG412-1-013, BLDG412-1-014, RANTTOG-1-003, RANTTOG-1-004, RANTTOG-1-006, RANTTOG-2-001, TRU LLW-1-001</td>
<td>AGTRU-2-001, AGTRU-2-003, AGTRU-2-031, AGTRU-3-024, AGTRU-5-001, AGTRU-5-002, AGTRU-5-003, AGTRU-5-004, AGTRU-5-005, AGTRU-5-006, AGTRU-5-007, AGTRU-5-008, AGTRU-5-009, AGTRU-5-010, AGTRU-5-011, BGTRUCSK-5-001, BGTRUCSK-5-003, BGTRUPIT-5-001, BGTRUPIT-5-003</td>
<td>BGTRUCSK-5-002, BGTRUPIT-5-002, RANTTOG-5-001</td>
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TA-54, Area G
Los Alamos National Laboratory

6.2.1.2

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November 2014

Collocated Worker (C) Risk Bins

Table 6.2-2 below summarizes the results of unmitigated risk binning for the CW. The risk bins in this
table represent the bounding risk from the radiological or physical consequences for the TRU and nonTRU event scenarios taken from the HE Tables in Section 9.4. SIHs are not part of this table.

Table 6.2-2

Collocated (C) Worker Risk Bins

Collocated Worker Events - Physical
None
Collocated Worker (I) Events - Radiological
AGTRU-1-027, AGTRU-1-028, AGTRU-1-029, AGTRU-1-030, AGTRU-1-031, AGTRU-1-037, AGTRU-1-040, AGTRU-1041, AGTRU-1-044, AGTRU-1-073, AGTRU-1-074, AGTRU-1-076, AGTRU-1-080, AGTRU-2-008, AGTRU-2-012,
AGTRU-2-016, AGTRU-2-017, AGTRU-2-028, AGTRU-2-028a, AGTRU-2-030, AGTRU-2-032, AGTRU-2-034, AGTRU-2034a, AGTRU-2-036prev e-1, AGTRU-6-002, AGTRU-7-007, BGTRUCSK-1-003, BGTRUCSK-1-006, BGTRUCSK-1-007,
Collocated Worker (II) Events - Radiological
AGTRU-1-001, AGTRU-1-002, AGTRU-1-004, AGTRU-1-005, AGTRU-1-006, AGTRU-1-007, AGTRU-1-008, AGTRU-1009, AGTRU-1-010, AGTRU-1-011, AGTRU-1-013, AGTRU-1-014, AGTRU-1-015, AGTRU-1-016, AGTRU-1-017,
AGTRU-1-018, AGTRU-1-019, AGTRU-1-021, AGTRU-1-022, AGTRU-1-023, AGTRU-1-024, AGTRU-1-025, AGTRU-1026, AGTRU-1-032, AGTRU-1-033, AGTRU-1-034, AGTRU-1-039, AGTRU-1-042, AGTRU-1-043, AGTRU-1-045,
AGTRU-1-046, AGTRU-1-048, AGTRU-1-050, AGTRU-1-051, AGTRU-1-052, AGTRU-1-053, AGTRU-1-054, AGTRU-1055, AGTRU-1-056, AGTRU-1-057, AGTRU-1-058, AGTRU-1-060, AGTRU-1-062, AGTRU-1-064, AGTRU-1-066,
AGTRU-2-014, AGTRU-2-015, AGTRU-2-018, AGTRU-2-019, AGTRU-2-021, AGTRU-2-022, AGTRU-2-024, AGTRU-2025, AGTRU-2-029, AGTRU-2-033, AGTRU-2-035prev e-1, AGTRU-3-001, AGTRU-3-002, AGTRU-3-003, AGTRU-3-004,
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TRU H3-1-004, TRU H3-1-005, TRU H3-1-006, TRU H3-1-007, TRU H3-1-008, TRU LLW-1-002, TRU LLW-3-001
Collocated Worker (III) Events - Radiological
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BGTRUCSK-3-011, BGTRUCSK-3-012, BGTRUCSK-3-013, BGTRUCSK-3-017, BGTRUCSK-6-001, BGTRUPIT-1-003,

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Appendix 3H

3H-28


### Table 6.2-2  Collocated (C) Worker Risk Bins

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6.2.1.3 Worker (W) Risk Bins

Table 6.2-3 below summarizes the results of unmitigated risk binning for the W (personnel in the facility closest to the hazard). The risk bins in this table represent the bounding risk from the radiological or physical consequences for the TRU and non-TRU event scenarios taken from the HE Tables in Section 9.4. SIHs are not part of this table.

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Table 6.2-3 Worker (W) Risk Bins

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### Table 6.2-3  Worker (W) Risk Bins

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6.3 PRELIMINARY CLASSIFICATION

6.3.1 Control Strategy Development

Control strategies are developed for the event scenarios that were determined to present high risk (Risk Rank I and II event scenarios). The SSCs and ACs that function to maintain the facility in a safe configuration and to protect the Public, CWs, Ws, and the environment were identified. The CHAP team examined each event scenario and identified those safety functions that are required to prevent or mitigate a release of radiological material.

For offsite Public protection, safety-class SSCs, SACs (where appropriately justified in accordance with DOE-STD-1186-2004 [Ref. 22]), and TSRs are required for radiological event scenarios that challenge 10 rem Total Effective Dose (TED) offsite (regardless of frequency) in accordance with DOE-STD-5506-2007 [Ref. 9]. Event scenarios resulting in unmitigated high offsite radiological consequences must be evaluated. A set of unique and representative event scenarios is identified to encompass that entire suite of high-consequence events. This set of unique and representative event scenarios is submitted for quantitative AA and confirmation of the functional classification as safety-class controls. Safety-significant controls may also be warranted for protection of the Public.

Several unmitigated event scenarios fell into Risk Rank I and II as shown in Table 9.3-1; therefore, safety-class/safety-significant controls may be required. For most unmitigated event scenarios that fall in Risk Rank I/II, credited controls were selected to drive the risk to Risk Rank III, or sometimes Risk Rank IV. It should be noted that the control selection for some Risk Rank I/II unmitigated event scenarios did not reduce the frequency or consequence. These event scenarios are then subject to risk acceptance. Controls selected for event scenarios that are designated safety-significant in Section 9.4, HE Tables, are summarized in Section 9.5, Table 9.4-3. DOE-STD-5506-2007 [Ref. 9] provides a risk ranking process and associated control selection guidelines that collectively give a qualitative tool to facilitate discussion between SMEs, facility staff, and operational staff to enhance the judgment process inherent in selection of hazard controls. Some safety-significant controls credited with providing a preventive function at the start of the event scenario may be designated as an IC. No ICs were identified as potential safety-class. The ICs are not credited as frequency or consequence reducers, as they preserve the assumed conditions of the postulated accident. These controls are designated as IC in Section 9.4, HE Tables, and may require protection in the TA-54, Area G Safety Basis.

In addition, some postulated event scenarios qualitatively show that the unmitigated consequences to the Public are Moderate and unmitigated consequences to the CW are High. These unique event scenarios were submitted for AA for determination of potential credited controls.

6.4 UNIQUE AND REPRESENTATIVE EVENT SCENARIOS

The results of the CHA are used to identify the set of unique and representative event scenarios to be selected for further evaluation for the TA-54, Area G Safety Basis. Based on the unmitigated HA, some event scenarios had sufficiently high-consequence estimates that challenged (the CHAP team used 10 rem), or even exceeded, the offsite evaluation guideline (EG) of 25 rem and represent situations of major concern to the Public. DOE-STD-3009-94 [Ref. 4] states

... that unique accidents are those with sufficiently high-risk estimates that individual examination is needed (e.g., a single fire whose specific parameters result in approaching the EG, situations of major concern). In addition, representative accidents bound a number of similar accidents of lesser risk (e.g., the worst fire for a number of similar fires).
Representative accidents are examined to the extent they are not bounded by unique accidents. In any case, at least one bounding accident from each of the major types determined from the CHA (e.g., fire, explosion, spill, etc.) should be selected unless the bounding consequences are “Low”. Accidents are identified and listed by accident category (i.e., internally and externally initiated) and type (e.g., fire, explosion, spill, etc.).

Unique and representative event scenarios from these event types (i.e., fire, deflagration, loss of confinement, external, and NPH) for TRU facility operations were selected for the AA. These event scenarios are shown below in Table 6.3-1.

Representative event scenarios bound a number of similar event scenarios of equal or lesser risk (e.g., the worst pool fire event scenario bounds and represents a group of similar fires). Grouping event scenarios as “similar” means that the MAR values, accident initiators, and unmitigated frequency and consequences in the grouping correlate well. Unique event scenarios are events that require individual examination because they involve a set of controls different from events of the same type (e.g., pool fires versus vehicle accidents, deflagrations during handling or transportation), or because they individually represent a major risk concern. Some event scenarios that have safety-significant controls do not warrant further analysis. TA-54, Area G TRU event scenarios by event type that were identified as the unique and representative event scenarios are summarized in Table 6.3-1. In addition, event scenarios that were qualitatively analyzed to be bounded by specific event scenarios are shown with the corresponding Unique and Representative Events scenario, if applicable. It should be noted that, upon refined analysis (AA), additional consolidation may be possible to further reduce the number of unique and representative event scenarios identified in the report. Specific event scenario details are shown in Section 9.4.

Table 6.3-1  Unique and Representative Event Scenarios Forwarded for Accident Analysis

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<td>AGTRU-1-027, AGTRU-1-028, AGTRU-1-029, AGTRU-1-030, AGTRU-1-073, AGTRU-1-074, AGTRU-1-080, BGTRUCMP-1-002, BGTRUPIT-1-005, BGTRUPIT-1-023, BLDG412-1-005, RANTTOG-1-007, RANTTOG-1-008, RANTTOG-1-009, RANTTOG-1-010, RANTTOG-1-011, RANTTOG-1-012, TRU LLW-1-002, H3-1-012</td>
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Table 6.3-1  Unique and Representative Event Scenarios Forwarded for Accident Analysis

<table>
<thead>
<tr>
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<tr>
<td>AGTRU-1-044</td>
<td>AGTRU-1-046, AGTRU-1-070, AGTRU-1-076, AGTRU-1-083, BGTRUCSK-1-011, BGTRUPIT-1-020, BGTRUPIT-1-040, BLDG412-1-014</td>
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<td>AGTRU-1-072</td>
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<tr>
<td>AGTRU-1-081</td>
<td>AGTRU-1-082</td>
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<tr>
<td>BGTRUCSK-1-003</td>
<td>AGTRU-1-040, AGTRU-1-045, AGTRU-1-053, AGTRU-1-060, AGTRU-1-062, BGTRUCSK-1-005, BGTRUCSK-1-016</td>
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<td>BGTRUCSK-1-007</td>
<td>BGTRUCSK-1-006</td>
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<td>BGTRUCSK-1-008</td>
<td>AGTRU-1-037, AGTRU-1-043, AGTRU-1-047, AGTRU-1-049, AGTRU-1-051, AGTRU-1-064, BGTRUCSK-1-009, BGTRUCSK-1-012, BGTRUPIT-1-034, BGTRUPIT-1-035</td>
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<td>BGTRUPIT-1-002</td>
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<td>BGTRUPIT-1-017</td>
<td>BGTRUPIT-1-027</td>
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**Deflagration (E-2)**

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<td>AGTRU-2-007</td>
<td>AGTRU-2-011, AGTRU-2-017, AGTRU-2-018, AGTRU-2-019, AGTRU-2-021, AGTRU-2-022, AGTRU-2-023, AGTRU-2-033, BGTRUCSK-2-008,</td>
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<tr>
<td>AGTRU-2-008</td>
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</tr>
<tr>
<td>AGTRU-2-012</td>
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<tr>
<td>AGTRU-2-028a</td>
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<td>AGTRU-2-030</td>
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<td>AGTRU-2-032</td>
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### Table 6.3-1 Unique and Representative Event Scenarios Forwarded for Accident Analysis

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<tr>
<td>BGTRUCSK-2-002</td>
<td>BGTRUCSK-2-003, BGTRUCSK-2-004, BGTRUCSK-2-006, BGTRUCSK-2-017, BGTRUPIT-2-002, BGTRUPIT-2-006</td>
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<td>BGTRUCSK-2-005</td>
<td>BGTRUPIT-2-005</td>
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<td>BGTRUCSK-2-007</td>
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<td>BGTRUCSK-2-011</td>
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<td>BGTRUCSK-2-014</td>
<td>AGTRU-2-013</td>
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<tr>
<td>BGTRUPIT-2-011</td>
<td>AGTRU-2-006, AGTRU-2-029, BGTRUCSK-2-009, BGTRUCSK-2-010</td>
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<tr>
<td>RANTTOG-2-001</td>
<td>AGTRU-2-024, BGTRUCSK-2-012, BGTRUPIT-2-012</td>
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#### Loss of Confinement/ Containment/ Spill

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<tr>
<td>Loss of Confinement (E-3)</td>
<td>AGTRU-3-012</td>
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<td>AGTRU-3-016</td>
<td>AGTRU-3-008, AGTRU-3-015, AGTRU-3-026, AGTRU-3-027, BGTRUCSK-3-008, BGTRUCSK-3-010, BGTRUPIT-3-008, BGTRUPIT-3-016, BGTRUPIT-3-026</td>
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<tr>
<td>AGTRU-3-019</td>
<td>AGTRU-3-020, AGTRU-3-024, AGTRU-3-025, BGTRUCSK-3-007, BGTRUCSK-3-012, BGTRUCSK-3-017, BGTRUPIT-3-021, BGTRUPIT-3-022, BGTRUPIT-3-023</td>
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<td>AGTRU-3-017</td>
<td>AGTRU-3-005, AGTRU-3-006, AGTRU-3-007, AGTRU-3-009, AGTRU-3-014, AGTRU-3-022, AGTRU-3-030, AGTRU-3-037, AGTRU-3-040, AGTRU-3-041, BGTRUCMP-3-013, BGTRUCSK-3-002, BGTRUCSK-3-003, BGTRUCSK-3-004, BGTRUCSK-3-005, BGTRUCSK-3-006, BGTRUCSK-3-011, BGTRUCSK-3-013, BGTRUCSK-3-005, BGTRUPIT-3-006, BGTRUPIT-3-007, BGTRUPIT-3-015, BGTRUPIT-3-018, BGTRUPIT-3-019, BGTRUPIT-3-024, BGTRUPIT-3-027, BGTRUPIT-3-028, BGTRUPIT-3-029, BGTRUPIT-3-034, BGTRUPIT-3-035, BGTRUPIT-3-036, BGTRUPIT-3-037, BGTRUPIT-3-038, BGTRUPIT-3-039, LLW-3-007, LLW-3-008, LLW-3-009, LLW-3-010, LLW-3-012, LLW-3-015</td>
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#### Direct Exposure

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<th>Unique and Representative Events</th>
<th>Bounded Events</th>
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<tr>
<td>Direct Exposure (E-4)</td>
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#### Criticality

<table>
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<th>Event Type</th>
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</thead>
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<td>Criticality (E-5)</td>
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Table 6.3-1  Unique and Representative Event Scenarios Forwarded for Accident Analysis

<table>
<thead>
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<th>Unique and Representative Events</th>
<th>Bounded Events</th>
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<td>External (E-6)</td>
<td>AGTRU-6-001, BGTRUCSK-6-001, BGTRUPIT-6-001</td>
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<td>AGTRU-6-002</td>
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<tr>
<td>Natural Phenomena Hazard (NPH)</td>
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<tr>
<td>NPH (E-7)</td>
<td>AGTRU-7-002a, AGTRU-7-001, AGTRU-7-002, BGTRUCSK-7-001, BGTRUPIT-7-001</td>
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<td>AGTRU-7-007</td>
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</tr>
<tr>
<td>BGTRUPIT-7-002</td>
<td>BGTRUPIT-7-001, BGTRUPIT-7-002</td>
<td>none</td>
</tr>
</tbody>
</table>

* SB-DO:CALC-11-023, Criticality Scenario Dose Consequences for Area G, determined that the conservative, unmitigated dose to the public would not challenge the Evaluation Guideline and controls beyond the use of the LANL Nuclear Criticality Safety Program are not required for protection of the public or collocated worker. No criticality events were carried forward as DBAs.

7.0 CONCLUSIONS

A comprehensive review of hazards associated with the TA-54, Area G Facility was performed utilizing the combination of HAZOP study and What-If techniques to identify possible process event scenarios. The hazards reviewed, including potential control strategies, were identified and are documented in the HE Tables in Section 9.4. The event scenarios identified in the HE Tables were reviewed to identify the limiting event scenarios for TA-54, Area G facilities. This evaluation considered the unmitigated consequences and the selected controls.

As evaluated, the offsite dose to the Public at the site boundary challenged the offsite EG (Risk Rank I and II) for several event scenarios. Therefore, safety-class SSC and/or AC controls may be required. Risk Rank III event scenarios are generally protected by SMPs. Event scenarios that are determined to be HIGH to the Public require safety-class SSC and/or AC controls. The CW and W doses from several event scenarios challenge or exceed the consequence level thresholds shown in Table 9.3-2 of Section 9.3 (Risk Rank I, II, or III). These event scenarios require safety-significant SSC and/or AC controls. Safety-significant SSCs and ACs are required to ensure that the consequences do not challenge the onsite EG, and also to further reduce the risk. These controls are shown in Chapter 3.
8.0 REFERENCES

1. ABD-WFM-001, Rev. 0, *TA-54 Area G Documented Safety Analysis*, Los Alamos National Laboratory, Los Alamos, NM.
2. ABD-WFM-002, Rev. 1.0, *Technical Safety Requirements (TSRs) for Technical Area 54 Area G*, Los Alamos National Laboratory, Los Alamos, NM.


### 9.0 TABLES AND EXHIBITS

#### 9.1 HAZARD IDENTIFICATION CHECKLIST

**Table 9.1-1 Hazard Identification Checklist – TA-54, Area G**

<table>
<thead>
<tr>
<th>Location</th>
<th>Electrical</th>
<th>Thermal</th>
<th>Open Flame</th>
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<td>(identifier for system, sub-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>system, or operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>feature in this facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>section)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA-54, Area G General</td>
<td>X X X X X X</td>
<td>X X</td>
<td>X X X X X</td>
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<tr>
<td>SSSR</td>
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<td>X X X X X</td>
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<td>TRU Characterization</td>
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<td>X X X X X</td>
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<td>TRU Venting</td>
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<td>X X X X X</td>
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<tr>
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<td>X</td>
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</tr>
<tr>
<td>Pit 9 Retrieval Area</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Trenches A-D Retrieval</td>
<td>X</td>
<td></td>
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<tr>
<td>Mobile Loading Operations</td>
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<tr>
<td>TRU Storage Areas</td>
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<td>X X X</td>
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<tr>
<td>Mesita del Buey Rd.</td>
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</tr>
<tr>
<td>LLW-MLLW-Tritium</td>
<td>X</td>
<td>X X X X</td>
<td>X X X</td>
</tr>
</tbody>
</table>

X = Refers to the hazards considered applicable

FOOTNOTES: 1) Lasers also associated with a Computer
### Table 9.1-1  Hazard Identification Checklist – TA-54, Area G

<table>
<thead>
<tr>
<th>Location</th>
<th>Hazardous Energy Sources and Materials</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Flammable</td>
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<td>Pyrophoric (Pu &amp; U Metal)</td>
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<td>SSSR</td>
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<tr>
<td>TRU Characterization</td>
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<tr>
<td>TRU Venting</td>
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</tr>
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<td>Building 412</td>
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<tr>
<td>CMP Retrieval Area</td>
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<tr>
<td>Pit 9 Retrieval Area</td>
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<tr>
<td>Trenches A-D Retrieval</td>
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</tr>
<tr>
<td>Mobile Loading Operations</td>
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<td>TRU Storage Areas</td>
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<td>Mesita del Buey Rd.</td>
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<tr>
<td>LLW-MLLW-Tritium</td>
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</tbody>
</table>

X = Refers to the hazards considered applicable

**FOOTNOTES:**
- Chemicals contained in waste are less than quantities which require accountability or are less than threshold values
- Flammable/combustible liquids on transport and personnel vehicles in TA-54, Area G are generally < 50 gallons per unit total capacity
- Propane is limited to ~ 40 gallons per unit located in forklifts fuel tanks
### Table 9.1-1  Hazard Identification Checklist – TA-54, Area G

<table>
<thead>
<tr>
<th>Location</th>
<th>Radioactive Material</th>
<th>Fissile Material</th>
<th>Non-Ionizing Radiation</th>
<th>Ionizing Radiation</th>
<th>Hazardous Materials</th>
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<td>TA-54, Area G-General</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>SSSR</td>
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<tr>
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<td>Pit 9 Retrieval Area</td>
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<td>Trenches A-D Retrieval</td>
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<td>Mobile Loading Operations</td>
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X = Refers to the hazards considered applicable

**FOOTNOTES:**

Chemicals contained in waste are less than quantities which require accountability or are less than threshold values.
### Table 9.1-1 Hazard Identification Checklist – TA-54, Area G

<table>
<thead>
<tr>
<th>Location</th>
<th>Kinetic - Linear and Rotational (Friction)</th>
<th>Potential (Pressure)</th>
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<td></td>
<td>Belts, Bearings, Cranes, Fork Lifts, Cars, Dollys, Drills, Shears, Fans, Gears, Motors, Power Tools, Other (turntable, doors)</td>
<td>Gas Receivers, Coiled Springs, Pressure Vessel He²³, Heated Surge Tanks, Boilers, Autoclaves, Furnaces, Stressed Members, Fire Headers/Line, Other</td>
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<td>X</td>
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<td>SSSR</td>
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X = Refers to the hazards Considered applicable

**FOOTNOTES:**

None
### Table 9.1-1  Hazard Identification Checklist – TA-54, Area G

<table>
<thead>
<tr>
<th>Location</th>
<th>Hazardous Energy Sources and Materials</th>
<th>Natural Phenomena</th>
<th>Vehicles in Motion</th>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mobile Loading Operations</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TRU Storage Areas</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mesita del Buey Rd.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>LLW-MLLW-Tritium</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

X = Refers to the hazards considered applicable

FOOTNOTES:

None
9.2  TA-54, AREA G GEOLOGICAL INVENTORY

9.2.1  Radiological Inventories

A large number of different radionuclides are present in the waste materials at TA-54, Area G. The radionuclides of primary concern are the transuranics and H3. This section describes the radiological inventories, along with background information on the various forms and types of TRUs and H3 used in Section 9.3. Some trace fission products are also present in the waste; however, the quantities are too low to require further evaluation and controls separate from TRU waste. These products are less of a concern because they are disposed of in pits and shafts and not a major component of surface storage. A summary of the bounding radiological inventories is shown in Table 9.2-1.

Most radiological material is packaged and confined inside metal waste containers. Certain large waste components are packaged in metal or FRP containers. A detailed description of each major waste container type and their handling/disposition in TA-54, Area G is shown in Chapter 2 of the BIO.

The MAR for each event scenario is estimated using the upper-bound MAR values listed in Table 9.2-1. The MAR is estimated as the amount of radiological material that can potentially be affected by the postulated event scenario. The MAR is generally estimated to be the quantity of material in the vicinity of the event without consideration of release mechanisms. The waste matrix used in the CHA is the same as that used in the AA, and is based upon statistical analysis of TA-54, Area G waste streams. In some cases, the MAR evaluated in the CHA is more conservative than the MAR used in source term calculations in the AA. This does not invalidate the HA, but does provide a mechanism for a particular hazard scenario to undergo a more thorough AA.

<table>
<thead>
<tr>
<th>Affected Location/Component</th>
<th>MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-54, Area G Site – Above-ground storage</td>
<td>( \leq 57,000 ) PE-Ci₁</td>
</tr>
<tr>
<td>Below Grade Storage (buried waste, including pits, shafts)</td>
<td>( \leq 111,000 ) PE-Ci²</td>
</tr>
<tr>
<td>Single TRU Waste Container – direct loaded</td>
<td>( \leq 553 ) PE-Ci</td>
</tr>
<tr>
<td>TRU Waste Container (55+-gal drums, SWBs or Ten-Drum Overpacks (TDOPs) as an overpack)</td>
<td>( \leq 1,100 ) PE-Ci</td>
</tr>
<tr>
<td>SWB or TDOP (Direct Loaded)</td>
<td>560 PE-Ci</td>
</tr>
<tr>
<td>Pipe Overpack Container (POC)</td>
<td>1,800 PE-Ci³</td>
</tr>
<tr>
<td>Truckload of TRU Waste Containers</td>
<td>1,100 PE-Ci</td>
</tr>
<tr>
<td>SSSR Activities</td>
<td>18 equivalent combustible PE-Ci, in-process, and 18 equivalent combustible PE-Ci staged in closed containers</td>
</tr>
</tbody>
</table>

Table 9.2-1  Upper-Bound Material-at-Risk Values for Hazard Analysis Consequence Estimates
Table 9.2-1  Upper-Bound Material-at-Risk Values for Hazard Analysis Consequence Estimates

<table>
<thead>
<tr>
<th>Affected Location/Component</th>
<th>MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 412 combined total within the building</td>
<td>≤ 56 PE-Ci</td>
</tr>
<tr>
<td>H3 Areas (TA-54, Area G above ground area and site totals)</td>
<td>≤ 4,000,000 Ci H₃</td>
</tr>
<tr>
<td></td>
<td>(1,000,000 Ci per area)</td>
</tr>
<tr>
<td>LLW Areas including Disposal Pit (total in exposed layers at TA-54, Area G site)</td>
<td>≤ 100 PE-Ci and ≤ 3,000 Ci H₃</td>
</tr>
<tr>
<td>LLW truckload</td>
<td>(≤ 35 PE-Ci and ≤ 3,000 Ci H₃)</td>
</tr>
<tr>
<td>Truckload-H3 contaminated waste Containers/Components</td>
<td>≤ 1,000,000 Ci H₃</td>
</tr>
<tr>
<td>CMP</td>
<td>≤ 11,000 PE-Ci⁴</td>
</tr>
<tr>
<td>Exposed shaft (cask lid off) in Trenches A through D</td>
<td>≤ 1,500 PE-Ci</td>
</tr>
</tbody>
</table>

¹ This is a bounding value for all above grade MAR at TA-54, Area G
² This is a bounding value for all below grade MAR at TA-54, Area G including TRU, LLW, and H3. No additional TRU MAR will be added to below grade storage so this MAR is not protected in the TSRs. Overburden and shaft covers protect the underground MAR. This is an IC.
³ The total TRU waste content in a single POC shall be no more than 1,800 PE-Ci. Only 10 percent of the POC content is applicable to the MAR for POCs (Ref. 9, Table 4.4.4-1).
⁴ Equivalent Combustible - That quantity of any other waste stream which would provide the equivalent source term (ST) as 2.5 Plutonium-239 Equivalent Curies (PE-Ci) of waste contained in a 100% combustible matrix at SSSR, or 56 PE-Ci of waste contained in a 100% combustible matrix in Building 54-412.

Statistical MAR values are identified in Chapter 3 of the BIO.

For each TRU waste container, the generator provides the quantity of radiological material by radioisotope. To represent the relative hazards presented by the different radioisotopes, the quantity of each radioisotope is converted into a single unit. The ²³⁹Pu PE-Ci, also referred to as the ²³⁹Pu equivalent curie, is generally recognized as the standard unit for expressing radiological material quantities for TRU waste and for evaluating the human health consequences of inhaling TRU releases. Process controls at TA-54, Area G include programs to convert MAR values of radionuclides in waste containers into the PE-Ci unit for MAR tracking.

9.2.2  Summary of Waste Container MAR Values Used During the Consolidated Hazard Analysis

Container contents and MAR values are required to be supplied by the waste generator in accordance with the LANL WAC. The MAR values that the CHA Team used were derived from a facility review of the TA-54, Area G Container Inventory Database, which is maintained to track the known amount of containerized radiological material upon receipt. Some MAR values for legacy BGTRU containers do not accurately show a MAR value, as the information at the time of receipt was not provided by the generator. Therefore, the highest known BGTRU MAR value was used for conservatism where applicable. Table 9.2-2 is a summary of the MAR values, by container type and defined area, that were used by the CHA Team. In accordance with the
guidance in DOE-STD-5506-2007 [Ref. 9], and where applicable, the highest known MAR value for a single container was used in the process activity or in transport. When multiple containers are involved in the event scenario, the MAR value reflects the four statistical high MAR containers, and the remaining container values are at the statistical mean. In other cases, the statistical mean, which includes the highest MAR, was used for the remaining quantity of required containers postulated in the event scenario.

Table 9.2-2 Material-at-Risk Values for AGTRU and BGTRU Event Scenarios

<table>
<thead>
<tr>
<th>Container Type and Location</th>
<th>MAR Value (PE-Ci)</th>
<th>MAR Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, metal(^1), AGTRU</td>
<td>553</td>
<td>Highest known single</td>
</tr>
<tr>
<td>Two (2) metal, AGTRU</td>
<td>609</td>
<td>Two (2) statistical highest (one at 553 and 1 at 56)</td>
</tr>
<tr>
<td>Four (4) metal, AGTRU</td>
<td>651</td>
<td>Four (4) statistical highest on one pallet</td>
</tr>
<tr>
<td>24 metal, Statistical Mean, AGTRU</td>
<td>748</td>
<td>Four (4) statistical highest and 20 statistical mean</td>
</tr>
<tr>
<td>48 metal, Statistical Mean, AGTRU</td>
<td>864</td>
<td>Four (4) statistical highest and 44 statistical mean</td>
</tr>
<tr>
<td>96 metal, Statistical Mean, AGTRU</td>
<td>1097</td>
<td>Four (4) statistical highest and 92 statistical mean</td>
</tr>
<tr>
<td>Single non-metal container, AGTRU</td>
<td>310</td>
<td>Highest single Fiberglas Reinforced Plywood</td>
</tr>
<tr>
<td>6 non-metal containers, AGTRU</td>
<td>855</td>
<td>Statistical FRPs</td>
</tr>
<tr>
<td>Single, metal(^2), Cask</td>
<td>750</td>
<td>Highest known includes 20% margin</td>
</tr>
<tr>
<td>Multiple metal(^3), Cask</td>
<td>7,500</td>
<td>10 drums (750 PE-Ci each) not overpacked removed from trench casks</td>
</tr>
<tr>
<td>Single, metal(^2), Pit 9</td>
<td>278</td>
<td>PIT waste container with 20% margin</td>
</tr>
<tr>
<td>Multiple, metal, Pit 9</td>
<td>336</td>
<td>Statistical MAR of 48 drums</td>
</tr>
<tr>
<td>One (1) Pit 9 Cell</td>
<td>2,055</td>
<td>70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)</td>
</tr>
<tr>
<td>Single CMP (^4)</td>
<td>200</td>
<td>Corrugated Metal Pipe</td>
</tr>
</tbody>
</table>

\(^1\) AGTRU waste was deemed sufficiently characterized, and therefore does not require the DOE-STD-5506-2007 (Section 4.3.2) assumption to increase the highest container MAR by 20% for single-container event scenarios.

\(^2\) BGTRU PIT and CASK waste are not sufficiently characterized, and therefore require the DOE-STD-5506-2007 [Ref. 9] assumption to increase the highest container MAR by 20% for single-container event scenarios.
The statistical data for BGTRU Cask event scenarios was not available at the time of the HA. Consequently, the CHA Team conservatively used the highest single container MAR and multiplied that value by the number of containers involved in the postulated event scenario.

The radiological waste contained in the CMPs was mixed in a cement matrix, poured into the CMP, and then caps were placed at each end. Therefore, the waste in the CMP is neither burnable nor dispersible and does not require the DOE-STD-5506-2007 [Ref. 9] assumption to increase the highest container MAR by 20% for single-container event CMP scenarios.

In general, TRU waste bounds H3-contaminated waste in terms of potential consequences from events. The MAR values in Table 9.2-1 were developed from current inventories, with some consideration of potential inventory limits that will be developed later in the AA. The values in the table are intended as conservatively high, upper-bound estimates to be used in the CHA. Lower inventory limits may be developed in the AA, where necessary, and could be different from the values in Table 9.2-1. This is because DOE-STD-5506-2007 [Ref. 9] provides methodologies for determining the MAR involved in an event scenario. Inventory restrictions that are required to protect assumptions in the AA are carried forward to the TSRs as required.

In addition to TRU waste quantities, Table 9.2-1 also provides the MAR values for LLW. Low-level waste (LLW) is defined at LANL as waste not classified as high-level waste, TRU waste, or spent nuclear fuel, and containing less than 100 nanoCuries per gram (nCi/g) of TRU radioisotopes. The LLW quantities in Table 9.2-1 are not based on reported data but are estimates developed from the 100 nCi/g limit and typical waste container weights. These estimates are based on $^{239}$Pu with respect to activity in the LLW. Thus, the quantities were derived in terms of curies of $^{239}$Pu or PE-Ci. The LLW can contain radioisotopes other than TRU radioisotopes; however, the primary waste streams at the Laboratory include mostly TRU waste. The quantities of non-TRU radioisotopes in the LLW streams contribute only minor public doses from credible accidents, since the percentage of non-TRU radioisotopes is significantly less than that of the TRU radioisotopes.
9.3 METHODOLOGY TABLES

Table 9.3-1 Qualitative Risk Ranking Bins

<table>
<thead>
<tr>
<th>Consequence Level</th>
<th>Beyond Extremely Unlikely (BEU) Below $10^{-6}$/yr</th>
<th>Extremely Unlikely (EU) $10^{-4}$ to $10^{-6}$/yr</th>
<th>Unlikely (U) $10^{-2}$ to $10^{-4}$/yr</th>
<th>Anticipated (A) $10^{-1}$ to $10^{-2}$/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Consequence</td>
<td>III</td>
<td>II</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Moderate Consequence</td>
<td>IV</td>
<td>III</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Low Consequence</td>
<td>IV</td>
<td>IV</td>
<td>III</td>
<td>III</td>
</tr>
</tbody>
</table>

Note: Industrial event scenarios that are not initiators or contributors to postulated event scenarios are addressed as SIH.

* For external event scenarios, frequencies of occurrence below $10^{-6}$/yr conservatively calculated or $10^{-7}$/yr realistically calculated are BEU.

Not Physically Plausible (NPP) is a term used in the HE tables (Section 9.4) to define the CHA Team’s unmitigated frequency evaluation of an event scenario. This acronym is used for the frequency of event scenarios that would require a unique combination of coincidental and independent conditions to occur. In theory, these events could happen; however, a number of assumptions that are obviously ridiculous and impossible would be required for the event scenario to occur.

Not Credible (NC) is a term which could be used in the HE Tables (Section 9.4) to define the CHA Team’s unmitigated frequency for external manmade event scenarios only.

Table 9.3-2 Consequence Levels and Risk Evaluation Guideline

<table>
<thead>
<tr>
<th>Consequence Level (Abbreviation)</th>
<th>Public</th>
<th>Collocated Worker (at 100 m)</th>
<th>Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (H)</td>
<td>Considerable offsite impact on people or the environment CHALLENGE 10 rem TED¹</td>
<td>Significant onsite impact on people or the environment $&gt; 100$ rem TED</td>
<td>For SS designation, consequence levels such as prompt death, serious injury, or significant radiological exposure must be considered.</td>
</tr>
<tr>
<td>Moderate (M)</td>
<td>Only minor off-site impact on people or the environment $\geq 1$ rem TED</td>
<td>Considerable on-site impact on people or the environment $\geq 25$ rem TED</td>
<td>No distinguishable threshold*</td>
</tr>
<tr>
<td>Low (L)</td>
<td>Negligible off-site impact on people or the environment $&lt; 1$ rem TED</td>
<td>Minor on-site impact on people or the environment $&lt; 25$ rem TED</td>
<td>No distinguishable threshold*</td>
</tr>
</tbody>
</table>

¹TED: Total Effective Dose
Public Minimally Exposed Offsite Individual:
- Offsite consequences that challenge 10 rem must be protected with SC controls independent of frequency. See Section 6.3 of DOE-STD-5506-2007 [Ref. 9] for further clarification of challenging the EG.
- For elevated releases, use location of highest dose.

Collocated Worker (at 100 meters):
- For elevated releases, use location of highest dose.

* Based on the CHA Methodology, the Team assigned lesser worker consequences where appropriate. The lower-consequence event scenarios (Moderate or Low) may be evaluated and any results identified in the Comments section for the hazardous condition. These lesser worker consequences are normally controlled through application of existing SMPs.

9.4 HAZARD EVALUATION TABLES

Table 9.4-1 Consolidated Hazard Analysis
## Hazard Evaluation Table - Event AGTRU-1-001

### Description:
A vehicle transporting a TRU waste container at ≤ 10 mph impacts stored waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste container in transport as well as the stored waste resulting in a release of radiological material. Two (2) stacks of twelve containers (4 drums x 3 tiers) collapse as a result of the impact. The remaining containers within the fuel pool are stacked to 3 tiers.

### Locations:
- TRU storage areas except BLDG 412

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Unmitigated Frequency:
EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

- **Engineered**
  - Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of ≤ 15 mph) with a gross weight of ≤ 150,000 lbs and a ground clearance of ≤ 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
  - Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

- **Admin**
  - Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment must be escorted along designated routes of travel except for emergency response vehicles)
  - Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
  - Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
  - Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
  - Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
  - Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

### Mitigative Features:

- **Engineered**
  - Hazardous Material and Waste Management - TRU Waste Container (Meta TRU waste container are of sound integrity)
  - Waste Packaging Control (Waste is packaged)

- **Admin**
  - Escort of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
  - Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers)</td>
</tr>
</tbody>
</table>
### High Risk Locations

must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches.

- The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

### Safety Function:

The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
<thead>
<tr>
<th>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</th>
<th>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</th>
<th>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PSAC Fire Protection - Thermal Separation Distance - Defined Area</th>
<th>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PSAC Fire Protection - Control of Transient Combustibles</th>
<th>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>---</td>
</tr>
</tbody>
</table>

### Mitigators

#### PSAC Fire Protection - Control of Transient Combustibles

Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.

#### PSAC Radiological Inventory Management - TRU Waste Drum Doublepack

Doublepack radiological waste drums ≥ 200 PEC

### Notes:

None

### References:

None

### DOE 5506 Detail:

- Fuel Pool Fire - Staging and Storage (1d)
- Collapse of Stacked Containers - Staging and Storage (11d)
Hazard Evaluation Table - Event AGTRU-1-002

Description:
A vehicle transporting multiple TRU waste containers at ≤ 10 mph impacts stored waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste containers in transport as well as the stored waste. Two (2) stacks of twelve containers (4 drums x 3 tiers) collapse as a result of the impact. The containers in transport are not stacked and the remaining stored containers within the fuel pool are stacked to 3 tiers.

Locations:
- TRU storage areas except BLDG 412

Release Mechanisms:
- Fuel pool fire release
- Low energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

Mitigative Features:

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
<th>DSA Mit.</th>
<th>Unmit.</th>
<th>DSA Mit.</th>
<th>Unmit.</th>
<th>DSA Mit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>H</td>
<td>II</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs
<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS Vehicle Barriers- High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventative safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

Notes: • A sensitivity study found that on a per PE-Ci basis, the consequences from a compliant container in a pool fire were bounded by those from a non-compliant container.
• Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
• It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
• The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506
Fuel Pool Fire - Staging and Storage (1d)
Collapse of Stacked Containers - Staging and Storage (11d)
## Hazard Evaluation Table - Event AGTRU-1-003

### Description:
Two (2) vehicles, one transporting a single TRU waste container and the other transporting multiple TRU waste containers, impact at < 10 mph. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport.

### Locations:
- **Area G**

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
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<td>W</td>
<td>M</td>
<td>III</td>
<td>L</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Preventive Features:
Engineered None

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)).
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)).
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation).
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)).
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity).
- (SS) (IC) Waste Packaging Control (Waste is packaged).

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles).
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport).

### Credited SSCs and ACs

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<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.

| Mitigators | PSAC | Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G | Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles | Rad: P, C, W; |

**Safety Function:** Reduces likelihood of fuel interaction with MAR

<p>| PSAC | Radiological Inventory Management - TRU Waste | Doublepack radiological waste drums ≥ 200 PEC | Rad: P, C, W; |</p>
<table>
<thead>
<tr>
<th><strong>Drum Doublepack</strong></th>
<th><strong>Safety Function:</strong> Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
</table>
| **Notes:**           | • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
• The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle). |
| **References:**      | None |
| **DOE 5506:**        | • Fuel Pool Fire - Container Handling (1b)  
• Fuel Pool Fire - Staging and Storage (1d) |
Hazard Evaluation Table - Event AGTRU-1-004

**Description:**
A vehicle transporting a TRU waste container at ≤ 10 mph impacts a V&P activity causing an impact to an unvented container with subsequent waste dispersal. Fuel is leaked and ignited resulting in a pool fire engulfing the waste resulting in the release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Container unvented or inadequately vented allowing the accumulation of internal pressure
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
EU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
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<tr>
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<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
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<td>H</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond</td>
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<td>Safety Function:</td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</strong></td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC Fire Protection - Thermal Separation Distance - Defined Area</strong></td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mitigators</strong></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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<td></td>
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<tr>
<td><strong>PSAC Fire Protection - Control of Transient Combustibles</strong></td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
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</tr>
<tr>
<td><strong>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</strong></td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
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<td></td>
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<td><strong>Safety Function:</strong></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
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</table>
| **Notes:** | ● Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.  
● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| **References:** | None |
| **DOE 5506 Detail:** | ● Fuel Pool Fire - Venting and/or Abating/Purging (1c) |
## Hazard Evaluation Table - Event AGTRU-1-005

**Description:**
A vehicle transporting multiple TRU waste containers at ≤ 10 mph impacts a V&P activity causing an impact to an unvented container with subsequent waste dispersal. Fuel is leaked and ignited resulting in a pool fire engulfing the waste resulting in the release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Area G</td>
<td>● 311 PEC (Statistical 48 metal containers (One vehicle load) without high MAR container)</td>
</tr>
<tr>
<td></td>
<td>● 553 PEC (One [1] TRU waste container in activity)</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
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<td>DSA Mit.</td>
<td>Unmit.</td>
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<td>H</td>
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<tr>
<td>W</td>
<td></td>
<td>H</td>
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</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers))
  - Must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- Waste Packaging Control (Waste is packaged)

**Admin**
- Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<tr>
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<td>Vehicle Barriers-High Risk Locations</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:**
The safety function is preventive when the vehicle barrier at a high-risk location reduces the...
likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

| PSAC Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | All |
| Safety Function: | Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas. |

| PSAC Fire Protection - Control of Transient Combustibles | Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited. | Rad: P, C, W; |


| Notes: | • Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR. • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. • The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. |

| References: | None |

| DOE 5506 Detail: | • Fuel Pool Fire - Venting and/or Abating/Purging (1c) |
Hazard Evaluation Table - Event AGTRU-1-006

Description:
A vehicle transporting multiple TRU waste containers at ≤ 10 mph is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. No additional waste is sufficiently close to the fire to be affected by heating.

Locations:
- Area G not adjacent to stored waste

Release Mechanisms:
- Fuel pool fire release
- Low energy impact

Assumptions:
None

Causes:
- Degraded/ inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Unmitigated Frequency: EU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</tbody>
</table>

Preventive Features:
Engineered: None

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back.).
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)).
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation).
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)).
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph).

Mitigative Features:
Engineered: None

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles).
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bidg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)).
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.).
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC).
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport).

Credited SSCs and ACs

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<td>Safety Function:</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
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<td>Safety Function:</td>
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<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Doublepack radiological waste drums &gt; 200 PEC</td>
<td></td>
</tr>
<tr>
<td>Drum Doublepack</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
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<td>-----------------</td>
<td>-------------------------------------------------------------------------------------</td>
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</tbody>
</table>
| Notes:          | ● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
                  ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. |
| References:     | None                                                                                   |
| DOE 5506        | Detail: Fuel Pool Fire - Container Handling (1b)                                        |
### Hazard Evaluation Table - Event AGTRU-1-007

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</tr>
</tbody>
</table>

#### Preventive Features:
- **Engineered (SS) Vehicle Barriers - High Risk Locations**: Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.
- **Engineered (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk**: Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored.
- **Engineered (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Containers**: Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)
- **Engineered (PSAC) Fire Protection - Thermal Separation Distance - Defined Area - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.**
- **Engineered (SMP) Maintenance Program - Vehicle/Equipment - Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift).**
- **Engineered (SMP) Training and Qualification Program - Qualifications**: Personnel maintain applicable LANL qualifications for vehicle and equipment operation.
- **Administrative (DID) Hazardous Material and Waste Management - Inclement Weather Control - Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc).**
- **Administrative (DID) Vehicle/Equipment Safety Controls - Speed Limits**: Post speed limits < 15 mph

#### Mitigative Features:
- **Engineered (SS) Hazardous Material and Waste Management - TRU Waste Container**: Metal TRU waste container are of sound integrity.
- **Engineered (SS) Waste Packaging Control**: Waste is packaged.
- **Engineered (PSAC) Fire Protection - Control of Transient Combustibles**: Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.
- **Engineered (PSAC) Radiological Inventory Management - Defined Area MAR Control - Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas**: TRU Storage Areas not collocated with SSSR Areas.
- **Engineered (PSAC) Radiological Inventory Management - Defined Area MAR Control**: SSSR (Limit the Equivalent Combustible MAR in an SSSR Area).
- **Engineered (PSAC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers**: The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.
- **Engineered (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack**: Doublepack radiological waste drums > 200 PEC.
- **Administrative (DID) Hazardous Material and Waste Management - Secure Transport**: TRU waste containers are secured during transport.

#### Credited SSCs and ACs
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<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers - High Risk Locations</td>
<td>Vehicle barriers installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches.</td>
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</table>
- The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

<table>
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<tr>
<th>Safety Function:</th>
<th>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</th>
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<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (I.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators PSAC Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
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</table>

Notes: • Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR. • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506 Detail: • Fuel Pool Fire - Container Handling (1b) • Fuel Pool Fire - Waste Repackaging (1f)
Hazard Evaluation Table - Event AGTRU-1-008

Description:
A vehicle transporting a TRU waste container at ≤ 10 mph impacts an SSSR activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and uncontained waste in SSSR resulting in a release of radiological material.

Locations:
- Area G

MARS:
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process
- 553 PEC (One [1] TRU waste container)

Release Mechanisms:
- Fuel pool fire release
- Low energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

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<tr>
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Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of ≤ 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and ≥800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<tr>
<td>Safety Function</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
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<tr>
<td>Notes</td>
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<tr>
<th>Applicability</th>
<th>PSAC Fire Protection - Thermal Separation Distance - Defined Area</th>
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<tr>
<td>Safety Function</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td>All Rad: P, C, W;</td>
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<tr>
<th>Applicability</th>
<th>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</th>
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<tr>
<td>Safety Function</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td>Notes</td>
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</tbody>
</table>

Notes:  
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  

References: None  

DOE 5506  
- Fuel Pool Fire - Container Handling (1b)  
- Fuel Pool Fire - Waste Repackaging (1f)
### Hazard Evaluation Table - Event AGTRU-1-009

**Description:**
A vehicle transporting multiple TRU waste containers at ≤ 10 mph is involved in an accident. The accident impacts no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. Additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- TRU storage areas except BLDG 412

**MARS:**
- 3,679 PEC (Statistical MAR for 100 gallon fuel pool exposure)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
Observation

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**Consequence / Risk Rank**

**Preventive Features:**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches). The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.
- (SS) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci) will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SS) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Mitigative Features:**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment must be escorted along designated routes of travel except for emergency response vehicles)
- (SS) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SS) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (SS) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

**Credited SSCs and ACs**

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<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Containers</td>
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<td>Safety Function:</td>
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<td>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
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<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td>Safety Function:</td>
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</table>

Notes: ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506 Detail: ● Fuel Pool Fire - Characterization (1a) ● Fuel Pool Fire - Container Handling (1b) ● Fuel Pool Fire - Venting and/or Abating/Purging (1c) ● Fuel Pool Fire - Staging and Storage (1d) ● Fuel Pool Fire - Waste Repackaging (1f) ● Fuel Pool Fire - Type B Container Loading/Unloading (1g)
Hazard Evaluation Table - Event AGTRU-1-010

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**Preventive Features:**

- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back.).)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)).
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation).
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.)).
- (DID) Vehicle/Equipment Safety Controls - Speed Limits (Posted speed limits < 15 mph).

**Mitigative Features:**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity).
- (SS) (IC) Waste Packaging Control (Waste is packaged).
- (PSAC) Escort of >100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles).
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)).
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.).
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC).
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport).

**Credited SSCs and ACs:**

<table>
<thead>
<tr>
<th>Class</th>
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</tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back.).</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Escort of &gt;100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles.</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
<td>Rad: P, C, W:</td>
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<tr>
<td>------</td>
<td>-----------------------------------------------------------</td>
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</table>

**Safety Function:** Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).

**References:** None

**DOE 5506 Detail:** Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event AGTRU-1-011

**Description:**
Two (2) vehicles, each transporting a single TRU waste container, impact at ≤ 10 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. No additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Area G
- MARs: 553 PEC (One [1] TRU waste container in transport)
- 56 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

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<th>Receptor</th>
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<td>C</td>
<td>H</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
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</tbody>
</table>

**Preventive Features:**
None

**Engineered:**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

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<td>Safety Function:</td>
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<td></td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-70
<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
</table>
| Notes:          | • 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste.  
  • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
  • The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle). |
| References:     | None |
| DOE 5506 Detail: | • Fuel Pool Fire - Container Handling (1b) |
## Hazard Evaluation Table - Event AGTRU-1-012

**Description:**
A vehicle transporting a TRU waste container at ≤ 10 mph is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. No additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Area G not adjacent to stored waste

**MARS:**
- 553 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU
**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>III</td>
<td>L</td>
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</table>

**Preventive Features:**
None

**Administrative Measures:**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
None

### Credited SSCs and ACs

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<td>Mitigators</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
</tbody>
</table>

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12/17/2013
| Notes:                         | ● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
                                   ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. |
| References:                   | None                                                                                                       |
| DOE 5506 Detail:              | ● Fuel Pool Fire - Container Handling (1b)                                                                    |
### Hazard Evaluation Table - Event AGTRU-1-013

**Description:**
A vehicle transporting a TRU waste container at ≤ 10 mph is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. Additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- TRU storage areas except BLDG 412

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

**Consequence / Risk Rank**

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<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**
Engineered
None

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
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<td>Safety Function:</td>
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<td></td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Reduces likelihood of progression of a fire between defined areas.</td>
<td></td>
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<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
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<td>Rad: P, C, W;</td>
<td>Safety Function: Reduces likelihood of fuel interaction with MAR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rad: P, C, W;</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506 Detail:
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
## Hazard Evaluation Table - Event AGTRU-1-014

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph is involved in an accident (no impacts to any additional waste). Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. No additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Area G

**MARS:**
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Mitigators**
- BEU Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

### Consequence / Risk Rank

<table>
<thead>
<tr>
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<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Preventive Features:**
None

**Engineered**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

**Mitigative Features:**
None

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)
- Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))

**Credited SSCs and ACs**

### Preventers

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<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.

### Mitigators

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<td>Escort of &gt; 100 gallons Flammable Liquid Inventory</td>
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<td>Notes:</td>
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<td>The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
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<td>References:</td>
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<td>DOE 5506 Detail:</td>
<td>Fuel Pool Fire - Container Handling (1b)</td>
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## Hazard Evaluation Table - Event AGTRU-1-015

### Description:
A vehicle transporting a TRU waste container at > 10 mph and ≤ 35 mph is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. Additional waste is sufficiently close to the fire to be affected by heating.

### Locations:
- TRU storage areas except BLDG 412
- MARs:
  - 3,679 PEC (Statistical MAR for 100 gallon fuel pool exposure)
  - 553 PEC (One [1] TRU waste container)

### Release Mechanisms:
- Exposure Fire
- Fuel pool fire release
- Impact and spill
- Moderate energy impact
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Assumptions:
None

### Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>DSA Mit.</th>
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<td>M</td>
<td>IV</td>
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</table>

### Preventive Features:
- **Engineered** None

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back))
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
<table>
<thead>
<tr>
<th>PSAC</th>
<th>Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
</tr>
<tr>
<td></td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
</tr>
<tr>
<td></td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
</tr>
<tr>
<td></td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
</tr>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</table>

Notes: The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506 Detail: Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event AGTRU-1-016

Description:
A vehicle transporting multiple TRU waste containers at > 10 mph and < 35 mph impacts a V&P activity. Fuel is leaked and ignited resulting in a pool fire engulfing the spilled waste resulting in a release of radiological material.

Locations:
- Area G
- MARS:
  - 311 PEC (Statistical 48 metal containers (One vehicle load) without high MAR container)
  - 553 PEC (One [1] TRU waste container in activity)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Unmitigated Frequency:
EU

Consequence / Risk Rank

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back))
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the routes flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

Preventers
- SS Vehicle Barriers-High Risk Locations
  - Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier,
after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

**Safety Function:**

The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

| PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers | Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back). | All |
| PSAC Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | All |
| Mitigators | Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas. |
| PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G | Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles | Rad: P, C, W; |
| **Safety Function:** | **Safety Function:** |
| Notes: | 
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. |
| References: | None |
| DOE 5506 | 
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c) |

**PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers**

Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).

**PSAC Fire Protection - Thermal Separation Distance - Defined Area**

Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.

**Mitigators**

Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles.

Doublepack radiological waste drums > 200 PEC.
Hazard Evaluation Table - Event AGTRU-1-017

Description:
A vehicle transporting a TRU waste container at > 10 mph and ≤ 35 mph impacts a V&P activity. Fuel is leaked and ignited resulting in a pool fire engulfing the spilled waste. No additional waste is sufficiently close to be affected by heating.

Locations:
- TRU storage areas except BLDG 412

MARS:
- 553 PEC (One [1] TRU waste container in activity)
- 56 PEC (One [1] TRU waste container in transport)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Mitigated System Effects:

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>DSA Mit.</th>
<th>Phy</th>
<th>DSA Mit.</th>
</tr>
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<td>H</td>
<td>I</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigate Features:

Engineered
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) [IC] Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<td><strong>Mitigators</strong></td>
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<tr>
<td>---------------------</td>
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<td></td>
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<tr>
<td>required thermal separation distance for the defined area at a high-risk location.</td>
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<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
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<td></td>
</tr>
<tr>
<td>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>Safety Function:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td></td>
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<td>Mitigators</td>
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<td></td>
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<tr>
<td>Notes:</td>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
<td></td>
<td></td>
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<tr>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td>None</td>
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</tr>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-1-018

**Description:**
A vehicle transporting a TRU waste container at > 10 mph and ≤ 35 mph impacts stored waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and the stored waste.

**Locations:**
- TRU storage areas except BLDG 412
- MARS:  
  - < 22,000 PEC (Storage limit, metal containers ONLY)
  - 553 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Methods of Detection:**
- Observation

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

### Consequence / Risk Rank

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</tr>
<tr>
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**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-C will be escorted by a rolling roadblock (i.e. escort vehicle in front and back)).
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

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barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

**Safety Function:**

The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

### PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers

Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).

**Safety Function:**

Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.

### PSAC Fire Protection - Thermal Separation Distance - Defined Area

Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.

**Safety Function:**

Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

### Mitigators

#### PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G

Vehicles/ equipment greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles.

**Safety Function:**

Reduces likelihood of fuel interaction with MAR

#### PSAC Fire Protection - Control of Transient Combustibles

Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.

**Safety Function:**

Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.

#### PSAC Radiological Inventory Management - TRU Waste Drum Doublepack

Doublepack radiological waste drums > 200 PEC

**Safety Function:**

Reduce radiological consequences by limiting amount of MAR involved

### Notes:

- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

### References:

- None

### DOE 5506 Detail:

- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
Hazard Evaluation Table - Event AGTRU-1-019

Description:
A vehicle transporting multiple TRU waste containers at >10 mph and ≤35 mph impacts stored waste. Four (4) stacks of twelve containers (4 drums x 3 tiers) collapse as a result of the impact. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste container in transport as well as the stored waste.

Locations:
- TRU storage areas except BLDG 412

MARS:
- 3,679 PEC (Statistical MAR for 100 gallon fuel pool exposure)
- ≤1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of <15 mph) with a gross weight of <150,000 lbs and a ground clearance of <40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci) will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits <15 mph)

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci) will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤100 lb of transient combustible material or attended. Fuel packages shall be ≥9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥3 ft away from metal containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle Limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums >200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle Limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums >200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk</td>
<td>All</td>
</tr>
<tr>
<td>Locations</td>
<td>with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G - Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;600 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
<td>• Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>● Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR. ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
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<tr>
<td>References:</td>
<td>None</td>
<td></td>
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<tr>
<td>DOE 5506</td>
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<tr>
<td>Detail:</td>
<td>● Fuel Pool Fire - Characterization (1a) ● Fuel Pool Fire - Container Handling (1b) ● Fuel Pool Fire - Venting and/or Abating/Purging (1c) ● Fuel Pool Fire - Staging and Storage (1d) ● Fuel Pool Fire - Waste Repackaging (1f) ● Fuel Pool Fire - Type B Container Loading/Unloading (1g) ● Collapse of Stacked Containers - Characterization (11a) ● Collapse of Stacked Containers - Container Handling (11b) ● Collapse of Stacked Containers - Venting and/or Abating/Purging (11c) ● Collapse of Stacked Containers - Staging and Storage (11d) ● Collapse of Stacked Containers - Waste Repackaging (11f) ● Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)</td>
<td></td>
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</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-1-020

**Description:**
A vehicle transporting a TRU waste container at >10 mph and ≤35 mph is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport. No additional waste is sufficiently close to be affected by heating.

**Locations:**
- Area G not adjacent to stored waste

**MARS:**
- 553 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
- None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
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<td>C</td>
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<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>III</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and >450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits <15 mph)

**Mitigative Features:*

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums >200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<tbody>
<tr>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt;450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers</td>
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</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event AGTRU-1-021

Description:
Two (2) vehicles, each transporting a single TRU waste container, impact at > 10 mph and ≤ 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. No additional waste is sufficiently close to be affected by heating.

Locations:
• Area G

MARS:
• 553 PEC (One [1] TRU waste container in transport)
• 56 PEC (One [1] TRU waste container in transport)

Release Mechanisms:
• Fuel pool fire release
• Impact and spill
• Moderate energy impact

Preventive Features:

Engineered (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back));
• (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G– Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back));
• (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift));
• (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation);
• (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc));
• (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity);
• (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles);
• (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas));
• (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC);
• (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Consequence / Risk Rank

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</table>

Preventers

Safeguard PSAC Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Compliant Containers

Safety Function: Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.

Credited SSCs and ACs

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<td>Preventers</td>
<td>PSAC Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>PSAC Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Non-compliant</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td>Containers</td>
<td>Safety Function: Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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</tr>
<tr>
<td>Mitigators</td>
<td><strong>PSAC</strong> Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G <strong>Safety Function:</strong> Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles <strong>Rad:</strong> P, C, W;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack <strong>Safety Function:</strong> Doublepack radiological waste drums ≥ 200 PEC <strong>Rad:</strong> P, C, W;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>• It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. • The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
<td></td>
<td></td>
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<tr>
<td>DOE 5506</td>
<td>Fuel Pool Fire - Container Handling (1b)</td>
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</table>
## Hazard Evaluation Table - Event AGTRU-1-022

### Description:
Two (2) vehicles, each transporting multiple compliant TRU waste containers, impact at > 10 mph and < 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste containers in transport. No additional waste is sufficiently close to be affected by heating.

### Locations:
- Area G

### MARs:
- 1,096 PEC (Statistical 96 metal containers: 48 containers per vehicle)

### Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- EU

### Consequence / Risk Rank

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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:
- None

#### Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
- None

#### Admin
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-CI.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-CI.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</table>
| Notes: | It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
|       | The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).  
|       | When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| References: | None |
| DOE 5506 | Fuel Pool Fire - Container Handling (1b) |
**Hazard Evaluation Table - Event AGTRU-1-023**

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph is involved in an accident (no impacts to any additional waste). Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport. Additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- TRU storage areas except BLDG 412

**MARS:**
- 3,679 PEC (Statistical MAR for 100 gallon fuel pool exposure)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, AAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<tbody>
<tr>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transport vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
</tbody>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H
<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SS</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
<th>Metal TRU waste container are of sound integrity</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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</tr>
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<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits-compliant metal containers (IC)</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Rad: P, C, W;</td>
<td></td>
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<tr>
<td>Safety Function:</td>
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<td>Reduce radiological consequences by limiting MAR involved</td>
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<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506
Detail:
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
## Hazard Evaluation Table - Event AGTRU-1-024

**Description:**
Two (2) vehicles, one transporting a single TRU waste container and the other transporting multiple TRU waste containers, impact at > 10 mph and < 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport.

**Locations:**
- Area G

**MARS:**
- 311 PEC (Statistical 48 metal containers (One vehicle load) without high MAR container)
- 553 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
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<td>II</td>
<td>M</td>
<td>IV</td>
</tr>
</tbody>
</table>

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**
- **Unmitigated Frequency:** EU
- **Mitigated Frequency:** BEU

**Preventive Features:**
Engineering
- None

**Mitigative Features:**
Engineering
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
</tbody>
</table>

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12/17/2013
<table>
<thead>
<tr>
<th>Containers</th>
<th>Safety Function:</th>
<th>Mitigators</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
<th>Safety Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td>SS</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
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<td></td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control (IC)</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Notes:</td>
<td></td>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle). When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>References:</td>
<td>None</td>
<td>Reference: None</td>
</tr>
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<td></td>
<td></td>
<td>DOE 5506</td>
<td>Fuel Pool Fire - Container Handling (1b)</td>
<td>Reference: DOE 5506</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detail:</td>
<td></td>
<td>Reference: DOE 5506</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-1-025

Description:
A vehicle transporting multiple TRU waste containers at > 10 mph and < 35 mph impacts an SSSR activity. Staged TRU waste containers are located in proximity to the SSSR activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the transported waste, staged waste, and uncontained SSSR waste.

Locations:
- Area G

MARS:
- ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
<thead>
<tr>
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<th>Chm</th>
</tr>
</thead>
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<tr>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered:
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin:
- (PSAC) Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:
Engineered:
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin:
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)
### Credited SSCs and ACs

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<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. *The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
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</tr>
<tr>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>All</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>Rad: P, C, W;</td>
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<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</table>

**Notes:**
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- None

**Detail:**
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Waste Repackaging (1f)
### Hazard Evaluation Table - Event AGTRU-1-026

**Description:**
A vehicle transporting a TRU waste container at > 10 mph and ≤ 35 mph impacts an SSSR activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport, staged, and uncontained SSSR waste.

**Locations:**
- Area G

**MARS:**
- < 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident

**Mitigative Features:**

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU
**Mitigated Frequency:** BEU

#### Consequence / Risk Rank

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<td>W</td>
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#### Preventive Features:

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.).)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

#### Mitigative Features:

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 3 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs
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<th>Vehicle Barriers - High Risk Locations</th>
<th>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</th>
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<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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<td></td>
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<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>• Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>• Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR. • The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
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</tr>
<tr>
<td>References:</td>
<td>None</td>
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<tr>
<td>DOE 5506</td>
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<td>Fuel Pool Fire - Container Handling (1b)</td>
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<td></td>
</tr>
<tr>
<td>Detail:</td>
<td></td>
<td>Fuel Pool Fire - Waste Repackaging (1f)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Hazard Evaluation Table - Event AGTRU-1-027

**Description:**
A vehicle transporting multiple TRU waste containers at ≤ 10 mph impacts TRU waste. The vehicle impacts two (2) stacks of twelve containers. A fire is ignited which involves the impacted containers and the containers in transport resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**MARS:**
- 690 PEC (Statistical 24 metal containers, sphere of fire heating influence)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fire
- Low energy impact

**Assumptions:**
None

**Preventive Features:**
**Admin (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)**

**Engineered (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)**

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Chm</th>
<th>DSA Mit.</th>
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<tr>
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<td>H</td>
<td>I</td>
<td>M</td>
<td>III</td>
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<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
<td>III</td>
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**Mitigated Frequency:** EU

**Preventive Features:**
**Admin (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back)).**

**Engineered (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)**

**Mitigative Features:**
**Engineered (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)**

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position</td>
</tr>
</tbody>
</table>

| Mitigators | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
| Mitigators | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |
| Mitigators | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | Rad: P, C, W; |
| Mitigators | Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers | The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci. | Rad: P, C, W; |
| Mitigators | Doublepack radiological waste drums > 200 PEC | Doublepack radiological waste drums > 200 PEC | Rad: P, C, W; |

**Safety Function:**

Reduce radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

**Safety Function:**

Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.

**Safety Function:**

Reduce the radiological consequences as waste is agglomerated and burns as packaged.

**Safety Function:**

Reduce radiological consequences by limiting the amount of MAR involved.

**Safety Function:**

Reduce radiological consequences by limiting the MAR involved.

**Safety Function:**

Reduce radiological consequences by limiting amount of MAR involved.

**Notes:**

- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**

- None

**DOE 5506 Detail:**

- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Small Fire - Type B Container Loading/Unloading (2g)
- Collapse of Stacked Containers - Characterization (11a)
- Collapse of Stacked Containers - Container Handling (11b)
- Collapse of Stacked Containers - Venting and/or Abating/Purging (11c)
- Collapse of Stacked Containers - Staging and Storage (11d)
- Collapse of Stacked Containers - Waste Repackaging (11f)
Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)
### Hazard Evaluation Table - Event AGTRU-1-028

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph impacts stored TRU waste. The impact results in the toppling of 48 TRU waste containers in storage. Combustible materials are ignited and burn in conjunction with waste in transport and in storage resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**MARS:**
- 233 PEC (48 containers at mean of 4.84)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Transient combustibles
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**

**Unmitigated Frequency:** U

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rad</td>
</tr>
<tr>
<td>P</td>
<td>H</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and > 800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle Limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
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<tr>
<td>Preverters</td>
<td>SS</td>
<td>Vehicle Barriers-</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers)</td>
</tr>
<tr>
<td>High Risk Locations</td>
<td>Mitigators</td>
<td>Safety Function</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>-----------------</td>
<td></td>
</tr>
</tbody>
</table>
| Safety Function:    | Hazardous Material and Waste Management - TRU Waste Container (IC) | The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. 
| PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers | Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back). | All |
| PSAC Fire Protection - Control of Transient Combustibles | Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers. | All |
| PSAC Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | Rad: P, C, W; |
| PSAC Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers | The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci. | Rad: P, C, W; |

Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail: Small Fire - Characterization (2a)
Small Fire - Container Handling (2b)
<table>
<thead>
<tr>
<th>Event Description</th>
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<tbody>
<tr>
<td>Small Fire - Venting and/or Abating/Purging (2c)</td>
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<tr>
<td>Small Fire - Staging and Storage (2d)</td>
</tr>
<tr>
<td>Small Fire - Waste Repackaging (2f)</td>
</tr>
<tr>
<td>Small Fire - Type B Container Loading/Unloading (2g)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Characterization (11a)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Container Handling (11b)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Venting and/or Abating/Purging (11c)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Staging and Storage (11d)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Waste Repackaging (11f)</td>
</tr>
<tr>
<td>Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-1-029

**Description:**
A vehicle/ equipment handling multiple TRU waste containers catches on fire adjacent to TRU waste. The heat of the fire affects the TRU waste being handled and containers in proximity to the vehicle. The vehicle/ equipment does not impact any storage containers.

**Locations:**
- Area G

**MARS:**
- 117 PEC (24 containers at mean of 4.84)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical short
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**
None

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
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<tr>
<td></td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td></td>
</tr>
</tbody>
</table>

**Mitigators**
- SS Hazardous Material and Waste Management - Metal TRU waste container are of sound integrity
  - Rad: P, C, W;
### TRU Waste Container (IC)

**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>SS Waste Packaging Control (IC)</th>
<th>Waste is packaged</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
</table>

### SS Waste Packaging Control (IC)

**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged.

### PSAC Combustible/Flammable Liquids Control

**Safety Function:** Reduce radiological consequences by limiting amount of MAR involved.

|-----------------------------------------------------------------|--------------------------------------------------------------------------------|----------------|

### PSAC Radiological Inventory Management - Defined Area MAR Control

**Safety Function:** Reduces the radiological consequences by limiting the MAR involved.

<table>
<thead>
<tr>
<th>PSAC Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers</th>
<th>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
</table>

### PSAC Radiological Inventory Management - TRU Waste Drum Doublepack

**Safety Function:** Reduce radiological consequences by limiting amount of MAR involved.

|-------------------------------------------------------------------|-------------------------------------------|----------------|

### Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
- None

### DOE 5506 Detail:
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Small Fire - Type B Container Loading/Unloading (2g)
**Hazard Evaluation Table - Event AGTRU-1-030**

**Description:**
A vehicle transporting multiple TRU waste containers at ≤ 10 mph impacts SSSR activities. No additional waste is sufficiently close by to be affected by the fire. The collision event initiates a fire which involves both the uncontained SSSR material and the transported waste affected by the impact resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** U

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<td>DSA Mit.</td>
<td>Unmit.</td>
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<td>I</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
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<td>I</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (PSAC) Fire Protection - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible Material in an SSSR Area)
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-110


12/17/2013
<table>
<thead>
<tr>
<th>Preventers</th>
<th>SS</th>
<th>Vehicle Barriers- High Risk Locations</th>
<th>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td></td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td></td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td></td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>References:</td>
<td>DOE 5506</td>
<td>DOE 5506</td>
<td>DOE 5506</td>
<td>DOE 5506</td>
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<tr>
<td>Detail:</td>
<td>● Small Fire - Container Handling (2b)</td>
<td>● Small Fire - Container Handling (2b)</td>
<td>● Small Fire - Container Handling (2b)</td>
<td>● Small Fire - Container Handling (2b)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-1-031

**Description:**
A vehicle transporting multiple non-metal TRU waste containers at > 10 mph and ≤ 35 mph impacts SSSR activities and staged waste. The collision event initiates a fire which involves the uncontained SSSR waste, the waste in transport, and the staged waste affected by the impact resulting in a release of radiological material.

**Locations:**
- Area G

<table>
<thead>
<tr>
<th>MARs:</th>
<th>&lt; 18 PEC equivalent combustible TRU waste, closed, staged for SSSR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process</td>
</tr>
<tr>
<td></td>
<td>≤ 615 PEC (MAR limit for non-metal containers on single transport vehicle)</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Exposure Fire
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/Equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Preventive Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rad</td>
<td>DSA Mit.</td>
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<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
</tr>
<tr>
<td>P</td>
<td>H</td>
<td>I</td>
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<tr>
<td>C</td>
<td>H</td>
<td>I</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G– Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit (The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport to process areas.)
### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers- High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
<td></td>
</tr>
<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within Ta-54, Area G- Non-compliant Containers</td>
<td>Escort of High MAR TRU Waste Transport Within Ta-54, Area G- Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
</tr>
<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
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<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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<tr>
<td>Mitigators</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
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</tbody>
</table>

**Notes:** None  
**References:** None  
**DOE 5506 Detail:**  
- Small Fire - Container Handling (2b)  
- Small Fire - Waste Repackaging (2f)
### Hazard Evaluation Table - Event AGTRU-1-032

**Description:**
Characterization equipment overheats and ignites a fire during characterization activities. The heat of the fire affects the TRU waste container being processed and staged waste in the vicinity of the characterization activity resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 195 PEC (Statistical 24 metal containers, excluding high MAR container)
- 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Ignition source

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>M</td>
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<tr>
<td>C</td>
<td>M</td>
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<td>W</td>
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### Consequence / Risk Rank

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<tr>
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</tr>
</tbody>
</table>

**Preventive Features:**
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W</td>
</tr>
<tr>
<td>SS</td>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC Radiological Inventory Management - Defined Area MAR Control</strong></td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</strong></td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SMP Radiation Protection Program</strong></td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Bounds all characterization activities. RTR has maximum of 3 containers inside. HENC has only 1 container.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
# Hazard Evaluation Table - Event AGTRU-1-033

**Description:**
A fire occurs in proximity to characterization activities. The heat of the fire affects the TRU waste container being processed and the staged waste in the vicinity of the characterization activity resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Lightning

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
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</tr>
<tr>
<td>W</td>
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<td>I</td>
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</tr>
</tbody>
</table>

**Consequence / Risk Rank**

**Preventive Features:**
- None

- Admin
  - (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
  - (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)

**Mitigative Features:**
- Engineered
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) (IC) Waste Packaging Control (Waste is packaged)

- Admin
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

## Preventers
- **Class:** SMP
  - **Control:** Good Housekeeping and Inspections
  - **Attribute:** Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE
  - **Safety Function:** Reduces the likelihood of fire progression
  - **Affected Receptors:** All

- **Class:** SMP
  - **Control:** Hot Work and Ignition Source Control
  - **Attribute:** Ignition source control within defined areas.
  - **Safety Function:** Reduce likelihood of fire from ignitables/ combustibles
  - **Affected Receptors:** All

## Mitigators
- **Class:** SS
  - **Control:** Hazardous Material and Waste Management - TRU Waste Container (IC)
  - **Attribute:** Metal TRU waste container are of sound integrity
  - **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
  - **Affected Receptors:** Rad: P, C, W;

- **Class:** SS
  - **Control:** Waste Packaging Control (IC)
  - **Attribute:** Waste is packaged
  - **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged.
  - **Affected Receptors:** Rad: P, C, W;

- **Class:** PSAC
  - **Control:** Radiological Inventory Management - Defined Area MAR Control
  - **Attribute:** Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)
  - **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged.
  - **Affected Receptors:** Rad: P, C, W;
<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduces the radiological consequences by limiting the MAR involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>SMP Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported ● Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
</tr>
<tr>
<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection ● Rad: W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
<tr>
<td>SMP Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls ● Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
</tr>
</tbody>
</table>

Notes: ● When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506 Detail: ● Small Fire - Characterization (2a) ● Small Fire - Staging and Storage (2d) ● Lightning - Characterization (20a)
Hazard Evaluation Table - Event AGTRU-1-034

Description:
A small fire occurs in a single TEU. The heat of the fire affects the TRU waste containers within that TEU resulting in a release of radiological material.

Locations:
- Area G Pad 10
- MARs: 877 PEC (Statistical 48 (all) containers)

Release Mechanisms:
- Exposure Fire

Assumptions:
- Fire will not propagate from one TEU to the other TEU.

Causes:
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Ignition source
- Lightning
- Radiant heating
- Transient combustibles

Unmitigated System Effects:
- None

Methods of Detection:
- None

Unmitigated Frequency: A

<table>
<thead>
<tr>
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<tr>
<td>W</td>
<td></td>
<td>H</td>
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<td>M</td>
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</tbody>
</table>

Preventive Features:

Engined None

Admin
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

Mitigative Features:

Engineered None (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
</tr>
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<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<p>| Mitigators | SS | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |</p>
<table>
<thead>
<tr>
<th>SMP Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
<th>Safety Function: Reduces radiological consequences due to exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td>• Combustible /flammable materials external to container</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
</tr>
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<td>References:</td>
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<tr>
<td>DOE 5506</td>
<td>• Small Fire - Characterization (2a)</td>
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<td>Detail:</td>
<td>• Lightning - Characterization (20a)</td>
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<td>I</td>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- **Admin**
  - (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
  - (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)

**Mitigative Features:**
- **Admin**
  - (PSAC) Pole-Mounted Transformer Distance from TRU Waste Storage Areas (Pole-mounted transformers must be located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool possible from the spilled transformer flammable/combustible oil, and the associated thermal separation distance necessary to prevent the TRU non-metal containers from becoming affected by the transformer fuel pool fire. Alternatively, the pole-mounted transformer can fall at a berm, ditch, curb, or ditch, or equivalent liquid impediment, which is at a safe thermal separation distance away from a TRU waste storage area.)
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

**Preventers**
- **PSAC**
  - Fire Protection - Thermal Separation Distance - Defined Area
  - **Safety Function:**
    - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
  - **Affected Receptors:**
    - All

**Mitigators**
- **PSAC**
  - Pole-Mounted Transformer Distance from TRU Waste Storage Areas
  - **Safety Function:**
    - The safety function of this SAC is to prevent pole-mounted transformers from falling onto or in close proximity to waste storage areas, to prevent a post-seismic transformer fuel pool fire from impacting waste, thereby mitigating consequences from a post-seismic fire.
  - **Affected Receptors:**
    - Rad: P, C, W,
<table>
<thead>
<tr>
<th>Inventory Management - Defined Area MAR Control (IC)</th>
<th>C, W;</th>
<th>Inventory Management - Defined Area MAR Control (IC)</th>
<th>C, W;</th>
</tr>
</thead>
</table>

**Safety Function:** Reduces the radiological consequences by limiting the MAR involved.

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of three hundred (300) gallons of fuel at 0.15 inch depth.
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Venting and/or Abating/Purging (20c)
- Lightning - Staging and Storage (20d)
- Lightning - Type B Container Loading/Unloading (20g)
- Seismic Event with Fire - Characterization (25a)
- Seismic Event with Fire - Container Handling (25b)
- Seismic Event with Fire - Venting and/or Abating/Purging (25c)
- Seismic Event with Fire - Staging and Storage (25d)
- Seismic Event with Fire - Type B Container Loading/Unloading (25g)
### Hazard Evaluation Table - Event AGTRU-1-039

**Description:**
A fire occurs in proximity to stored TRU waste containers with the heat of the fire affecting the waste containers resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Ignition source

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** U

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
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</table>

#### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

#### Mitigative Features:

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

#### Credited SSCs and ACs

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Stationary Fire Watch During Hot Work</td>
<td>Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.</td>
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<td></td>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
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<td></td>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
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<td>SMP</td>
<td>Radiation Protection</td>
<td>Evaluates radiological conditions and processes for worker</td>
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<tr>
<td>Program</td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces radiological consequences due to exposure</td>
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<tr>
<td>SMP Training and Qualification</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
<td></td>
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</tbody>
</table>

**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Type B Container Loading/Unloading (2g)
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Venting and/or Abating/Purging (20c)
- Lightning - Staging and Storage (20d)
- Lightning - Type B Container Loading/Unloading (20g)
- Seismic Event with Fire - Characterization (25a)
- Seismic Event with Fire - Container Handling (25b)
- Seismic Event with Fire - Venting and/or Abating/Purging (25c)
- Seismic Event with Fire - Staging and Storage (25d)
- Seismic Event with Fire - Type B Container Loading/Unloading (25g)
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<thead>
<tr>
<th>Receptor</th>
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</tbody>
</table>

### Preventive Features:

**Engineered**

- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered**

- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

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<tr>
<th>Class</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<tr>
<td></td>
<td>PSAC</td>
<td>Stationary Fire Watch During Hot Work</td>
<td>Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
</tbody>
</table>

### Notes:
- Combustible /flammable materials external to container
| Lightning - Container Handling (20b) |
| Lightning - Venting and/or Abating/Purging (20c) |
| Lightning - Staging and Storage (20d) |
| Lightning - Type B Container Loading/Unloading (20g) |
| Seismic Event with Fire - Characterization (25a) |
| Seismic Event with Fire - Container Handling (25b) |
| Seismic Event with Fire - Venting and/or Abating/Purging (25c) |
| Seismic Event with Fire - Staging and Storage (25d) |
| Seismic Event with Fire - Type B Container Loading/Unloading (25g) |
### Hazard Evaluation Table - Event AGTRU-1-041

**Description:**
A small fire within stored non-compliant TRU waste propagates to involve additional TRU waste containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)
- \( \leq 1,500 \) PEC (Retrieval Area MAR limit)
- \( \leq 2,000 \) PEC (MAR limit for Storage Area with non-metal containers)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Small fire event

**Unmitigated System Effects:**
Methods of Detection:
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

<table>
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<th>Consequence / Risk Rank</th>
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</table>

**Preventive Features:**

**Engineered None**

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be \( \leq 100 \) lb of transient combustible material or attended. Fuel packages shall be \( \geq 9 \) ft away from non-metal waste containers and other fuel packages. Fuel packages shall be \( \geq 3 \) ft away from metal containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

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<tr>
<th>Class</th>
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<tr>
<td></td>
<td>Fire Prevention - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC Stationary Fire Watch During Hot Work</td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fire event.</td>
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</tr>
<tr>
<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
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<tr>
<td></td>
<td>SS Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>Rad: P,</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Description</td>
<td>Notes</td>
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</tr>
<tr>
<td><strong>PSAC Fire Protection - Control of Transient Combustibles</strong></td>
<td>Reduces the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td>● Rad: P, C, W; Notes: When metal and non-compliant non-metal containers are stored within the same Storage Area, the lower non-metal MAR limit applies. With Thermal Separation Distance and Transient Combustible Controls in place to limit fire spread from one defined area to another, the mitigated consequences are Moderate for a fire in either the metal or non-metal Storage Area.</td>
<td></td>
</tr>
<tr>
<td><strong>PSAC Radiological Inventory Management - Defined Area MAR Control</strong></td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>● Rad: P, C, W;</td>
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<tr>
<td><strong>PSAC Radiological Inventory Management - Retrieval Area MAR Limit (IC)</strong></td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>● Rad: P, C, W;</td>
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<tr>
<td><strong>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</strong></td>
<td>Doublepack radiological waste drums $\geq 200$ PEC</td>
<td>● Rad: P, C, W;</td>
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</table>

Notes:

- When metal and non-compliant non-metal containers are stored within the same Storage Area, the lower non-metal MAR limit applies.
- With Thermal Separation Distance and Transient Combustible Controls in place to limit fire spread from one defined area to another, the mitigated consequences are Moderate for a fire in either the metal or non-metal Storage Area.
Hazard Evaluation Table - Event AGTRU-1-042

**Description:**
Non-metal TRU waste containers are ignited by transient combustibles and burn resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412
- 475 PEC (Statistical 2 non-metal containers)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
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<td>L</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<td><strong>Preventers</strong></td>
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<tr>
<td>PSAC</td>
<td>Stationary Fire Watch During Hot Work</td>
<td>Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.</td>
<td>All</td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduces the likelihood of fire progression

| **Mitigators** |          |           |                    |
| SS   | Waste Packaging Control (IC) | Waste is packaged | All |

**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged

| PSAC | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | All |

**Safety Function:** Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

| SMP  | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | All |

**Safety Function:** Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
None

**DOE 5506**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Staging and Storage (2d)
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Staging and Storage (20d)
- Seismic Event with Fire - Characterization (25a)
- Seismic Event with Fire - Container Handling (25b)
- Seismic Event with Fire - Staging and Storage (25d)

---

Hazard Evaluation Table - Event AGTRU-1-043

Description:
Combustible/flammable liquid (e.g., gasoline, diesel fuel, transient combustible liquids) adjacent to stored TRU waste containers is ignited resulting in a pool fire with a release of radiological material.

Locations:
- Area G

MARS:
- 1,140 PEC [Statistical mean exposed along one side of 22,000 PEC storage array]

Release Mechanisms:
- Exposure Fire

Assumptions:
- None

Causes:
- Equipment malfunction
- Hot Work
- Ignition source
- Lightning
- Operator error
- Vehicle accident

Unmitigated System Effects:
- Methods of Detection:
  - Observation

Unmitigated Frequency: U
Mitigated Frequency: EU

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<tr>
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<td>I</td>
<td>M</td>
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</tbody>
</table>

Preventive Features:
- Engineered: None
- Admin: (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

Mitigative Features:
- Engineered: None
- Admin: (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:
- None

DOE 5506
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
- Lightning - Characterization (20a)

12/17/2013
<table>
<thead>
<tr>
<th>Event Type</th>
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<tbody>
<tr>
<td>Lightning - Container Handling (20b)</td>
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<tr>
<td>Lightning - Venting and/or Abating/Purging (20c)</td>
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<td>Lightning - Staging and Storage (20d)</td>
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<tr>
<td>Lightning - Waste Repackaging (20f)</td>
</tr>
<tr>
<td>Lightning - Type B Container Loading/Unloading (20g)</td>
</tr>
<tr>
<td>Seismic Event with Fire - Characterization (25a)</td>
</tr>
<tr>
<td>Seismic Event with Fire - Container Handling (25b)</td>
</tr>
<tr>
<td>Seismic Event with Fire - Venting and/or Abating/Purging (25c)</td>
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</tr>
<tr>
<td>Seismic Event with Fire - Waste Repackaging (25f)</td>
</tr>
<tr>
<td>Seismic Event with Fire - Type B Container Loading/Unloading (25g)</td>
</tr>
</tbody>
</table>
### Description:
Combustible/flammable liquid (e.g., gasoline, diesel fuel, transient combustible liquids) container within stored TRU waste is ruptured in coincidence with an ignition source resulting in a pool fire with a release of radiological material.

### Locations:
- Area G

### MARs:
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

### Release Mechanisms:
- Fuel pool fire release

### Assumptions:
None

### Causes:
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
Observation

### Release Mechanism:
Fuel pool fire release

### Assumptions:
None

### Causes:
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
Observation

### Unmitigated Frequency:
U

### Mitigated Frequency:
EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
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<tr>
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<tr>
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<td>I</td>
<td>III</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>III</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered:** None

**Admin:**
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

### Mitigative Features:

**Engineered:**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin:**
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Stationary Fire Watch During Hot Work</td>
<td>Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.</td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce the likelihood of a fire event.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Mitigators | SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
| **Safety Function:** | Reduces the radiological consequences as waste is agglomerated and burns as packaged. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers. |

| SS | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |
| **Safety Function:** | Reduces the radiological consequences as waste is agglomerated and burns as packaged. |

| PSAC | Combustible/Flammable Liquids Control | Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals. | Rad: P, C, W; |
| **Safety Function:** | Reduce radiological consequences by limiting amount of MAR involved |

<p>| PSAC | Radiological Inventory | Doublepack radiological waste drums &gt; 200 PEC | Rad: P, |</p>
<table>
<thead>
<tr>
<th>Management - TRU Waste Drum Doublepack</th>
<th>C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Function:</strong> Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:** None

**DOE 5506**

**Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Venting and/or Abating/Purging (20c)
- Lightning - Staging and Storage (20d)
- Lightning - Waste Repackaging (20f)
- Lightning - Type B Container Loading/Unloading (20g)
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- Seismic Event with Fire - Container Handling (25b)
- Seismic Event with Fire - Venting and/or Abating/Purging (25c)
- Seismic Event with Fire - Staging and Storage (25d)
- Seismic Event with Fire - Waste Repackaging (25f)
- Seismic Event with Fire - Type B Container Loading/Unloading (25g)
## Hazard Evaluation Table - Event AGTRU-1-045

### Description:
Equipment fire (e.g., forklift, man-lift, etc.) ignites in the vicinity of stored waste resulting in a release of radiological material.

### Locations:
- TRU storage areas except BLDG 412
- MARs: 699 PEC (Statistical 24 (all) containers, sphere of fire heating influence)

### Release Mechanisms:
- Exposure Fire

### Assumptions:
None

### Causes:
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Release Mechanisms:
- Exposure Fire

### Assumptions:
None

### Causes:
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A

### Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Phy</th>
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<td>DSA Mit.</td>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

#### Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

#### Mitigative Features:

#### Admin
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

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<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
<td>All</td>
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<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Description</td>
<td>PSAC / Notes</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
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</tr>
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<td>Rad: P, C, W;</td>
<td></td>
</tr>
</tbody>
</table>

Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail:
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Small Fire - Type B Container Loading/Unloading (2g)
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Venting and/or Abating/Purging (20c)
- Lightning - Staging and Storage (20d)
- Lightning - Waste Repackaging (20f)
- Lightning - Type B Container Loading/Unloading (20g)
- Seismic Event with Fire - Characterization (25a)
- Seismic Event with Fire - Container Handling (25b)
- Seismic Event with Fire - Venting and/or Abating/Purging (25c)
- Seismic Event with Fire - Staging and Storage (25d)
- Seismic Event with Fire - Waste Repackaging (25f)
- Seismic Event with Fire - Type B Container Loading/Unloading (25g)
### Hazard Evaluation Table - Event AGTRU-1-046

**Description:**
Large refueling vehicle accident results in fuel spill with subsequent pool fire engulfing stored TRU waste resulting in a release of radiological material. The vehicle accident does not involve a crash into the stored waste.

**Locations:**
- Area G

**Locations:**
- Area G

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered:** None

**Admin:**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (DIID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)
- Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

**Mitigative Features:**

**Engineered:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin:**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

#### Credited SSCs and ACs

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<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control (IC)</td>
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<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
<tr>
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<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- None
- DOE 5506 - Fuel Pool Fire - Characterization (1a)
<table>
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<tr>
<td>• Fuel Pool Fire - Container Handling (1b)</td>
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<td>• Fuel Pool Fire - Waste Repackaging (1f)</td>
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<tr>
<td>• Fuel Pool Fire - Type B Container Loading/Unloading (1g)</td>
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</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-1-047

**Description:**
Large refueling vehicle spills fuel with subsequent pool fire adjacent to but not engulfing stored TRU waste results in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 1,140 PEC [Statistical mean exposed along one side of 22,000 PEC storage array]

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Equipment malfunction
- Ignition source
- Leaks/ drips
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- NC

### Consequence / Risk Rank

<table>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II H</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

**Mitigative Features:**

**Engineered**
- None

- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

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<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Vehicle/ Equipment Safety Control – Refueling Location</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fire from a refueling accident involving a TRU waste transportation vehicle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>All</td>
</tr>
</tbody>
</table>

**Notes:**
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
## Hazard Evaluation Table - Event AGTRU-1-048

### Description:
A large refueling vehicle traveling at > 10 mph and ≤ 35 mph impacts multiple stored TRU waste containers. Fuel is leaked and ignited, resulting in a fuel pool fire that engulfs the stored waste, causing a release of radiological material.

### Locations:
- TRU storage areas except BLDG 412

### Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

### Assumptions:
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

### Causes:
- Degraded/inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
Methods of Detection:
- Observation

### Unmitigated Frequency:
- EU

### Mitigated Frequency:
- BEU

## Consequence / Risk Rank

<table>
<thead>
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<th>Consequence / Risk Rank</th>
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### Preventive Features:
- **Engineered**
  - (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
  - (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

### Mitigative Features:
- **Engineered**
  - (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)

### Credited SSCs and ACs

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<thead>
<tr>
<th>Class</th>
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<th>Affected Receptors</th>
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<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
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<td>Preparers</td>
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<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
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<td>PSAC</td>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
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<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>Rad: P, C, W;</td>
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<td>Notes:</td>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
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<td>The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.</td>
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<td>Fuel Pool Fire - Staging and Storage (1d)</td>
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<td>Fuel Pool Fire - Waste Repackaging (1f)</td>
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<td>Fuel Pool Fire - Type B Container Loading/Unloading (1g)</td>
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Hazard Evaluation Table - Event AGTRU-1-049

**Description:**
Stationary vehicle adjacent to stored TRU waste spills/leaks fuel in coincidence with ignition source resulting in fire releasing radiological material.

**Locations:**
- Area G

**MARs:**
- 1,140 PEC [Statistical mean exposed along one side of 22,000 PEC storage array]

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
- None

**Causes:**
- Ignition source
- Leaks/drips

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

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</table>

**Preventive Features:**

**Engineered:**
- None

**Admin:**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

**Mitigative Features:**

**Engineered:**
- None

**Admin:**
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

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<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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<td>Mitigators</td>
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<td>Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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**Notes:**
- None

**References:**
- None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Small Fire - Type B Container Loading/Unloading (2g)
**Hazard Evaluation Table - Event AGTRU-1-050**

**Description:**
A non-waste bearing vehicle impacts stored TRU waste at > 10 mph and < 35 mph resulting in fuel tank leak/ rupture with ignition source resulting in fuel pool fire releasing radiological material.

**Locations:**
- Area G

**MARS:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Ignition source
- Inclement weather
- Leaks/ drips
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

### Consequence / Risk Rank

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**Preventive Features:**

- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)

- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Mitigative Features:**

- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

<table>
<thead>
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<th>Preventers</th>
<th>Control</th>
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<tbody>
<tr>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>All</td>
</tr>
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</table>

**Safety Function:**
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact.

The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

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<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

<p>| PSAC       | Radiological | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport | Rad: P; |</p>
<table>
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<th>Inventory Management - Defined Area MAR Control (IC)</th>
<th>Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</th>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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**Notes:**
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:** None

**DOE 5506 Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
Hazard Evaluation Table - Event AGTRU-1-051

**Description:**
A vehicle/equipment fuel tank spills, leaks, or ruptures adjacent to stored TRU waste with a subsequent pool fire. The pool is adjacent to, but does not engulf but exposes the adjacent waste resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412
- MARs: 1,140 PEC (Statistical mean exposed along one side of 22,000 PEC storage array)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Inclement weather
- Leaks/drips
- Operator error
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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**Preventive Features:**
- **Engineered:** None
- **Admin:** (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

**Mitigative Features:**
- **Engineered:** None
- **Admin:** (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

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<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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| Mitigators | PSAC Combustible/Flammable Liquids Control | Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals. | • Rad: P, C, W; |
| Safety Function: | Reduce radiological consequences by limiting amount of MAR involved. |

| PSAC Radiological Inventory Management - Defined Area MAR Control (IC) | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) | • Rad: P, C, W; |
| Safety Function: | Reduces the radiological consequences by limiting the MAR involved |

**Notes:**
- Deleted
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
None

**Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
### Hazard Evaluation Table - Event AGTRU-1-052

**Description:**
Large refueling vehicle spills fuel during refueling of loaded TRU waste transport vehicle with subsequent pool fire engulfing the transport vehicle resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Equipment malfunction
- Ignition source
- Leaks/drips
- Operator error
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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</table>

**Preventive Features:**

**Engineered None**

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (PSAC) Vehicle Refueling Prohibition (Vehicles/equipment transporting MAR are not to be refueled)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered None**

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

**Preventers**
- PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers
  - **Safety Function:** Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
- PSAC Vehicle Refueling Prohibition
  - **Safety Function:** Reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.

**Mitigators**
- PSAC Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (IC)
  - **Safety Function:** Reduce radiological consequences by limiting MAR involved
- PSAC Radiological Inventory Management - TRU Waste Drum Doublepack
  - **Safety Function:** Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
- Deleted
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- DOE 5506
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
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**Chapter 3: Hazard and Accident Analysis**

**Appendix 3H**

- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
## Hazard Evaluation Table - Event AGTRU-1-053

### Description:
Contents in waste storage area sump ignites. The fire exposes the adjacent stored waste to heat causing container rupture resulting in a release of radiological material.

### Locations:
- TRU storage areas with sumps

### MARs:
- 699 PEC (Statistical 24 (all) containers, sphere of fire heating influence)

### Release Mechanisms:
- Exposure Fire

### Assumptions:
None

### Causes:
- Combustible material in sump
- Hot Work
- Ignition source

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Consequence / Risk Rank

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### Preventive Features:
**Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

### Mitigative Features:
**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
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<tr>
<td>SMP Fire Protection Program - Good Housekeeping and Inspections</td>
<td></td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
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<td>Safety Function:</td>
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<td></td>
<td>Reduces the likelihood of fire progression</td>
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<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>PSAC Combustible/ Flammable Liquids Control</td>
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<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
<td>Rad: P, C, W;</td>
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<td>Safety Function:</td>
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<tr>
<td></td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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### Notes:
- Deleted

### References:
None

### DOE 5506
- Small Fire - Characterization (2a)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Small Fire - Type B Container Loading/Unloading (2g)

---


12/17/2013
## Hazard Evaluation Table - Event AGTRU-1-054

### Description:
Self-igniting or flammable/combustible material in TRU waste container being processed ignites and burns during SSSR repackaging activities resulting in a fire and a release of radiological material. Adjacent staged waste is affected by heating from the fire.

### Locations:
- Area G

### MARS:
- < 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

### Release Mechanisms:
- Exposure Fire
- Fire

### Assumptions:
- None

### Causes:
- Chemical incompatibility w/ absorption material
- Chemical reaction
- Flammable/ combustible material
- Ignition source
- Mechanical failure
- Operator error
- Pyrophorics

### Unmitigated System Effects:
- None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A

### Mitigated Frequency: U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
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<tr>
<td>C</td>
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<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:
- **Admin** (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- **Engineered** (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- **Admin** (PSAC) Waste Packaging Control (Waste is packaged)

### Mitigative Features:
- **Engineered** (SS) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- **Admin** (PSAC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- **Admin** (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- **SMP** Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- **SMP** Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- **SMP** Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Stationary Fire Watch</td>
<td>A stationary fire watch is required in the SSSR process area</td>
</tr>
<tr>
<td>During SSSR Activities</td>
<td>whenever TRU waste is exposed.</td>
<td>Safety Function: Reduce the consequences of a fire event</td>
<td></td>
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<tr>
<td>-----------------------</td>
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</table>

### Notes:
None

### References:
None

### DOE 5506
- Small Fire - Waste Repackaging (2f)
- Enclosure Fire - Waste Repackaging (3f)
## Hazard Evaluation Table - Event AGTRU-1-055

**Description:**
Transient combustibles ignite and burn TRU waste being processed in SSSR causing a fire and resulting in a release of radiological material. Adjacent staged waste is affected by heating from the fire.

**Locations:**
- Area G

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
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<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<table>
<thead>
<tr>
<th>Preventive Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
</tr>
<tr>
<td>(PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)</td>
</tr>
<tr>
<td>(SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
<tr>
<td>(SS) (IC) Waste Packaging Control (Waste is packaged)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Mitigative Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
</tr>
<tr>
<td>(PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)</td>
</tr>
<tr>
<td>(PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)</td>
</tr>
<tr>
<td>(SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
<tr>
<td>(SS) (IC) Waste Packaging Control (Waste is packaged)</td>
</tr>
<tr>
<td>(PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)</td>
</tr>
<tr>
<td>(SSP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
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</table>

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
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</table>

| Mitigators | PSAC | Fire Protection - Control of Transient Combustibles | Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers. | P, C, W; |
|            | Safety Function: | | | |

### Notes:
- Deleted

### References:
None

### DOE 5506
- Small Fire - Waste Repackaging (2f)
| Detail               | Enclosure Fire - Waste Repackaging (3f) |
### Hazard Evaluation Table - Event AGTRU-1-056

**Description:**
During size reduction activities in the SSSR, the use of equipment (e.g., wet vac, power drill, nibbler, chop saw, grinder) provides an ignition source and causes TRU waste to ignite with subsequent fire and affects staged waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<td>Unmit. Chm</td>
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</tr>
<tr>
<td>W</td>
<td>Unmit. Phy</td>
<td>DSA Mit.</td>
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</table>

#### Preventive Features:

**Engineered**

- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**

- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is</td>
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|    |         | Safety Function: | | |}
<table>
<thead>
<tr>
<th>PSAC</th>
<th>Stationary Fire Watch During SSSR Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
</tr>
</tbody>
</table>

Reduce the consequences of a fire event.

**Notes:** None

**References:** None

**DOE 5506**

- Small Fire - Waste Repackaging (2f)

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12/17/2013
### Hazard Evaluation Table - Event AGTRU-1-057

**Description:**
During size reduction activities in the SSSR, support equipment (e.g., vehicle, forklift, overhead hoist, compacting equipment) fail or overheat causing TRU waste to ignite with subsequent fire resulting in a release of radiological material. Adjacent staged waste is affected by heating from the fire.

**Locations:**
- Area G
- MARs:
  - ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
  - ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

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</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
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<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduce the likelihood of progression of a fire between defined areas.</td>
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</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of progression within a defined area so that MAR involvement is limited.</td>
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<tr>
<td>PSAC</td>
<td>Stationary Fire Watch During SSSR Activities</td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce the consequences of a fire event.</td>
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</tbody>
</table>
Notes: None
References: None

DOE 5506

Detail: Small Fire - Waste Repackaging (2f)
Hazard Evaluation Table - Event AGTRU-1-058

Description:
Radiant heating equipment in use during SSSR processing of TRU waste ignites and burns uncontained waste results in the release of radiological material. Adjacent staged waste is effected by the heat of the fire.

Locations:
- Area G

MARS:
- ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

Release Mechanisms:
- Exposure Fire
- Fire

Assumptions:
None

Causes:
- Ignition source
- Operator error
- Radiant heating

Unmitigated System Effects:

Unmitigated Frequency: A

Methods of Detection:
- Observation

Consequence / Risk Rank

Preventive Features:
Engineered: None

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

Mitigative Features:
Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

Preventers
PSAC
- Fire Protection - Thermal Separation Distance - Defined Area
  - Control: Prevent
  - Attribute: Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
  - Affected Receptors: All

Safety Function:
Reduce radiological consequences by limiting the amount of MAR involved.
Reduce the likelihood of progression of a fire between defined areas.

Mitigators

PSAC
- Fire Protection - Control of Transient Combustibles
  - Control: Prevent
  - Attribute: Reduce the likelihood of progression of a fire between defined areas.
  - Affected Receptors: All

Safety Function:
Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.

PSAC
- Stationary Fire Watch During SSSR Activities
  - Control: Prevent
  - Attribute: A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.
  - Affected Receptors: All

Safety Function:
Reduce the consequences of a fire event.

Notes:
None

References:
None
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<tr>
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<th>Detail</th>
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<tr>
<td></td>
<td>Small Fire - Waste Repackaging (2f)</td>
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Hazard Evaluation Table - Event AGTRU-1-060

**Description:**
Contents in waste storage area sump ignite. The fire affects the adjacent non-metal TRU waste containers resulting in a release of radiological material.

**Locations:**
- TRU storage areas with sumps

**MARS:**
- 1,611 PEC (36 statistical non-metal containers)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Combustible material in sump
- Hot Work
- Ignition source

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
<th>DSA Mit.</th>
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<th>DSA Mit.</th>
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<td>M</td>
<td>III</td>
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</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td></td>
</tr>
</tbody>
</table>

| SMP | Fire Protection Program - Good Housekeeping and Inspections |
| Safety Function: | Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE |

| Mitigators | SS | Waste Packaging Control (IC) |
| Safety Function: | Waste is packaged |

| PSAC | Combustible/ Flammable Liquids Control |
| Safety Function: | Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals. |

**Notes:**
- Deleted

**References:**
None

**DOE 5506 Detail:**
- Large Fire - Characterization (4a)
- Large Fire - Staging and Storage (4d)
- Large Fire - Waste Repackaging (4f)
### Hazard Evaluation Table - Event AGTRU-1-062

**Description:**
Equipment (e.g., liquid fueled forklift) transporting a payload for MLU loading operation catches on fire adjacent to staged/ stored TRU waste containers resulting in release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**MARS:**
- 1,950 PEC (TRUPACT MAR)
- 699 PEC (Statistical 24 (all) containers, sphere of fire heating influence)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- MAR in closed TRUPACT is excluded from payload process inventory.

**Causes:**
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error
- Vehicle accident

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
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<tbody>
<tr>
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<tr>
<td>W</td>
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</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the likelihood of fire progression</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
</tr>
</tbody>
</table>

**Mitigators**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- Rad: P, C, W,
<table>
<thead>
<tr>
<th>IC</th>
<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>Waste Packaging Control (IC) Waste is packaged Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- None

**DOE 5506 Detail:**
- Small Fire - Type B Container Loading/Unloading (2g)
### Hazard Evaluation Table - Event AGTRU-1-064

**Description:**
Support equipment (e.g., diesel generator) ignites staged TRUPACT payload during MLU operations resulting in release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412
- MARs: 1,950 PEC (TRUPACT MAR)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

<table>
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<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<table>
<thead>
<tr>
<th>Preventive Features:</th>
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</thead>
<tbody>
<tr>
<td><strong>Engineered</strong> None</td>
</tr>
<tr>
<td><strong>Admin</strong></td>
</tr>
</tbody>
</table>

- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

<table>
<thead>
<tr>
<th>Mitigative Features:</th>
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</thead>
<tbody>
<tr>
<td><strong>Engineered</strong> None</td>
</tr>
<tr>
<td><strong>Admin</strong></td>
</tr>
</tbody>
</table>

- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)

#### Credited SSCs and ACs

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<tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce radiological consequences by limiting the amount of MAR involved

**Safety Function:**
Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
- Deleted

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Type B Container Loading/Unloading (2g)
# Hazard Evaluation Table - Event AGTRU-1-066

**Description:**
Transient combustibles ignite during MLU operations affecting TRUPACT payload resulting in a fire releasing radiological material.

**Locations:**
- TRU storage areas except BLDG 412
- MARS: 1.950 PEC (TRUPACT MAR)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
EU

## Consequence / Risk Rank

<table>
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<tr>
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<th>Affected Receptors</th>
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</thead>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
</tr>
<tr>
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<td>SMP</td>
<td>Safety Function:</td>
<td>Reduces the likelihood of fire progression</td>
</tr>
<tr>
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<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
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<tr>
<td></td>
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<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Safety Function:</td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Safety Function:</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles</td>
</tr>
</tbody>
</table>

**Notes:**
- Combustible /flammable materials external to container
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

---

CHA Report  
Basis for Interim Operation Rev. 3.0  
November 2014

Chapter 3: Hazard and Accident Analysis  
Appendix 3H

3H-162
## Hazard Evaluation Table - Event AGTRU-1-069

| Description: | Two (2) vehicles, each transporting multiple TRU waste containers, impact at > 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste containers in transport resulting in the release of radiological material. |
| locations: | MARs: |
| Area G | 1,096 PEC (Statistical 96 metal containers: 48 containers per vehicle) |

### Release Mechanisms:
- Fuel pool fire release
- High energy impact
- Impact and spill

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Unmitigated Frequency: EU

### Consequence / Risk Rank

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<th>Receptor</th>
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</tr>
</tbody>
</table>

### Preventive Features:
- Admin
  - (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
  - (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
  - (PSAC) Escort of High MAR TRU Waste Transport Within Ta-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
  - (PSAC) Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)
- Engineer
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) (IC) Waste Packaging Control (Waste is packaged)

### Mitigative Features:
- Admin
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
  - (PSAC) Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit (The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.)
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G– Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
<th>Metal TRU waste container are of sound integrity</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit</td>
<td>The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
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</tbody>
</table>

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event AGTRU-1-070

Description:
A vehicle/equipment fuel tank spills, leaks, or ruptures adjacent to TRU waste SSSR with a subsequent pool fire involving only the SSSR MAR resulting in a release of radiological material.

Locations:
- Area G

MARS:
- \( \leq 18 \) PEC equivalent combustible TRU waste, open, in SSSR process

Release Mechanisms:
- Fuel pool fire release

Assumptions:
None

Causes:
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U

Mitigated Frequency: EU

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
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<tr>
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<tr>
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<td>L</td>
<td>IV</td>
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</tr>
</tbody>
</table>

Consequence / Risk Rank

Preventive Features:
- None
  - (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

Mitigative Features:
- None
  - (PSAC) Combustible/Flammable Liquids Control (Control of Combustible/Flammable Liquids in Defined Areas) (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
  - (PSAC) Fire Protection - Control of Transient Combustibles (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

Credited SSCs and ACs

Preventers
- Fire Protection - Thermal Separation Distance - Defined Area
  - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
  - Safety Function: Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

Mitigators
- Combustible/Flammable Liquids Control
  - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
  - Safety Function: Reduce radiological consequences by limiting the amount of MAR involved

- Fire Protection - Control of Transient Combustibles
  - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
  - Safety Function: Reduce radiological consequences by limiting the amount of MAR involved

Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:
- None
- DOE 5506
- Fuel Pool Fire - Waste Repackaging (1f)

Hazard Evaluation Table - Event AGTRU-1-071

Description:
A vehicle transporting multiple unvented TRU waste containers at > 10 mph and ≤ 35 mph is involved in an accident (no impacts to any additional waste). A portion of the waste is spilled due to containers being ruptured by the impact. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the unvented TRU waste in transport resulting in the release of radiological material. No additional waste is sufficiently close to the fire to be affected by heating.

Locations:
- Area G

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

Methods of Detection:
- Observation

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)).
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)).
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation).
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)).
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph).

Mitigative Features:
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport).

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
<td>All</td>
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<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P,</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Safety Function: Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion.</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References:
None

DOE 5506 Detail:
- Fuel Pool Fire - Container Handling (1b)
**Hazard Evaluation Table - Event AGTRU-1-072**

**Description:**
Two (2) vehicles, one transporting a single TRU waste container and the other transporting multiple unvented TRU waste containers, impact at > 10 mph and < 35 mph. The accident involves no additional waste. A portion of the waste is spilled due to containers being ruptured by the impact. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the unvented TRU waste in transport resulting in the release of radiological material.

**Locations:**
- Area G
- MARs:
  - 311 PEC (Statistical 48 metal containers (One vehicle load) without high MAR container)
  - 553 PEC (One (1) TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Ph</th>
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<th>Ph</th>
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<td>IV</td>
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</tr>
</tbody>
</table>

**Preventive Features:**
- Engineered None

- Admin
  - (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.)
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- Engineered
  - (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) Waste Packaging Control (Waste is packaged)

- Admin
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<tr>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

### Safety Function:
- Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
- Reduces the radiological consequences as waste is agglomerated and burns.
as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>SS</th>
<th>Waste Packaging Control (IC)</th>
<th>Waste is packaged</th>
<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>Safety Function: Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
</tr>
</tbody>
</table>

Notes:  
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506  
Detail: Fuel Pool Fire - Container Handling (1b)
### Hazard Evaluation Table - Event AGTRU-1-073

**Description:**
A vehicle transporting multiple unvented TRU waste containers catches on fire adjacent to TRU waste. The heat of the fire affects the unvented TRU waste being transported and the TRU waste in proximity to the vehicle resulting in a release of radiological material.

**Locations:**
- Area G
- MAR:
  - 690 PEC (Statistical 24 metal containers, sphere of fire heating influence)
  - ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- None

**Causes:**
- Electrical short
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<td>Unmit.</td>
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<tr>
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<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))

**Mitigative Features:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker) (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
</tbody>
</table>

| Safety Function: | Reduces the frequency of vehicle accidents and impact to stored radiological waste containers. |

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**Chapter 3: Hazard and Accident Analysis**

Appendix 3H

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| PSAC | Fire Protection - Control of Transient Combustibles | Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers. |
| Safety Function: | Reduces the radiological consequences as waste is agglomerated and burns as packaged |
| PSAC | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. |
| Safety Function: | Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas. |
| PSAC | TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation | Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker. |
| Safety Function: | Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion |

### Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
None

### DOE 5506 Detail:
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Type B Container Loading/Unloading (2g)
## Hazard Evaluation Table - Event AGTRU-1-074

### Description:
A non-waste bearing vehicle/equipment impacts unvented TRU waste container storage area at > 10 mph and ≤ 35 mph with subsequent fire. The impacted unvented containers are damaged and the contents burned resulting in a release of radiological material.

### Locations:
- Area G

### MARs:
- 877 PEC (Statistical 48 (all) containers, moderate impact release)

### Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Ignition source
- Improper equipment use
- Improperly maintained equipment
- Inclement weather
- Mechanical failure
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: U

### Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<tr>
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<td>I</td>
<td>M</td>
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</tbody>
</table>

### Preventive Features:

#### Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

#### Admin
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

#### Engineered
None

#### Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

### Credited SSCs and ACs

#### Class Control
- Preventers
  - SS

#### Preventers Class SS
- Vehicle Barriers-High Risk Locations
  - Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

#### Safety Function:
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the

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Chapter 3: Hazard and Accident Analysis
Appendix 3H

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Radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
<thead>
<tr>
<th>PSAC</th>
<th>TRU Waste Container Management - Isolate Unvented Containers</th>
<th>Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container</th>
<th>All</th>
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<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for deflagration</td>
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<table>
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<tr>
<th>Mitigators</th>
<th>PSAC</th>
<th>Fire Protection - Thermal Separation Distance - Defined Area</th>
<th>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</th>
<th>Rad: P, C, W;</th>
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</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
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</table>

Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail: • Small Fire - Venting and/or Abating/Purging (2c)
• Small Fire - Staging and Storage (2d)
Hazard Evaluation Table - Event AGTRU-1-075

Description:
Waste handling vehicle/ equipment enters the storage array and catches on fire adjacent to TRU waste. The heat of the fire affects the TRU waste being handled and the stored containers in proximity to the vehicle results in a release of radiological material.

Locations:
- TRU storage areas except BLDG 412

MARS:
- 699 PEC (Statistical 24 (all) containers, sphere of fire heating influence)

Release Mechanisms:
- Exposure Fire

Assumptions:
None

Causes:
- Electrical short
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: EU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tbody>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
None

Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Periodic inspections for housekeeping are conducted to minimize solid transient combustibles, and vegetation control, to include inspection by a LANL FPE.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

Preventers

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Safety Function: Reduce likelihood of equipment malfunction</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
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<td>Safety Function: Reduces likelihood for vehicle and equipment accidents</td>
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Mitigators

<table>
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<tr>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<td></td>
<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
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<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
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<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
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<tr>
<td></td>
<td>Safety Function: Reduces radiological consequences due to exposure</td>
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</table>

Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction
may be given based on the robustness of the programs and the individual elements

<table>
<thead>
<tr>
<th>References</th>
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<tr>
<td>DOE 5506</td>
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<td>Detail:</td>
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<td></td>
<td>● Small Fire - Characterization (2a)</td>
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<td>● Small Fire - Container Handling (2b)</td>
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<tr>
<td></td>
<td>● Small Fire - Venting and/or Abating/Purging (2c)</td>
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<tr>
<td></td>
<td>● Small Fire - Staging and Storage (2d)</td>
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<td></td>
<td>● Small Fire - Waste Repackaging (2f)</td>
</tr>
<tr>
<td></td>
<td>● Small Fire - Type B Container Loading/Unloading (2g)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-1-076

**Description:**
Liquid fuel is spilled while refueling equipment (non-waste bearing, less than 100 gallons capacity tank, with subsequent pool fire engulfing stored TRU waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- None

**Causes:**
- Equipment malfunction
- Ignition source
- Leaks/ drips
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
<tr>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

### Mitigative Features:

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (PSAC) Vehicle Refueling Prohibition (Vehicles/ equipment transporting MAR are not to be refueled)

### Credited SSCs and ACs

**Preventers**
- PSAC Vehicle/ Equipment Safety Control – Refueling Location

**Safety Function:**
- Refueling location will be separated from MAR in defined areas by the thermal separation distance.
- Reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.

**Mitigators**
- SS Hazardous Material and Waste Management - TRU Waste Container (IC)

**Safety Function:**
- Metal TRU waste container are of sound integrity
- Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

**PSAC Waste Packaging Control (IC)**

**Safety Function:**
- Waste is packaged
- Reduces the radiological consequences as waste is agglomerated and burns as packaged

**PSAC Radiological Inventory Management - Defined Area MAR Control (IC)**

**Safety Function:**
- Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)
- Reduces the radiological consequences by limiting the MAR involved

**PSAC Radiological Inventory Management - TRU Waste Drum Doublepack**

**Safety Function:**
- Doublepack radiological waste drums > 200 PEC
- Reduces radiological consequences by limiting amount of MAR involved

**PSAC Vehicle Refueling Prohibition**

**Safety Function:**
- Vehicles/ equipment transporting MAR are not to be refueled
- Reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.

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**Chapter 3: Hazard and Accident Analysis**

**Appendix 3H**

3H-177

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The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

<table>
<thead>
<tr>
<th>References: None</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOE 5506</strong></td>
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<tr>
<td><strong>Detail:</strong></td>
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<td>● Fuel Pool Fire - Characterization (1a)</td>
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<tr>
<td>● Fuel Pool Fire - Container Handling (1b)</td>
</tr>
<tr>
<td>● Fuel Pool Fire - Venting and/or Abating/Purging (1c)</td>
</tr>
<tr>
<td>● Fuel Pool Fire - Staging and Storage (1d)</td>
</tr>
<tr>
<td>● Fuel Pool Fire - Waste Repackaging (1f)</td>
</tr>
<tr>
<td>● Fuel Pool Fire - Type B Container Loading/Unloading (1g)</td>
</tr>
</tbody>
</table>
## Hazard Evaluation Table - Event AGTRU-1-077

### Description:
Two (2) vehicles, each transporting multiple non-compliant TRU waste containers, impact at > 10 mph and < 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

### Locations:
- Area G

### MARs:
- 805 PEC (Statistical 4 non-metal containers)

### Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU
Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
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<td>P</td>
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<td>II</td>
<td>H</td>
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<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

### Preventive Features:

- (PSAC) Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

- (SS) Rad Radiological Inventory Management - Defined Area MAR Control (Waste is packaged)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
</tr>
<tr>
<td></td>
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<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit</td>
<td>The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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<td>-----------------</td>
<td>----------------------------------------------------------</td>
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</tr>
</tbody>
</table>
| Notes:          | - It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| References:     | None |
| DOE 5506        | Fuel Pool Fire - Container Handling (1b) |

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.
Description:
A large refueling vehicle traveling at > 10 mph and ≤ 35 mph impacts a process area with multiple unvented TRU waste containers retrieved from Pit 9. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in the process area resulting in a release of radiological material.

Locations:
- Area G

MARS:
- 877 PEC (Statistical 48 (all) containers)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: BEU

Consequence / Risk Rank

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<thead>
<tr>
<th>Receptor</th>
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<td>Chm</td>
</tr>
<tr>
<td>W</td>
<td>Rad</td>
<td>Chm</td>
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Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)

Mitigative Features:

Engineered
None

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>All</td>
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<td>Safety Function:</td>
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<tr>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
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<td>Fire Protection -</td>
<td>Reduce the frequency of the propagation of fire between defined areas by</td>
<td>Rad: P,</td>
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<tr>
<td>Thermal Separation Distance - Defined Area</td>
<td>C, W; limiting the heat flux to radiological waste containers.</td>
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<tr>
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<td>-------------------------------------------------------------</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Notes:                                   | • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
• The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth. |
| References:                              | None |
| DOE 5506 Detail:                         | • Fuel Pool Fire - Characterization (1a)  
• Fuel Pool Fire - Container Handling (1b)  
• Fuel Pool Fire - Venting and/or Abating/Purging (1c)  
• Fuel Pool Fire - Staging and Storage (1d)  
• Fuel Pool Fire - Waste Repackaging (1f)  
• Fuel Pool Fire - Type B Container Loading/Unloading (1g) |
Hazard Evaluation Table - Event AGTRU-1-079

Description:
Vehicle transporting multiple TRU waste containers crashes into Pit 9 at > 10 mph and ≤ 35 mph, breaches containers, and ruptures fuel tank resulting in a pool fire with the release of radiological material.

Locations:
- Area G

MARS:
- ≤ 1,100 PEC (MAR limit for single transport vehicle)
- ≤ 1,500 PEC (Retrieval Area MAR limit)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
Observation

Unmitigated Frequency: EU

Mitigated Frequency: BEU

Consequence / Risk Rank

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<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) (IC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
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<tr>
<th>Class</th>
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<td>Preventers</td>
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<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)</td>
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<tr>
<td>Mitigators</td>
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<td>------------</td>
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<td>--------</td>
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</tr>
<tr>
<td>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
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<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit (IC)</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. 
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail: 
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event AGTRU-1-080

**Description:**
Vehicle transporting multiple TRU waste containers crashes into Pit 9 and breaches containers resulting in a fire with the release of radiological material.

### Locations:
- **Area G**

### Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- U

### Mitigated Frequency:
- BEU

### Consequence / Risk Rank

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<th>Receptor</th>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
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</table>

### Preventive Features:

#### Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches.
- The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

#### Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

#### Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

#### Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) (IC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit (The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph)</td>
</tr>
<tr>
<td>Locations</td>
<td>with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
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<td>---</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</td>
<td></td>
<td></td>
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<tr>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back). All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC) Metal TRU waste container are of sound integrity • Rad: P, C, W;</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
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<tr>
<td>SS</td>
<td>Waste Packaging Control (IC) Waste is packaged • Rad: P, C, W;</td>
<td></td>
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<tr>
<td>Safety Function:</td>
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<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit (IC)</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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<tr>
<td>PSAC Radiological Inventory Management - Transportation Vehicle Mixed Load MAR Limit</td>
<td>The total TRU MAR inventory on a transportation vehicle with one or more non-compliant metal or non-metal containers does not exceed 615 PE-Ci. • Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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<td></td>
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<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC • Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>• When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
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<td>References:</td>
<td>None</td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>• Small Fire - Staging and Storage (2d) • Small Fire - Retrieval and Excavation (2e)</td>
<td></td>
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</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-1-081

Description:
Non-waste bearing liquid fueled vehicle/ equipment operating at > 10 mph and ≤ 35 mph within storage array impacts stacked TRU waste containers. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the stored waste resulting in a release of radiological material.

Locations:
- TRU storage areas except BLDG 412

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
Observation

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>P</td>
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</tr>
<tr>
<td>W</td>
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<td>II</td>
<td>M</td>
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</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

Credited SSCs and ACs

Preventers

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<tbody>
<tr>
<td>SS</td>
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<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>All</td>
</tr>
</tbody>
</table>

Safety Function: The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste

Chapter 3: Hazard and Accident Analysis
Appendix 3H
containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SS</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
<th>Metal TRU waste container are of sound integrity</th>
<th>● Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>PSAC</td>
<td>Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
<td>● Rad: P, C, W;</td>
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<td>Safety Function:</td>
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</table>

**Notes:**
- Credited controls to restrict operations of a liquid fueled vehicle in storage areas and barriers around storage areas removes the storage pad inventory from the unmitigated MAR.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- None

**DOE 5506 Detail:**
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Waste Repackaging (1f)
Hazard Evaluation Table - Event AGTRU-1-082

Description:
Diesel powered forklift fuel tank is ruptured during FRP operations within stored TRU waste. Diesel fuel is spilled and ignited resulting in a pool fire with a release of radiological material.

Locations:  
- Area G

MARS:  
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

Release Mechanisms:  
- Fuel pool fire release

Assumptions:  
None

Causes:  
- Equipment malfunction
- Ignition source
- Operator error

Unmitigated System Effects:  
None

Methods of Detection:  
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: EU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
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<td>W</td>
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<td>II</td>
<td>M</td>
<td>III</td>
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Preventive Features:

Engineered None

Admin  
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

Mitigative Features:

Engineered  
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin  
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

Credited SSCs and ACs

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<tr>
<td>Preventers</td>
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<td>Waste Packaging Control (IC)</td>
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<td>Mitigators</td>
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<td>Waste Packaging Control (IC)</td>
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<tr>
<td>Safety Function:</td>
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<tr>
<td>PSAC</td>
<td>Combustible/Flammable Liquids Control</td>
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</table>

Notes:  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:  
None
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<thead>
<tr>
<th>DOE 5506</th>
<th>Detail:</th>
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<tr>
<td></td>
<td>• Fuel Pool Fire - Characterization (1a)</td>
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<td>• Fuel Pool Fire - Container Handling (1b)</td>
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<td>• Fuel Pool Fire - Staging and Storage (1d)</td>
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<td>• Fuel Pool Fire - Waste Repackaging (1f)</td>
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<td></td>
<td>• Fuel Pool Fire - Type B Container Loading/Unloading (1g)</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
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<td>-------------</td>
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<tr>
<td>Accident or malfunction involving propane powered forklift results in puncture or leak from forklift's propane fuel line or tank. Leaking propane fuel is ignited resulting in a flame jet (blowtorch) that impinges on stored TRU waste drums leading to a release of radioactive material.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Locations:</th>
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<tbody>
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<td>Area G</td>
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<th>MARs:</th>
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<tr>
<td>658 PEC (Statistical (all containers) 4 containers on pallet)</td>
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<th>Release Mechanisms:</th>
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<tr>
<td>Propane jet fire impinges on TRU waste drums</td>
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<td>Equipment malfunction</td>
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<tr>
<th>Preventive Features:</th>
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<tr>
<td>Engineered None</td>
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<tr>
<td>Admin (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)</td>
</tr>
<tr>
<td>(SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))</td>
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<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
</tr>
<tr>
<td>Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)</td>
</tr>
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<table>
<thead>
<tr>
<th>Mitigative Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered None</td>
</tr>
<tr>
<td>Admin (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
<tr>
<td>(SS) (IC) Waste Packaging Control (Waste is packaged)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credited SSCs and ACs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers None</td>
</tr>
<tr>
<td>Mitigators None</td>
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<tr>
<td>This event bounded by AGTRU-1-044.</td>
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<tr>
<td>Unmitigated frequency of EU considers a propane fuel leak small enough to create a pressurized jet (as opposed to a large breach causing a spill/evaporation/ignition/explosion), concurrent with an ignition source AND containers in the direct path of the flame jet and close enough to be exposed to the flame jet for a duration long enough to release material AND the involved MAR consisting of the four statistically high MAR containers.</td>
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</table>

<table>
<thead>
<tr>
<th>References:</th>
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<tr>
<th>Detail:</th>
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<tr>
<td>None</td>
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</table>
Hazard Evaluation Table - Event AGTRU-2-001

Description:
Propane/ gasoline vapors accumulate near compliant TRU waste containers with coincidental ignition source leads to a Vapor Cloud Explosion/ deflagration affecting TRU waste resulting in a release of radiological material.

Locations:
- TRU storage areas except BLDG 412

MARS:
- < 4,400 PEC (20% exposure of Storage Area containing < 22,000 PEC)

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

Assumptions:
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

Causes:
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Lighting
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: EU

<table>
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<tr>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
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</table>

Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td></td>
<td>Rad: P, C, W;</td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
</tbody>
</table>

Notes:
- The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.

References:
- DOE 5506
- Detail:
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Container Handling (5b)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Venting and/or Abating/Purging (5c)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)
  - Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Other (5h)
# Hazard Evaluation Table - Event AGTRU-2-002

**Description:**
A single vented TRU waste container is violently shaken causing a deflagration resulting in a release of radiological material.

**Locations:**
- **Area G**

**MARs:**
- 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Crane topples
- Drop
- Equipment malfunction
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

## Consequence / Risk Rank

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<th>Phy</th>
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</tr>
<tr>
<td>W</td>
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</table>

## Preventive Features:

**Engineered**
None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

## Mitigative Features:

**Engineered**
None

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

## Credited SSCs and ACs

**Preventers**
- **Class**: PSAC
- **Control**: Elevated Waste Movements and Critical Lifts - critical lifts
- **Attribute**: A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)
- **Safety Function**: Reduce likelihood for load drops resulting in release of radiological material
- **Affected Receptors**: All

**Mitigators**
- **Class**: PSAC
- **Control**: Radiological Inventory Management - TRU Waste Drum Doublepack
- **Attribute**: Doublepack radiological waste drums > 200 PEC
- **Safety Function**: Reduce radiological consequences by limiting amount of MAR involved
- **Affected Receptors**: Rad: P, C, W;

**Notes:**
- Exclude FRPs, other wooden boxes, and large metal containers (e.g., SWB, Sealand, Transportainer)
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- DOE 5506
- Waste Container Deflagration - Characterization (6a)
Detail:

- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Waste Container Deflagration - Staging and Storage (6d)
- Waste Container Deflagration - Type B Container Loading/Unloading (6g)
## Hazard Evaluation Table - Event AGTRU-2-003

### Description:
Flammable atmosphere developed around electric forklift/ drum handling equipment is ignited causing a deflagration during battery charging resulting in a release of radiological material.

### Locations:
- Area G

### MARs:
- < 4,400 PEC (20% exposure of Storage Area containing < 22,000 PEC)

### Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

### Assumptions:
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

### Causes:
- Ignition source
- Lead/acid battery offgas
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
EU

### Mitigated Frequency:
EU

### Consequence / Risk Rank

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<tr>
<td>W</td>
<td>M</td>
<td>III</td>
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</tr>
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</table>

### Preventive Features:
- Engineered: None
- Admin: None

### Mitigative Features:
- Engineered: None
- Admin: (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

<table>
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<tr>
<th>Class</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>Rad: P, C, W;</td>
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</table>

### Preventers:
None

### Mitigators:
- PSAC Radiological Inventory Management - Defined Area MAR Control (IC)
  - Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)

### Safety Function:
Reduces the radiological consequences by limiting the MAR involved

### Notes:
The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.

### References:
None

### DOE 5506 Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Container Handling (5b)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Venting and/or Abating/Purging (5c)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Other (5h)
### Hazard Evaluation Table - Event AGTRU-2-005

**Description:**
Multiple elevated vented TRU waste containers are violently shaken due to a fall inducing multiple deflagrations which result in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 699 PEC (Statistical 24 (all) containers, low impact release)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact

**Assumptions:**
- Newly vented containers are isolated and treated as unvented until hydrogen concentration is verified to be less than 8%.

**Locations:**
- Area G

**MARs:**
- 699 PEC (Statistical 24 (all) containers, low impact release)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact

**Assumptions:**
- Newly vented containers are isolated and treated as unvented until hydrogen concentration is verified to be less than 8%.

**Causes:**
- Container mishandling
- Drop from elevated conveyor
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Operator error
- Seismic event
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EB

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
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<th>Consequence</th>
<th>Risk Rank</th>
</tr>
</thead>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts - Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered**
- None

**Admin**
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

**Preventers**
- PSAC Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- Safety Function: Reduce likelihood for load drops resulting in release of radiological material

**Mitigators**
- PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- Safety Function: Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion

**Notes:**
- 24 containers bounds the statistical quantity of containers placed on the HENC conveyor system including the maximum MAR container.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None
<table>
<thead>
<tr>
<th>DOE 5506</th>
<th>Detail</th>
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<tr>
<td></td>
<td>● Multiple Waste Container Deflagration - Staging and Storage (7d)</td>
</tr>
<tr>
<td></td>
<td>● Seismic Event (Impact Only) - Staging and Storage (24d)</td>
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</table>
Hazard Evaluation Table - Event AGTRU-2-006

**Description:**
Flammable atmosphere develops in the thermal equalization unit that deflagrates during TRU waste container conditioning resulting in a release of radiological material.

**Locations:**
- Area G Pad 10

**MARs:**
- 877 PEC (Statistical 48 (all) containers)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Equipment malfunction
- Flammable gas buildup from container offgas
- Ignition source
- Operator error
- Radiant heating

**Unmitigated System Effects:**
None

**Methods of Detection:**
None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<td>H III</td>
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<tr>
<td>W</td>
<td>H II</td>
<td>H III</td>
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</table>

**Preventive Features:**

- Engineered None
- Admin (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)

**Mitigative Features:**

- Engineered None
- Admin None

**Credited SSCs and ACs**

- **Preventers**
  - PSAC TRU Waste Container Management - Vented TRU Waste Drums
    - Above-ground outer TRU waste containers shall be passively vented
    - Reduces likelihood for build-up of internal gases which could lead to deflagration and/or over-pressurization
    - Affected Receptors: All

- **Mitigators**
  - None

**Notes:**
- The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.
- The physical process required for this event to occur is not physically plausible. The Thermal Equalization Units are not sealed and thus can not contain enough flammable gasses during the temperature equalization process to produce a flammable atmosphere. Therefore this event is not physically plausible.

**References:**
- None
- DOE 5506
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
- Enclosure Deflagration - Characterization (8a)

---

### Hazard Evaluation Table - Event AGTRU-2-007

**Description:**
A deflagration occurs in an unvented TRU waste container that causes additional sympathetic TRU waste container deflagrations resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 609 PEC (Two metal containers: 1 at 553 and 1 at 56)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- Affects of a sympathetic drum deflagration is vertical.
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Chemical reaction
- Container unvented or inadequately vented allowing the accumulation of internal pressure
- External heat source (sparks, fire, thermal radiation, solar, lightning)
- Flammable headspace
- Ignition source
- Pyrophorics
- Seismic event
- Shock sensitive material
- Static electricity
- Violent shaking

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

**Consequence / Risk Rank**

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<td>H I M III</td>
<td>H I H II</td>
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</table>

**Preventive Features:**

**Engineered:**
- None

**Admin:**
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**

**Engineered:**
- None

**Admin:**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)

**Credited SSCs and ACs**

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<th>Class</th>
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<th>Attribute</th>
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<tr>
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<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
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<tr>
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<td>Reduces likelihood for deflagration</td>
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<td>Mitigators</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste containers are not stacked</td>
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<td>Safety Function:</td>
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<tr>
<td></td>
<td></td>
<td>Reduces the radiological consequences from a sympathetic deflagration</td>
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**Notes:**
- None

**References:**
- None

**DOE 5506 Detail:**
- Multiple Waste Container Deflagration - Characterization (7a)
- Multiple Waste Container Deflagration - Container Handling (7b)
- Multiple Waste Container Deflagration - Venting and/or Abating/Purging (7c)
- Multiple Waste Container Deflagration - Staging and Storage (7d)
- Multiple Waste Container Deflagration - Waste Repackaging (7f)
- Multiple Waste Container Deflagration - Type B Container Loading/Unloading (7g)
**Hazard Evaluation Table - Event AGTRU-2-008**

**Description:**
During intrusive inspection or characterization activities (e.g., head gas sampling, filter replacement, lid ring bolt tightening) of a vented container, a spark is generated causing a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of confinement
- Moderate energy impact

**Assumptions:**
- Newly vented containers are isolated and treated as unvented until hydrogen concentration is verified to be less than 8%.

**Causes:**
- Flammable headspace
- Ignition source
- Metal to metal contact
- Operator error
- Static electricity

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** BEU

**Mitigated Frequency:** BEU

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**Consequence / Risk Rank**

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**Preventive Features:**

- Engineered: None
- Admin: None

**Mitigative Features:**

- Engineered: None
- Admin: None

**Credited SSCs and ACs**

<table>
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</table>

**Notes:**
- Intrusive characterization can only be performed on a vented drum due to its configuration (i.e., metal container, metal lid, and metal lid ring).

**References:**
- DOE 5506
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Enclosure Deflagration - Characterization (6a)
### Hazard Evaluation Table - Event AGTRU-2-009

**Description:**
External heating source causes flammable gas generation within a TRU waste container in coincidence with an ignition source resulting in a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Characterization equipment heat sources
- Drum vent failure
- Equipment malfunction
- Flammable headspace
- Inadequate venting
- Increased gas generation due to temperature increase
- Operator error
- Portable lighting generators, etc.
- Radiant heating
- Solar heating
- Space heater
- Unvented Lid

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** BEU

**Mitigated Frequency:** BEU

#### Consequence / Risk Rank

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<tr>
<td>Mitigators</td>
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</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

**Notes:**
The physical process required for this event to occur is not physically plausible. Internal pressures within a TRU waste container, generated by an external heating source, would leak from the seals. Flammable gas quantities released would be insufficient to produce a flammable atmosphere. Therefore this event is not physically plausible.

**References:**
- DOE 5506
- Detail:
  - Waste Container Deflagration - Characterization (6a)
  - Waste Container Deflagration - Container Handling (6b)
  - Waste Container Deflagration - Venting and/or Abating/Purging (6c)
  - Waste Container Deflagration - Staging and Storage (6d)
  - Waste Container Deflagration - Waste Repackaging (6f)
  - Waste Container Deflagration - Type B Container Loading/Unloading (6g)
Hazard Evaluation Table - Event AGTRU-2-011

Description:
While venting/remediating inner container during SSSR (e.g. one gallon pail, etc.), a flammable atmosphere develops in coincidence with an ignition source causing a deflagration resulting in a release of radiological material.

Locations:
- Area G

MARs:
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

Release Mechanisms:
- Deflagration external to container with subsequent fire

Assumptions:
- None

Causes:
- Flammable gases
- Ignition source

Unmitigated System Effects:
- None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: EU

Consequence / Risk Rank

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Preventive Features:
- None

Admin:
- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Mitigative Features:
- None

Admin:
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

Credited SSCs and ACs

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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
</tr>
</tbody>
</table>

Safety Function:
- Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.

Mitigators
- None

Notes:
- None

References:
- None

DOE 5506
Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
- Waste Container Deflagration - Waste Repackaging (6f)
### Hazard Evaluation Table - Event AGTRU-2-012

**Description:**
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts a pallet of TRU waste containers causing it to deflagrate and resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- High energy impact
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Flammable atmosphere (volatile organic compounds –VOCs or hydrogen) in a container
- Gas cylinder degradation
- Gas cylinder mishandling
- Improper storage of gas cylinder
- Operator error
- Vehicle accident

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- BEU

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</table>

**Consequence / Risk Rank**

**Preventive Features:**

**Engineered:**
- None

**Admin:**
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

**Mitigative Features:**

**Engineered:**
- None

**Admin:**
- None

**Credited SSCs and ACs**

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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
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<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for deflagration</td>
<td></td>
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<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/ or over-pressurization</td>
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</table>

**Mitigators:**
- None

**Notes:**
- None

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Waste Container Deflagration - Staging and Storage (6d)
- Waste Container Deflagration - Waste Repackaging (6f)
- Waste Container Deflagration - Type B Container Loading/Unloading (6g)
**Hazard Evaluation Table - Event AGTRU-2-013**

**Description:**
Two (2) vented TRU waste containers are punctured by forklift tines or inadvertently breached and deflagrate resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 609 PEC (Two metal containers: 1 at 553 and 1 at 56)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact

**Assumptions:**
- Newly vented containers are isolated and treated as unvented until hydrogen concentration is verified to be less than 8%.

**Causes:**
- Flammable headspace
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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**Preventive Features:**

**Engineered None**

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered None**

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for deflagration</td>
<td></td>
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<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
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<td>Safety Function:</td>
<td>Reduce likelihood for build-up of internal gases which could lead to deflagration and/ or over-pressurization</td>
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### Mitigators

**PSAC**
- Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

**Safety Function:**
- Reduce radiological consequences by limiting amount of MAR involved
  - Rad: P, C, W;

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Waste Container Deflagration - Staging and Storage (6d)
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<th>Waste Container Deflagration - Waste Repackaging (6f)</th>
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<tr>
<td>Waste Container Deflagration - Type B Container Loading/Unloading (6g)</td>
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**Hazard Evaluation Table - Event AGTRU-2-014**

**Description:**
Flammable atmosphere accumulates during remote container V&P activity with coincidental ignition source causes a deflagration resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**MARs:**
- 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- Affects of a sympathetic drum deflagration is vertical.

**Causes:**
- Equipment malfunction
- Flammable gases
- Ignition source
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Methods of Detection:**
None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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**Preventive Features:**

- **Engineered:** None

- **Admin:** (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)

**Mitigative Features:**

- **Engineered:** None

- **Admin:** (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)

**Credited SSCs and ACs**

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<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
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<td>Safety Function: Reduce likelihood for ignition of flammables/combustibles or deflagration</td>
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<td>PSAC</td>
<td>Drum Venting of Unvented TRU Waste Drums</td>
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<tr>
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<td>Safety Function: Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.</td>
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<td>Rad: P, C, W;</td>
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**Notes:**
- The physical process required for this event to occur is not physically plausible. Remote drum venting is conducted in areas where flammable gasses can not accumulate causing a deflagration external to the drum. Flammable gas concentrations required for a deflagration would not be sufficient to produce a flammable atmosphere. Therefore this event is not physically plausible.

**References:**
- None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Venting and/or Abating/Purging (5c)
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**Consequence / Risk Rank**

**Preventive Features:**

**Engineered** None

- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered** None

- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration, A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduce likelihood for ignition of flammables/ combustibles or deflagration

**Mitigators**

- PSAC Drum Venting of Unvented TRU Waste Drums

**Safety Function:** Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.

**Notes:**

- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**

- None

**DOE 5506 Detail:**

- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
Hazard Evaluation Table - Event AGTRU-2-016

Description:
Miscellaneous TRU waste container activities (e.g., filter replacement, overpack lid replacement) on an unvented container deflagrates resulting in a release of radiological material.

Locations:
- Area G

MARS:
- 553 PEC (One [1] TRU waste container in activity)

Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

Assumptions:
None

Causes:
- Chemical reaction
- Equipment failure
- Flammable headspace
- Ignition source
- Mechanical failure
- Metal to metal contact
- Operator error
- Static electricity

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: U

Consequence / Risk Rank

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Preventive Features:
Engineered:
None

Admin:
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)

Mitigative Features:
Engineered:
None

Admin:
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
</tr>
</tbody>
</table>

Notes:
None

References:
None

Notes: None

References: None

DOE 5506
Detail:
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
# Hazard Evaluation Table - Event AGTRU-2-017

**Description:**
A loss of forced inerting purge gas permits flammable gas buildup within a TRU waste container with coincidental ignition source deflagrates resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
None

**Causes:**
- Equipment failure
- Flammable headspace
- Ignition source
- Incomplete or insufficient purge of container
- Insufficient inerting flow
- Loss of inert gas during purge cycle
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<table>
<thead>
<tr>
<th>Preventive Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)</td>
</tr>
<tr>
<td>• (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigative Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums &gt; 200 PEC)</td>
</tr>
<tr>
<td>• (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
</tr>
</tbody>
</table>

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/ or over-pressurization</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
None

**References:**
None

**DOE 5506**

**Detail:**
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
Hazard Evaluation Table - Event AGTRU-2-018

**Description:**
A flammable gas accumulates within the drum venting enclosure during maintenance activities while a TRU waste container is in the enclosure. An ignition source is created (e.g., equipment malfunction or maintenance activity) causing a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
None

**Causes:**
- Flammable atmosphere (volatile organic compounds –VOCs or hydrogen) in a container
- Ignition source
- Oxygen is present in container

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Chm</th>
<th>Rad</th>
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<td>W</td>
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<td>I</td>
<td>M</td>
<td>III</td>
<td>M</td>
<td>II</td>
<td>III</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered None**

**Admin**

- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)

**Mitigative Features:**

**Engineered None**

**Admin**

- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Mitigators | PSAC | Drum Venting of Unvented TRU Waste Drums | The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting. | Rad: P, C, W; |
| Safety Function: | Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting. |

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Enclosure Deflagration - Venting and/or Abating/Purging (8c)
# Hazard Evaluation Table - Event AGTRU-2-019

**Description:**
During SSSR, TRU Waste container inner liner deflagrates when penetrated resulting in the release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
- TRU waste container inner liner will only be accessed during SSSR

**Causes:**
- Chemical reaction
- Flammable headspace
- Ignition source
- Metal to metal contact
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** EU

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

## Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
<td>All</td>
<td></td>
</tr>
</tbody>
</table>

**Safety Function:**
- Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.

**Mitigators**
- None

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Waste Repackaging (6f)

---

Hazard Evaluation Table - Event AGTRU-2-020

Description:
Propane, gasoline, or hydrogen vapors accumulate near compliant TRU waste containers with coincidental ignition source leads to a deflagration affecting TRU waste resulting in a release of radiological material.

Locations:
- TRU storage areas except BLDG 412

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

Assumptions:
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

Causes:
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Lightning
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>H</td>
<td>III</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered None

- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Vehicle/Equipment Safety Controls - Forklift Recharging Locations (Electric-powered vehicles are charged in locations away from stored TRU waste containers, thereby reducing the frequency of a deflagration external to waste containers.)

Mitigative Features:
Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Combustible/ Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>PSAC</td>
<td>Stationary Fire Watch During Hot Work</td>
<td>Reduce the likelihood of a fire event.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>
and Waste
Management - TRU
Waste Container (IC)

Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

SS Waste Packaging Control (IC) Waste is packaged

Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged

PSAC Radiological Inventory Management - Defined Area MAR Control (IC) Limit MAR in Defined Areas: Process Areas, Bldg 412, LAAB, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)

Safety Function: Reduces the radiological consequences by limiting the MAR involved

PSAC Radiological Inventory Management - TRU Waste Drum Doublepack Doublepack radiological waste drums > 200 PEC

Safety Function: Reduce radiological consequences by limiting amount of MAR involved

Notes: The initial deflagration external to the container(s) causes the containers to violently shake or be toppled resulting in secondary internal container deflagrations.

References: None

DOE 5506 Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Container Handling (5b)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Venting and/or Abating/Purging (5c)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Other (5h)
### Hazard Evaluation Table - Event AGTRU-2-021

**Description:**
While opening container during SSSR activity, flammable headspace in container with a coincidental ignition source deflagrates resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Flammable headspace
- Ignition source
- Metal to metal contact
- Operator error
- Pyrophorics
- Shock sensitive material
- Static electricity

**Unmitigated System Effects:**
None

**Methods of Detection:**
None

**Mitigated Frequency:** EU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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</tr>
</thead>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**

- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**

**Engineered**

- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
<td></td>
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</tbody>
</table>

**Notes:**
None

**References:**
- DOE 5506

**Detail:**
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Waste Repackaging (6f)
### Hazard Evaluation Table - Event AGTRU-2-022

**Description:**
Accumulated flammable VOCs, hydrogen, etc above LFL in confined area while performing SSSR activity in coincidence with an ignition source causing a deflagration with a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Deflagration external to container with subsequent fire

**Assumptions:**
None

**Causes:**
- Ignition source
- Radiolytic decomposition or organic decomposition generates flammable gases such as hydrogen, methane, etc.

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** U

**Methods of Detection:**
- Observation

**Mitigated Frequency:** EU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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</table>

**Preventive Features:**
None

**Engineered**
- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**
None

**Engineered**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary FireWatch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
</tr>
</tbody>
</table>

**Safety Function:** Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.

| Mitigators | PSAC | Stationary Fire Watch During SSSR Activities | A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed. | Rad: P, C, W; |

**Safety Function:** Reduce the consequences of a fire event.

**Notes:**
None

**References:**
None

**DOE 5506**
- Enclosure Deflagration - Waste Repackaging (8f)
## Hazard Evaluation Table - Event AGTRU-2-023

**Description:**
Flammable atmosphere develops during SSSR activity in coincidence with an ignition source causing a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Flammable gases
- Ignition source
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<tr>
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</tr>
<tr>
<td></td>
<td>M</td>
<td>III</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- PSAC Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- SMP Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**

**Engineered**
- PSAC (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- PSAC Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- SMP Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- SMP Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong> Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
<td></td>
</tr>
</tbody>
</table>

| Mitigators | PSAC  | Stationary Fire Watch During SSSR Activities | A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed. | Rad: P, C, W; |
|            |       | **Safety Function:** Reduce the consequences of a fire event. | | |

**Notes:**
None

**References:**
None

DOE 5506

**Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
- Enclosure Deflagration - Waste Repackaging (8f)

---

### Hazard Evaluation Table - Event AGTRU-2-024

**Description:**
Liquid in a vented TRU waste container causes a chemical reaction producing accumulated flammable gas and with a coincidental ignition source deflagrates resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412
- MARs: 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
- A container with an internal flammable atmosphere will not deflagrate without an interaction with an external force (e.g., human or natural activity).
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Condensation from outside storage
- Ignition source
- Improper storage
- Incompatible chemicals
- Liquid from historical waste matrix
- Radiolytic decomposition or organic decomposition generates flammable gases such as hydrogen, methane, etc.
- Reactive (exothermic or pyrophoric) chemicals

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Risk</th>
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<td>II</td>
</tr>
<tr>
<td></td>
<td>W</td>
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</table>

**Preventive Features:**
- **Engineered:** None
- **Admin:** (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- **Engineered:** None
- **Admin:** (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
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<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
</tbody>
</table>

**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Waste Container Deflagration - Staging and Storage (6d)
- Waste Container Deflagration - Waste Repackaging (6f)
- Waste Container Deflagration - Type B Container Loading/Unloading (6g)
## Hazard Evaluation Table - Event AGTRU-2-025

### Description:
A deflagration occurs in an under-vented TRU waste container that causes additional sympathetic TRU waste container deflagrations resulting in a release of radiological material.

### Locations:
- Area G

### MARs:
- 609 PEC (Two metal containers: 1 at 553 and 1 at 56)

### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire

### Assumptions:
- Affects of a sympathetic drum deflagration is vertical.

### Causes:
- Chemical reaction
- Container unvented or inadequately vented allowing the accumulation of internal pressure
- External heat source (sparks, fire, thermal radiation, solar, lightning)
- Flammable headspace
- Ignition source
- Pyrophorics
- Shock sensitive material
- Static electricity
- Violent shaking

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- EU

### Mitigated Frequency:
- BEU

### Consequence / Risk Rank

<table>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
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</tbody>
</table>

### Preventive Features:
- None

#### Engineered
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

### Mitigative Features:
- None

#### Engineered
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Reduce likelihood for deflagration</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Reduce the radiological consequences from a sympathetic deflagration</td>
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</tr>
</tbody>
</table>

### Notes:
None

### References:
None

### DOEs:
- 5506

### Detail:
- Multiple Waste Container Deflagration - Staging and Storage (7d)
### Hazard Evaluation Table - Event AGTRU-2-026

**Description:** Flammable gasses accumulate near contact handled MLU staged waste are ignited causing a deflagration resulting in a release of radiological material.

**Locations:**
- MLU operations area

**MARS:**
- 1,950 PEC (TRUPACT MAR)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:** None

**Causes:**
- Equipment malfunction
- Flammable gases
- Ignition source
- Operator error
- Static electricity
- Vehicle (i.e., forklift, trucks, etc.)

**Unmitigated System Effects:** None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

<table>
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<tr>
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**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered None
- Admin None

**Mitigative Features:**
- Engineered None
- Admin None

**Credited SSCs and ACs**

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<th>Attribute</th>
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</table>

**Notes:**
- The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.

**References:**
- DOE 5506

**Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)

---

**Unmitigated System Effects:**

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

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<tr>
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**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered None
- Admin None

**Mitigative Features:**
- Engineered None
- Admin None

**Credited SSCs and ACs**

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**Notes:**
- The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.

**References:**
- DOE 5506

**Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)
## Hazard Evaluation Table - Event AGTRU-2-028

### Description:
A single unvented TRU waste container is violently shaken during handling causes a deflagration resulting in a release of radiological material.

### Locations:
- Area G

### MARs:
- 553 PEC (One [1] TRU waste container)

### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Container mishandling
- Container toppled (human or equipment error)
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

### Unmitigated System Effects:
None

### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Container mishandling
- Container toppled (human or equipment error)
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
A

### Mitigated Frequency:
EU

### Consequence / Risk Rank

<table>
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<td>M</td>
<td>III</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Preventive Features:
- None

#### Admin
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/removal (stacking/unstacking, loading/unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Untented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:
- None

#### Admin
- (PSAC) TRU Waste Container Management - Untented TRU Waste Drum Handling and Transportation (Untented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

#### Preventers
- PSAC

- Elevated waste movements and critical lifts – Spotter
  - Safety Function: Reduce likelihood for container puncture, topple, and impacts

- PSAC

- TRU Waste Container Management - Isolate Unvented Containers
  - Safety Function: Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container

- PSAC

- TRU Waste Container Management - Untented Containers are not Stacked
  - Safety Function: Reduces likelihood for deflagration

## Chapter 3: Hazard and Accident Analysis

Appendix 3H

3H-221

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>PSAC</th>
<th>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</th>
<th>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</th>
<th>Rad: P, C, W;</th>
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<tbody>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
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</tr>
<tr>
<td>Notes:</td>
<td></td>
<td>● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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<td>● Waste Container Deflagration - Staging and Storage (6d)</td>
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<td>● Waste Container Deflagration - Type B Container Loading/Unloading (6g)</td>
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</table>
## Hazard Evaluation Table - Event AGTRU-2-028a

**Description:**
A single unvented TRU waste container is inadvertently shaken causes a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- **Engineered**
  - None

- **Admin**
  - (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
  - (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
  - (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

- **Engineered**
  - None

- **Admin**
  - (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

<table>
<thead>
<tr>
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<tr>
<td>Preventers</td>
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<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
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<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
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<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste containers are not stacked</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
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<td>Waste Container Deflagration - Type B Container Loading/Unloading (6g)</td>
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Hazard Evaluation Table - Event AGTRU-2-029

**Description:**
External heating source causes flammable gas generation within an unvented TRU waste container in coincidence with an ignition source results in a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- A container with an internal flammable atmosphere will not deflagrate without an interaction with an external force (e.g., human or natural activity).

**Causes:**
- Characterization equipment heat sources
- Equipment malfunction
- Flammable headspace
- Increased gas generation due to temperature increase
- Operator error
- Radiant heating
- Solar heating
- Space heater
- Unvented Lid

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/ or over-pressurization</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The physical process required for this event to occur is not physically plausible. Internal pressures within a TRU waste container, generated by an external heating source, would leak from the seals. Flammable gas quantities released would be insufficient to produce a flammable atmosphere. Therefore this event is not physically plausible.

**References:**
- None
- DOE 5506
- Detail:
  - Waste Container Deflagration - Characterization (6a)
  - Waste Container Deflagration - Staging and Storage (6d)
  - Waste Container Deflagration - Waste Repackaging (6f)
  - Waste Container Deflagration - Type B Container Loading/Unloading (6g)
## Hazard Evaluation Table - Event AGTRU-2-030

**Description:**
Multiple unvented TRU waste containers are violently shaken during vehicle accident at > 10 mph and ≤ 35 mph. A single container deflagrates due to the violent shaking experienced during the vehicle accident. The deflagration impacts other containers on the transport.

**Locations:**
- Area G

**MARs:**
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Drop
- Flammable headspace
- Inclement weather
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle accident
- Vehicle impact
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)
- Violent shaking

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<td>W</td>
<td>H</td>
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<td>M</td>
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</tbody>
</table>

**Preventive Features:**
- **Engineered**
  - None

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- **Engineered**
  - None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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</table>

| Mitigators | PSAC | Radiological Inventory | Limit MAR in Defined Areas: Process Areas, Bldg 412, | Rad: P, |

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<table>
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<tr>
<th>Management - Defined Area MAR Control</th>
<th>LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</th>
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<tbody>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums $\geq$ 200 PEC</td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
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<tr>
<td>PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of $\geq$ 30 feet between the unvented TRU waste container and the worker</td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
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</tbody>
</table>

**Notes:** None

**References:** None

**DOE 5506 Detail:**
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Staging and Storage (6d)
- Waste Container Deflagration - Type B Container Loading/Unloading (6g)
- Multiple Waste Container Deflagration - Characterization (7a)
- Multiple Waste Container Deflagration - Container Handling (7b)
- Multiple Waste Container Deflagration - Staging and Storage (7d)
- Multiple Waste Container Deflagration - Type B Container Loading/Unloading (7g)
Hazard Evaluation Table - Event AGTRU-2-031

Description:
Propane/ gasoline vapors accumulate near non-compliant TRU waste containers (e.g., FRPs) with coincidental ignition source leads to a deflagration affecting TRU waste resulting in a release of radiological material.

Locations:
- TRU storage areas except BLDG 412

MARS:
- ≤ 2,000 PEC (MAR limit for Storage Area with non-metal containers)

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

Assumptions:
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

Causes:
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity

Unmitigated System Effects:
- None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: EU

Consequence / Risk Rank

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Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

Credited SSCs and ACs

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<tr>
<th>Class</th>
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<tr>
<td>Preventers</td>
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</table>

Safety Function: Reduces the radiological consequences by limiting the MAR involved

Notes:
- The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.

References:
- DOE 5506

Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Container Handling (5b)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Type B Container Loading/Unloading (5g)
## Hazard Evaluation Table - Event AGTRU-2-032

**Description:**
An unvented TRU waste container is punctured by forklift tines or inadvertently breached and deflagrates resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Flammable headspace
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<tr>
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</table>

**Preventive Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>Engineered</th>
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</table>

- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>Engineered</th>
<th>None</th>
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</table>

- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Elevated waste movements and critical lifts – Spotter</td>
<td>Spotted supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>PSAC TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Reduce likelihood for deflagration</td>
<td></td>
</tr>
<tr>
<td>PSAC TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Reduce likelihood of inadvertent container toppling</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduce likelihood for container puncture, topple, and impacts
- Reduce likelihood of deflagration
- Reduce likelihood of inadvertent container toppling
- Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Waste Container Deflagration - Characterization (6a)
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Venting and/ or Abating/Purging (6c)
- Waste Container Deflagration - Staging and Storage (6d)
● Waste Container Deflagration - Waste Repackaging (6f)
● Waste Container Deflagration - Type B Container Loading/Unloading (6g)
# Hazard Evaluation Table - Event AGTRU-2-033

**Description:**
While opening an unvented TRU waste container for SSSR, a deflagration occurs within the drum resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- None

**Causes:**
- Flammable gases
- Ignition source

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

## Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<table>
<thead>
<tr>
<th>Preventive Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered: None</td>
</tr>
</tbody>
</table>

**Admin**
- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

## Mitigative Features:

**Engineered None**

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities
- (SMP) Emergency Preparedness Program
- (SMP) Radiation Protection Program

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>PSAC</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Prohibition on opening sealed waste packages discovered during SSSR activities</td>
<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.

**Mitigators**
- PSAC Stationary Fire Watch During SSSR Activities
- A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.

**Safety Function:**
- Reduce the consequences of a fire event.

### Notes:
- None

### References:
- None

### DOE 5506
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Waste Repackaging (6f)
### Hazard Evaluation Table - Event AGTRU-2-034

**Description:**
A flashback explosion involving an acetylene gas cylinder damages containers in a storage dome and initiates a fire that burns expelled waste.

**Locations:**
- Storage domes

**MARs:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- flashback
- Improper equipment use
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

**Consequence / Risk Rank**

<table>
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<tr>
<th>Receptor</th>
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</tbody>
</table>
| P        | H     | I    | H    | III
| C        | H     | I    | H    | III
| W        | H     | I    | H    | III

**Preventive Features:**

- **Engineered**
  - (DID) Acetylene Cylinders Control (Acetylene cylinders located inside a defined area containing MAR will be equipped with flashback arrestors.)

- **Admin**
  - (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)

**Mitigative Features:**

- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

<table>
<thead>
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<th>Class</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
### Hazard Evaluation Table - Event AGTRU-2-034a

**Description:**
An explosion involving a damaged or leaking acetylene gas cylinder damages containers in a storage dome and initiates a fire that burns expelled waste.

**Locations:**
- Storage domes

**MARS:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Flammable gases
- Gas cylinder degradation
- Gas cylinder mishandling
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

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<td>H II H</td>
<td>H III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>H II H</td>
<td>H III</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)

**Mitigative Features:**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
</tr>
</tbody>
</table>

| Mitigators | SS | Hazardous Material and Waste Management - Defined Area MAR Control (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
| | | Safety Function: | Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers. | |

| | | Safety Function: | Reduces the radiological consequences by limiting the MAR involved | |

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)

---

12/17/2013
**Hazard Evaluation Table - Event AGTRU-2-035prev e-1**

**Description:**
Reactive or incompatible materials in vented TRU waste container are violently shaken during handling resulting in a fire within the container. The fire burns the contained waste.

**Locations:**
- TRU storage areas except BLDG 412
- MARs: 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Operator error
- Shock sensitive material
- Violent shaking

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** EU

**Methods of Detection:**
- Observation

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit. DSA Mit.</td>
<td>Unmit. DSA Mit.</td>
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<tr>
<td>P</td>
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<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered** None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

### Credited SSCs and ACs

**Class** Preventers PSAC

**Control** Elevated waste movements and critical lifts – Spotter

**Attribute** Spotted supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers

**Safety Function:**
Reduce likelihood for container puncture, topple, and impacts

**Class** Mitigators SS

**Control** Hazardous Material and Waste Management - TRU Waste Container (IC)

**Attribute** Metal TRU waste container are of sound integrity

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

**Class** SS

**Control** Waste Packaging Control (IC)

**Attribute** Waste is packaged

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged

**Class** PSAC

**Control** Radiological Inventory Management - TRU Waste Drum Doublepack

**Attribute** Doublepack radiological waste drums ≥ 200 PEC

**Safety Function:**
Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
For containers compliant with the WIPP WAC this event is considered extremely unlikely.
When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
<table>
<thead>
<tr>
<th>Event Type</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Fire</td>
<td>Waste Repackaging (2f)</td>
</tr>
<tr>
<td></td>
<td>Small Fire - Type B Container Loading/Unloading (2g)</td>
</tr>
<tr>
<td>High Wind</td>
<td>Characterization (21a)</td>
</tr>
<tr>
<td></td>
<td>Container Handling (21b)</td>
</tr>
<tr>
<td></td>
<td>Venting and/or Abating/Purging (21c)</td>
</tr>
<tr>
<td></td>
<td>Staging and Storage (21d)</td>
</tr>
<tr>
<td></td>
<td>Waste Repackaging (21f)</td>
</tr>
<tr>
<td></td>
<td>Type B Container Loading/Unloading (21g)</td>
</tr>
<tr>
<td>Seismic Event (Impact Only)</td>
<td>Characterization (24a)</td>
</tr>
<tr>
<td></td>
<td>Container Handling (24b)</td>
</tr>
<tr>
<td></td>
<td>Venting and/or Abating/Purging (24c)</td>
</tr>
<tr>
<td></td>
<td>Staging and Storage (24d)</td>
</tr>
<tr>
<td></td>
<td>Waste Repackaging (24f)</td>
</tr>
<tr>
<td></td>
<td>Type B Container Loading/Unloading (24g)</td>
</tr>
</tbody>
</table>
**Hazard Evaluation Table - Event AGTRU-2-036prev e-1**

**Description:**
During miscellaneous venting activities (e.g., filter or filter blank replacement, lid replacement) a TRU waste container venting flammable gas is ignited resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 553 PEC (One [1] TRU waste container in activity)

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Flammable headspace
- Hot Work
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

Engineered None

Admin
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)

**Mitigative Features:**

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
<td></td>
</tr>
<tr>
<td>PSAC TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/or over-pressurization</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
</tr>
<tr>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
None

**References:**
None

DOE 5506
- Small Fire - Venting and/or Abating/Purging (2c)
Detail: Enclosure Fire - Venting and/or Abating/Purging (3c)
## Hazard Evaluation Table - Event AGTRU-2-037

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>I</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>I</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>II</td>
<td>L</td>
<td>IV</td>
</tr>
</tbody>
</table>

### Preventive Features:

<table>
<thead>
<tr>
<th>Admin</th>
<th>Safety Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduce the likelihood of a deflagration.</td>
</tr>
</tbody>
</table>

### Mitigative Features:

<table>
<thead>
<tr>
<th>Admin</th>
<th>Safety Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduce the likelihood of a deflagration.</td>
</tr>
</tbody>
</table>

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Cease spark-generating processes</td>
<td>All</td>
</tr>
<tr>
<td>PSAC</td>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Container positioning</td>
<td>While the sealed inner container is venting, the container shall be positioned such that the opening(s) is at the high point of the container.</td>
<td>All</td>
</tr>
<tr>
<td>PSAC</td>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Grounding/Bonding</td>
<td>Workers and the sealed containers shall be bonded or grounded prior to loosening the lid/flare bolts.</td>
<td>All</td>
</tr>
<tr>
<td>PSAC</td>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Non-Sparking processes or tools</td>
<td>Loosening the lid/flare bolts on sealed inner containers during SSSR shall be performed using non-sparking processes or tools.</td>
<td>All</td>
</tr>
<tr>
<td>PSAC</td>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Resumption of spark-generating operations</td>
<td>Spark-generating operations shall not be resumed until the container has been vented and the hydrogen levels</td>
<td>All</td>
</tr>
</tbody>
</table>

### Description:

While opening sealed inner container (sealed container with bolted lid/flare) during SSSR, a flammable atmosphere is encountered coincident with an ignition source resulting in a deflagration/fire and airborne release of radioactive material with inhalation exposure.

### Locations:

- Area G, SSSR Area

### Release Mechanisms:

- Internal deflagration with lid/flare and debris ejection, and subsequent fire.

### Assumptions:

None

### Causes:

- Hydrogen accumulation in sealed container

### Unmitigated System Effects:

- None

### Methods of Detection:

- Observation

### Unmitigated Frequency: U

### Mitigated Frequency: EU
spark-generating operations at the opening are measured and demonstrated to be below the LFL (4% for hydrogen).

<table>
<thead>
<tr>
<th>Spark-generating Operations</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening sealed containers with bolted lids/flanges in SSSR - Lid/flange bolt loosening</td>
<td>Reduce the likelihood of deflagration.</td>
</tr>
</tbody>
</table>

Mitigators

| PSAC | Opening sealed containers with bolted lids/flanges in SSSR - Lid/flange bolt loosening |

Safety Function: Reduce the consequences of a deflagration.

| Notes: None |
| References: None |
| DOE 5506 Detail: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f) |
### Hazard Evaluation Table - Event AGTRU-2-038

**Description:**
While opening sealed inner container (sealed container with bolted lid/flange) during SSSR, a flammable atmosphere is encountered coincident with an ignition source resulting in a deflagration and physical injury to the worker.

**Locations:**
- Area G, SSSR Area

**Release Mechanisms:**
- Internal deflagration with ejection of lid/flange.

**Assumptions:**
- Deflagration is assumed to bound lid/flange ejection due to pressurized tank.

**Causes:**
- Hydrogen accumulation in sealed container

**Mitigators:**
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Lid/flange bolt loosening (The lid/flange bolts on sealed inner containers during SSSR shall be performed using non-sparking processes or tools.)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Unmit. DSA Mit.</td>
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<tr>
<td></td>
<td>L</td>
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<tr>
<td>C</td>
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</tr>
<tr>
<td></td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Cease spark-generating processes (Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts on the sealed container.)
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Container positioning (While the sealed inner container is venting, the container shall be positioned such that the opening(s) is at the high point of the container.)
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Grounding/Bonding (Workers and the sealed containers shall be bonded or grounded prior to loosening the lid/flange bolts.)
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Resumption of spark-generating operations (Spark-generating operations shall not be resumed until the container has been vented and the hydrogen levels at the opening are measured and demonstrated to be below the LFL (4% for hydrogen).)
- SMP Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**
- PSAC Opening sealed containers with bolted lids/flanges in SSSR - Lid/flange bolt loosening (The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange and allow venting without completely removing the bolts.)
- SMP Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)

**Credited SSCs and ACs**

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<td>Preventers</td>
<td>PSAC Opening sealed containers with bolted lids/flanges in SSSR - Cease spark-generating processes</td>
<td>Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts on the sealed container.</td>
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</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a deflagration.</td>
<td></td>
</tr>
<tr>
<td>PSAC Opening sealed containers with bolted lids/flanges in SSSR - Container positioning</td>
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<td>Safety Function:</td>
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<tr>
<td>PSAC Opening sealed containers with bolted lids/flanges in SSSR - Grounding/Bonding</td>
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<td>Safety Function:</td>
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<tr>
<td>PSAC Opening sealed containers with bolted lids/flanges in SSSR - Non-Sparking processes or tools</td>
<td>Loosening the lid/flange bolts on sealed inner containers during SSSR shall be performed using non-sparking processes or tools.</td>
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<td>Safety Function:</td>
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<td>Mitigators</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the consequences of a deflagration.</td>
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<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
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<tr>
<td>Notes:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>References:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DOE 5506</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Detail:</td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-3-001

**Description:**
A vehicle/equipment traveling at ≤ 10 mph within a storage array impacts stored TRU waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 699 PEC (Statistical 24 (all) containers, low impact release)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

**Methods of Detection:**
- Observation

**Mitigated Frequency:** A

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad Chm</th>
<th>Phy</th>
</tr>
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<tr>
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<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
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<td>M</td>
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</tr>
<tr>
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<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**

- None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
</tbody>
</table>

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Chapter 3: Hazard and Accident Analysis
Appendix 3H

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12/17/2013
<table>
<thead>
<tr>
<th>SMP</th>
<th>Safety Function</th>
<th>Description</th>
<th>Rad:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Preparedness Program</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td>P, C, W;</td>
</tr>
<tr>
<td>SMP Radiation Protection Program</td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>W;</td>
</tr>
<tr>
<td>SMP Training and Qualification Program - Hazards Recognition</td>
<td>Reduce likelihood and or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>P, C, W;</td>
</tr>
</tbody>
</table>

Notes: 
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail: Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
## Hazard Evaluation Table - Event AGTRU-3-002

**Description:**
A vehicle traveling \( \leq 10 \) mph impacts a vehicle transporting multiple TRU waste containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:** \( \leq 1,100 \) PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>(PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
</tr>
<tr>
<td></td>
<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
</tr>
<tr>
<td></td>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))</td>
</tr>
<tr>
<td></td>
<td>(DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ( &lt; 15 ) mph)</td>
</tr>
</tbody>
</table>

**Mitigative Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>(SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
</tr>
<tr>
<td></td>
<td>(PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)</td>
</tr>
<tr>
<td></td>
<td>(PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ( \geq 200 ) PEC)</td>
</tr>
<tr>
<td></td>
<td>(SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
</tr>
<tr>
<td></td>
<td>(DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)</td>
</tr>
</tbody>
</table>

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
</tbody>
</table>
### Waste Management - TRU Waste Container (IC)

<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</th>
</tr>
</thead>
</table>

### PSAC Radiological Inventory Management - Defined Area MAR Control

<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduces the radiological consequences by limiting the MAR involved</th>
</tr>
</thead>
</table>

### PSAC Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers

<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduce radiological consequences by limiting MAR involved</th>
</tr>
</thead>
</table>

### PSAC Radiological Inventory Management - TRU Waste Drum Doublepack

<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
</table>

### SMP Radiation Protection Program

<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduces radiological consequences due to exposure</th>
</tr>
</thead>
</table>

### Notes

- Non-compliant container consequences bound the compliant container consequences.

### References

- DOE 5506
  - Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
  - Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
### Hazard Evaluation Table - Event AGTRU-3-003 (r3.0)

**Description:**
A large, heavy vehicle (e.g., water tanker truck) traveling at > 10 mph impacts stored TRU waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 877 PEC (Statistical 48 (all) containers, moderate impact release)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chim</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/Equpment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>

**Safety Function:**
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is...
prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

| PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G | Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles | All |
| Safety Function: Reduces likelihood of fuel interaction with MAR |

| Mitigators PSAC Radiological Inventory Management - TRU Waste Drum Doublepack | Doublepack radiological waste drums ≥ 200 PEC | Rad: W; |
| Safety Function: Reduce radiological consequences by limiting amount of MAR involved |

Notes: The escort required for vehicles with > 100 gal of flammable liquid fuel limits the speed and path of travel of the escorted water tanker truck or other vehicle.

References: None

DOE 5506

Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
Hazard Evaluation Table - Event AGTRU-3-004

**Description:**
A vehicle/equipment traveling at > 10 mph and ≤ 35 mph impacts a vehicle transporting multiple TRU waste containers resulting in container damage and a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 877 PEC (Statistical 48 (all) containers, moderate impact release)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</tr>
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<tbody>
<tr>
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<tr>
<td>C</td>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered None**

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) Rad Hazardous Material and Waste Management - TRU Waste Container (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.).</td>
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<tr>
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<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
- Reduces the likelihood of equipment malfunction.
- Reduces likelihood for vehicle and equipment accidents.
- Reduces the radiological consequences as waste is agglomerated and burns.

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Appendix 3H

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as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

| PSAC Radiological Inventory Management - Transportation Vehicle limits-compliant metal containers | The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci. | Rad: P, C, W; |
| Safety Function: Reduce radiological consequences by limiting MAR involved |

| Safety Function: Reduce radiological consequences by limiting amount of MAR involved |

| SMP Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; |
| Safety Function: Reduces radiological consequences due to exposure |

Notes:
- Non-compliant container consequences bound the compliant container consequences.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References:
None

DOE 5506
- Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
### Hazard Evaluation Table - Event AGTRU-3-005

**Description:**
TRU waste container falls from > 4 feet but < 12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Drop
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
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<td>DSA Mit.</td>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:
- Engineered: None
- Admin: None

### Mitigative Features:
- Engineered: ● (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- Admin: ● (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>None</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>● Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
<th>● Rad: W;</th>
</tr>
</thead>
</table>

**Safety Function:**
Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
# Hazard Evaluation Table - Event AGTRU-3-006

## Description:
Multiple TRU waste containers fall > 4 feet but < 12 feet to the ground breaching resulting in a release of radiological material.

## Locations:
- Area G

## MARs:
- 698 PEC (4 containers/pallet x 3 tiers = statistical 12 (all) containers)

## Release Mechanisms:
- Loss of Confinement
- Low energy impact

## Assumptions:
None

## Causes:
- Container toppled (human or equipment error)
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Improper container placement or handling
- Inclement weather
- Mechanical failure
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

## Unmitigated System Effects:
None

## Methods of Detection:
- Observation

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>P</td>
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<td>L</td>
</tr>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

## Preventive Features:

### Admin
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/ crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)
- (SMP) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)).

## Mitigative Features:

### Admin
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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<thead>
<tr>
<th>Class</th>
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<td>Preventers</td>
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<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotted supports forklift/ rigger/ crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safety Function:</td>
</tr>
<tr>
<td>PSAC</td>
<td></td>
<td></td>
<td>Reduce radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection</td>
<td>Evaluates radiological conditions and processes for worker safety</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Program</td>
<td>Protection</td>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The MAR value for this event bounds containers on 1 pallet, HENC conveyor, and RTR container sled.
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
- High Wind - Characterization (21a)
- High Wind - Container Handling (21b)
- High Wind - Venting and/or Abating/Purging (21c)
- High Wind - Staging and Storage (21d)
- High Wind - Waste Repackaging (21f)
- High Wind - Type B Container Loading/Unloading (21g)
- Seismic Event (Impact Only) - Characterization (24a)
- Seismic Event (Impact Only) - Container Handling (24b)
- Seismic Event (Impact Only) - Venting and/or Abating/Purging (24c)
- Seismic Event (Impact Only) - Staging and Storage (24d)
- Seismic Event (Impact Only) - Waste Repackaging (24f)
- Seismic Event (Impact Only) - Type B Container Loading/Unloading (24g)
## Hazard Evaluation Table - Event AGTRU-3-007

**Description:**
Non-metal container falls > 4 to < 12 feet breaching the container and resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 310 PEC non-metal container

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A  
**Mitigated Frequency:** U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit. DSA Mit.</td>
<td>Unmit. DSA Mit.</td>
<td>Unmit. DSA Mit.</td>
</tr>
<tr>
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<td>M</td>
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<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered:** None

**Admin:**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)
- (SMP) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered:** None

**Admin:**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
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### Notes:
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
- DOE 5506: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
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</tr>
<tr>
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<td>H</td>
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### Preventive Features:

- **Engineered**
  - None

- **Admin**
  - (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

### Mitigative Features:

- **Engineered**
  - (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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<td>Mitigators</td>
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<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
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**Notes:**
- This event bounds the puncture of a single TRU waste container.
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Characterization (9a)
- Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
- Vehicle/Equipment Impacts Waste/Waste Containers - Venting and/or Abating/Purging (9c)
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
- Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)
- Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g)
### Hazard Evaluation Table - Event AGTRU-3-009

**Description:**
A TRU waste container is breached/crushed resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Crushing by roll-up door
- Equipment malfunction
- Limit switch failure
- Mechanical failure
- Operator error
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
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</thead>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Admin**
- None

**Mitigative Features:**
- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- **Admin**
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<th>Control</th>
<th>Attribute</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>None</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
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| PSAC | Radiological Inventory Management - TRU Waste Drum Doublepack | Doublepack radiological waste drums ≥ 200 PEC | Rad: W; |

| SMP | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; |

**Safety Function:**
- Reduce radiological consequences by limiting amount of MAR involved

**Safety Function:**
- Reduces radiological consequences due to exposure

**Notes:**
- Non-compliant container consequences bound the compliant container consequences.
- This event bounds all Area G power operated doors including the RTR and HENC.

**References:**
- DOE 5506
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
### Hazard Evaluation Table - Event AGTRU-3-010

**Description:**
Large forklift transporting a single FRP impacts stored TRU waste at > 10 mph and ≤ 35 mph causing the collapse of two (2) 3-tiered stacks resulting in a release of radiological material.

**Locations:**
- TRU storage areas except BLDG 412

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
U

**Consequence / Risk Rank**

<table>
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<tr>
<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
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<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>

**Safety Function:** The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste.
containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

### PSAC Elevated waste movements and critical lifts – Spotter

**Safety Function:** Reduce likelihood for container puncture, topple, and impacts

| Mitigators | SS Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W;
| --- | --- | --- | --- |

**Mitigators**

- **SS Hazardous Material and Waste Management - TRU Waste Container (IC)**
  - Metal TRU waste container are of sound integrity
  - Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>SMP Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
<th>Rad: W;</th>
</tr>
</thead>
</table>

**Safety Function:** Reduces radiological consequences due to exposure

**Notes:**
- Consequences of non-compliant container impacting compliant container array bounds any event involving compliant containers.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
- Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
- Collapse of Stacked Containers - Container Handling (11b)
- Collapse of Stacked Containers - Staging and Storage (11d)
### Hazard Evaluation Table - Event AGTRU-3-011

**Description:**
Vehicle transporting multiple non-metal TRU waste containers ≤ 10 mph impacts stored TRU waste in non-metal containers resulting in a release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRU storage areas except BLDG 412</td>
<td>• 475 PEC (Statistical 2 non-metal containers in transport)</td>
</tr>
<tr>
<td></td>
<td>• 805 PEC (Statistical 4 non-metal containers)</td>
</tr>
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<table>
<thead>
<tr>
<th>Release Mechanisms:</th>
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<tbody>
<tr>
<td>Loss of Confinement</td>
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<tr>
<td>Low energy impact</td>
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<tr>
<td>Degraded/ inadequate road condition (e.g., erosion, pot holes)</td>
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<tr>
<td>Equipment malfunction</td>
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<tr>
<td>Improper equipment use</td>
</tr>
<tr>
<td>Inclement weather</td>
</tr>
<tr>
<td>Large animal impact</td>
</tr>
<tr>
<td>Operator error</td>
</tr>
<tr>
<td>Vehicle accident</td>
</tr>
<tr>
<td>Vehicle/ equipment mechanical failure (e.g., steering, brakes)</td>
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<table>
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<th>Unmitigated System Effects:</th>
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<td>Observation</td>
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<table>
<thead>
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<th>Consequence / Risk Rank</th>
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<tr>
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<td>C</td>
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<td>W</td>
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</table>

<table>
<thead>
<tr>
<th>Preventive Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)</td>
</tr>
<tr>
<td>(SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PSAC) Escort of High MAR TRU Waste Transport Within Ta-54, Area G- Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))</td>
</tr>
<tr>
<td>(SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
</tr>
<tr>
<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
</tr>
<tr>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))</td>
</tr>
<tr>
<td>(DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits &lt; 15 mph)</td>
</tr>
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<table>
<thead>
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<th>Mitigative Features:</th>
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</thead>
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<table>
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<tbody>
<tr>
<td>(PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
</tr>
<tr>
<td>(DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)</td>
</tr>
</tbody>
</table>

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tbody>
<tr>
<td>Preventers SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barriers systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>

**Safety Function:** The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The

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3H-260

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mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

| PSAC Escort of High MAR TRU Waste Transport Within Ta-54, Area G–Non-compliant Containers |
| Safety Function: Reduces the frequency of vehicle accidents and impact to stored radiological waste containers |
| SMP Maintenance Program - Vehicle/Equipment |
| Safety Function: Reduce likelihood of equipment malfunction |
| SMP Training and Qualification Program - Qualifications |
| Safety Function: Reduces likelihood for vehicle and equipment accidents |

**Mitigators**

| PSAC Radiological Inventory Management - Defined Area MAR Control |
| Safety Function: Reduces the radiological consequences by limiting the MAR involved |

**Notes:**
- Non-compliant container consequences bound the compliant container consequences.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
- Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
**Hazard Evaluation Table - Event AGTRU-3-012**

**Description:**
Vehicle transporting multiple compliant TRU waste containers at > 10 mph and < 35 mph impacts stored non-compliant TRU waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 855 PEC (Statistical 6 non-metal containers)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
<tr>
<td></td>
<td>Unmit.</td>
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<td>C</td>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
</tbody>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
### Mitigators

| SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers. |
| SS | Vehicle Barriers - High Risk Locations | **Safety Function:** The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved. |

| PSAC | Radiological Inventory Management - Defined Area MAR Control | **Safety Function:** Reduces the radiological consequences by limiting the MAR involved |
| PSAC | Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers | **Safety Function:** Reduce radiological consequences by limiting MAR involved |
| PSAC | Radiological Inventory Management - TRU Waste Drum Doublepack | **Safety Function:** Reduce radiological consequences by limiting amount of MAR involved |

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Characterization (9a)
- Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)
- Vehicle/Equipment Impacts Waste/Waste Containers - Venting and/or Abating/Purging (9c)
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
- Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)
- Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g)
## Hazard Evaluation Table - Event AGTRU-3-013

**Description:**
Vehicle impacts TRU waste in SSSR area < 10 mph resulting in a dispersal of radiological material.

**Locations:**
- Area G

**MARS:**
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Impact and spill
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
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<td>L</td>
</tr>
<tr>
<td>C</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations [concrete barriers] must be capable of stopping a vehicle [moving at a velocity of < 15 mph] with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment [forklift, manlift])
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high-risk locations where TRU waste is stored)
- (SMP) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered** None

**Admin**
- (PSAC) [IC] Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations [concrete barriers] must be capable of stopping a vehicle [moving at a velocity of &lt; 15 mph] with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
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</table>

**Safety Function:**

The safety function is preventative when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

**Mitigators** None

**Notes:** None

**References:** None

**DOE 5506**

**Detail:** Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)
### Hazard Evaluation Table - Event AGTRU-3-014

#### Description:
Worker handling a TRU waste container inadvertently tips the container over causing impact with the ground resulting in a release of radiological material.

#### Locations:
- Area G

#### MARs:
- 553 PEC (One [1] TRU waste container)

#### Release Mechanisms:
- Low energy impact

#### Assumptions:
None

#### Causes:
- Improper container placement or handling
- Improperly installed closure ring
- Operator error

#### Unmitigated System Effects:
None

#### Methods of Detection:
- Observation

#### Unmitigated Frequency: A

#### Mitigated Frequency: A

#### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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<th>Phy</th>
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<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
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</tbody>
</table>

#### Preventive Features:
- Engineered: None
- Admin: None

#### Mitigative Features:
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

#### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td></td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
- Non-compliant container consequences bound the compliant container consequences.

#### References:
- DOE 5506

#### Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
**Hazard Evaluation Table - Event AGTRU-3-015**

**Description:**
Mobile crane (manlift, boomed vehicle) with a non-waste load topples onto or impacts TRU waste containers resulting in a breach and release of radiological material

**Locations:**
- Area G

**MARS:**
- 805 PEC (Statistical 4 non-metal containers)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Crane drops load (container, canister, load)
- Crane topples
- Improper equipment use
- Inclement weather
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

<table>
<thead>
<tr>
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<th>Phy</th>
</tr>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (Did) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
</tr>
</tbody>
</table>

| Mitigators | SMP | Emergency Preparedness Program | The program relies on adverse conditions being recognized by workers and reported | Rad: P, C, W; |
| Safety Function: | | Reduce the consequences of an accident for the worker and collocated worker | |
| SMP | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; |
| Safety Function: | | Reduces radiological consequences due to exposure | |
| SMP | Training and Qualification Program - Hazards Recognition | Personnel trained to recognize specific job hazards and associated controls | Rad: P, C, W; |
| Safety Function: | | Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles | |

**Notes:**
- Non-compliant container consequences (4 FRPs) bound the compliant container consequences (48 compliant containers - 1,188 PEC).
When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

<table>
<thead>
<tr>
<th>References:</th>
<th>None</th>
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<tbody>
<tr>
<td>DOE 5506</td>
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<tr>
<td>Detail:</td>
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<td></td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Characterization (9a)</td>
</tr>
<tr>
<td></td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)</td>
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<td></td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Venting and/or Abating/Purging (9c)</td>
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<td>Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)</td>
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<tr>
<td></td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)</td>
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<tr>
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<td>Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)</td>
</tr>
<tr>
<td></td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Characterization (21a)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Container Handling (21b)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Venting and/or Abating/Purging (21c)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Staging and Storage (21d)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Waste Repackaging (21f)</td>
</tr>
<tr>
<td></td>
<td>High Wind - Type B Container Loading/Unloading (21g)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-3-016

Description:
Large crane topples during Type B container activities onto staged waste or open TRUPACT resulting in a release of radiological material.

Locations:
- Area G

MARS:
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

Assumptions:
- None

Causes:
- Crane topples
- Equipment failure
- Equipment malfunction
- High wind
- Improper equipment use
- Mechanical failure
- Operator error
- Seismic event

Unmitigated System Effects:
- None

Unmitigated Frequency: A

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>M</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- None

Admin
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) MLU Payload Restriction - Lifts (MLU payloads shall not be lifted over TRU waste)
- (PSAC) MLU Payload Restrictions-MAR Limit (MLU payloads with MAR > 925 PE-Ci not lifted more than 12feet, measured from the bottom of the payload to the ground)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
<td>All</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduce likelihood for load drops resulting in release of radiological material</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>PSAC</th>
<th>Elevated waste movements and critical lifts – Spotter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigators SS</th>
<th>Hazardous Material and Waste Management - Metal TRU waste container are of sound integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
</tr>
</tbody>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H
**TRU Waste Container (IC)**

**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

**PSAC Radiological Inventory Management - Defined Area MAR Control (IC)**

**Limit MAR in Defined Areas:** Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)

**Safety Function:** Reduces the radiological consequences by limiting the MAR involved

**PSAC Radiological Inventory Management - TRU Waste Drum Doublepack**

**Doublepack radiological waste drums > 200 PEC**

**Safety Function:** Reduce radiological consequences by limiting amount of MAR involved

**Notes:**
- MAR limit is credited as it limits the consequence to the public to moderate
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
- High Wind - Type B Container Loading/Unloading (21g)
- Seismic Event (Impact Only) - Type B Container Loading/Unloading (24g)
### Hazard Evaluation Table - Event AGTRU-3-017

**Description:**
Large crane moving a TRU waste payload assembly drops the loaded payload assembly onto another payload assembly from ≥ 12 feet resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- Payload assembly configuration includes (one or two) 7-drum assemblies, similar to banded and palleted drums.

**Causes:**
- Crane drops load (container, canister, load)
- Equipment failure
- Mechanical failure
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
- All

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- EU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>DSA Mit.</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Mitigative Features:**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduce likelihood for load drops resulting in release of radiological material
- Reduce likelihood for container puncture, topple, and impacts
- Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to

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12/17/2013
waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>PSAC</th>
<th>MLU Payload Restrictions-MAR Limit</th>
<th>MLU payloads with MAR &gt; 925 PE-Ci not lifted more than 12feet, measured from the bottom of the payload to the ground</th>
<th>● Rad: P, C, W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces radiological consequences of limiting the source term in payload drop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
● MAR limit is credited as it limits the consequence to the public to moderate
● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506

Detail:
● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
### Hazard Evaluation Table - Event AGTRU-3-019

**Description:**
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts TRU waste. The impacted containers are breached resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 609 PEC (Two metal containers: 1 at 553 and 1 at 56)

**Release Mechanisms:**
- Impact and spill
- Loss of confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Gas cylinder mishandling
- Improper storage of gas cylinder
- Inadequate gas cylinder restraint
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- **Engineered** None
- **Admin**
  - (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

**Mitigative Features:**
- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>None</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
</tr>
<tr>
<td>Notes:</td>
<td>● When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
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</table>
| **DOE 5506 Detail:** | ● Vehicle/Equipment Impacts Waste/Waste Containers - Characterization (9a)  
 ● Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)  
 ● Vehicle/Equipment Impacts Waste/Waste Containers - Venting and/or Abating/Purging (9c)  
 ● Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)  
 ● Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)  
 ● Vehicle/Equipment Impacts Waste/Waste Containers - Type B Container Loading/Unloading (9g) |
<table>
<thead>
<tr>
<th>Description:</th>
<th>A pressurized TRU waste container is breached resulting in a release of radiological material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations:</td>
<td>Area G</td>
</tr>
<tr>
<td>MARs:</td>
<td>553 PEC (One [1] TRU waste container)</td>
</tr>
<tr>
<td>Release Mechanisms:</td>
<td>Pressurized venting</td>
</tr>
<tr>
<td>Assumptions:</td>
<td>None</td>
</tr>
<tr>
<td>Causes:</td>
<td>Buildup of gas/pressure inside container, Container mishandling, Container unvented or inadequately vented allowing the accumulation of internal pressure, Incompatible chemicals, Operator error, Radioisolation/hydrolysis in container, Seal failure, Solar heating, Thermal expansion of material/gases, Vent installation</td>
</tr>
<tr>
<td>Unmitigated System Effects:</td>
<td>None</td>
</tr>
<tr>
<td>Unmitigated Frequency:</td>
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</tr>
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<td>Unmitigated Consequence / Risk Rank</td>
<td>Rad Chm Phy</td>
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<td>---</td>
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</tr>
<tr>
<td>P</td>
<td>L III L II III</td>
</tr>
<tr>
<td>C</td>
<td>L III L II III</td>
</tr>
<tr>
<td>W</td>
<td>M II L II III</td>
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<tr>
<td>Preventive Features:</td>
<td>Engineer None, Admin None</td>
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<tr>
<td>Mitigative Features:</td>
<td>Engineer None, Admin SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
</tr>
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<td>Credited SSCs and ACs</td>
<td>Class</td>
</tr>
<tr>
<td>Preventers</td>
<td>None</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SMP Radiation Protection Program</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
<tr>
<td>Notes:</td>
<td>None</td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
</tr>
<tr>
<td>DOE 5506 Detail:</td>
<td>Waste Container Over-Pressurization - Characterization (12a), Waste Container Over-Pressurization - Container Handling (12b), Waste Container Over-Pressurization - Venting and/or Abating/Purging (12c), Waste Container Over-Pressurization - Staging and Storage (12d), Waste Container Over-Pressurization - Waste Repackaging (12f), Waste Container Over-Pressurization - Type B Container Loading/Unloading (12g)</td>
</tr>
</tbody>
</table>
**Hazard Evaluation Table - Event AGTRU-3-021**

**Description:**
Vehicle transporting multiple TRU waste containers drives off Mesa top at > 10 mph and < 35 mph breaching containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
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<tr>
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<td>C</td>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**

- None

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (IC) (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
<tr>
<td>MAR Control (IC)</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC</strong></td>
<td>Radiological Inventory Management - Transportation Vehicle limits - compliant</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>metal containers (IC)</td>
<td></td>
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<tr>
<td></td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant</td>
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</tr>
<tr>
<td></td>
<td>metal containers does not exceed 1,100 PE-Ci.</td>
<td></td>
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</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
### Hazard Evaluation Table - Event AGTRU-3-022

**Description:**
TRU waste container degrades resulting in release of radiological contamination.

**Locations:**
- Area G

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Buildup of gas/pressure inside container
- Component degradation
- Container degradation
- Corrosion
- Seal failure
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>P</td>
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<tr>
<td>C</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
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</tr>
<tr>
<td>Mitigators</td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td></td>
</tr>
</tbody>
</table>
  Evaluates radiological conditions and processes for worker protection | Rad: W; |
  Safety Function: Reduces radiological consequences due to exposure |

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Contaier, etc. - Venting and/or Abating/Purging (10c)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
## Hazard Evaluation Table - Event AGTRU-3-023

**Description:**
TRU waste container stack collapses resulting in the release of radiological material.

**Locations:**
- Area G

**MARS:**
- 698 PEC (4 containers/pallet x 3 tiers = statistical 12 (all) containers)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Container degradation
- Improper container placement or handling
- Operator error
- Pallet failure
- Storage structure degradation
- Uneven floor/ base surface

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<td>III</td>
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</tr>
<tr>
<td>C</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**
- None

**Engineered**
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Hazardous Material and Waste Management - Overpack (Overpacking of TRU waste containers in degraded/ suspect degraded or damaged condition)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduce likelihood for container puncture, topple, and impacts

- Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

- Reduce radiological consequences by limiting amount of MAR involved

- Reduces radiological consequences due to exposure
<table>
<thead>
<tr>
<th>SMP</th>
<th>Training and Qualification Program - Hazards Recognition</th>
<th>Personnel trained to recognize specific job hazards and associated controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles

**Notes:** When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Collapse of Stacked Containers - Characterization (11a)
- Collapse of Stacked Containers - Container Handling (11b)
- Collapse of Stacked Containers - Venting and/or Abating/Purging (11c)
- Collapse of Stacked Containers - Staging and Storage (11d)
- Collapse of Stacked Containers - Waste Repackaging (11f)
- Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)
- High Wind - Characterization (21a)
- High Wind - Container Handling (21b)
- High Wind - Venting and/or Abating/Purging (21c)
- High Wind - Staging and Storage (21d)
- High Wind - Waste Repackaging (21f)
- High Wind - Type B Container Loading/Unloading (21g)
- Snow/Ice/Volcanic Ash Build-up - Characterization (23a)
- Snow/Ice/Volcanic Ash Build-up - Container Handling (23b)
- Snow/Ice/Volcanic Ash Build-up - Venting and/or Abating/Purging (23c)
- Snow/Ice/Volcanic Ash Build-up - Staging and Storage (23d)
- Snow/Ice/Volcanic Ash Build-up - Waste Repackaging (23f)
- Snow/Ice/Volcanic Ash Build-up - Type B Container Loading/Unloading (23g)
- Seismic Event (Impact Only) - Characterization (24a)
- Seismic Event (Impact Only) - Container Handling (24b)
- Seismic Event (Impact Only) - Venting and/or Abating/Purging (24c)
- Seismic Event (Impact Only) - Staging and Storage (24d)
- Seismic Event (Impact Only) - Waste Repackaging (24f)
- Seismic Event (Impact Only) - Type B Container Loading/Unloading (24g)
### Hazard Evaluation Table - Event AGTRU-3-024

**Description:**
Excessive heating in thermal equalization unit causes TRU waste containers to over-pressurize resulting in a release of radiological material.

**Locations:**
- Area G Pad 10

**MARS:**
- 877 PEC (Statistical 48 (all) containers)

**Release Mechanisms:**
- Loss of Confinement
- Thermal (venting)

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Equipment malfunction
- Inadequate venting
- Operator error
- Radiant heating

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation
- Radcon instrumentation

**Unmitigated Frequency:** EU
**Mitigated Frequency:** EU

<table>
<thead>
<tr>
<th>Receptor</th>
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<tr>
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<td>IV</td>
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<td>IV</td>
<td></td>
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<tr>
<td>W</td>
<td>M</td>
<td>III</td>
<td>L</td>
<td>IV</td>
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</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Mitigative Features:**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- SMP Radiation Protection Program

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventers:**
- None

**Mitigators:**
- SMP Radiation Protection Program
- Safety Function: Evaluates radiological conditions and processes for worker protection
- Reduces radiological consequences due to exposure

**Notes:**
- None

**References:**
- None

**Detail:**
- DOE 5506
- Waste Container Over-Pressurization - Characterization (12a)
<table>
<thead>
<tr>
<th>Description</th>
<th>Forced inert purge gas system causes TRU waste container over pressurization resulting in a release of radiological material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations</td>
<td>● Area G</td>
</tr>
<tr>
<td></td>
<td>● 553 PEC (One [1] TRU waste container)</td>
</tr>
</tbody>
</table>
| Release Mechanisms | ● Loss of Confinement  
● Pressurized venting                                                                 |
| Assumptions | None                                                                                                                            |
| Causes      | ● Buildup of gas/ pressure inside container  
● Equipment malfunction  
● Improper installation of filter/ vent  
● Operator error                                                                 |
| Unmitigated System Effects | Methods of Detection:  
● Observation  
● Radon instrumentation                                                                 |
| Unmitigated Frequency | A |
| Consequence / Risk Rank | |
| Receptor  | Rad | Chm | Phy |
| P          | L   | III | L   | III |
| C          | L   | III | L   | III |
| W          | M   | II  | L   | III |
| Preventive Features | Engineered None  
Admin None |
| Mitigative Features | Engineered None  
Admin ● (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)  
SMP Radiation Protection Program Evaluates radiological conditions and processes for worker protection  
Safety Function: Reduces radiological consequences due to exposure  
Rad: W; |
| Credited SSCs and ACs | |
| Class | Control | Attribute | Affected Receptors |
| Preventers | None | | |
| Mitigators | SMP Radiation Protection Program Evaluates radiological conditions and processes for worker protection  
Safety Function: Reduces radiological consequences due to exposure  
Rad: W; |
| Notes | None | | |
| References | None | | |
| DOE 5506 Detail | ● Waste Container Over-Pressurization - Venting and/or Abating/Purging (12c) |
## Hazard Evaluation Table - Event AGTRU-3-026

### Description:
TRU waste handling equipment (e.g., parrot beak, drum grabber) damages container resulting in a release of radiological material.

### Locations:
- **Area G**
- **MARS:** 553 PEC (One [1] TRU waste container)

### Release Mechanisms:
- Loss of Confinement
- Spill

### Assumptions:
None

### Causes:
- Container degradation
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Operator error
- Securing devices fail

### Unmitigated System Effects:
None

### Release Mechanisms:
- Loss of Confinement
- Spill

### Assumptions:
None

### Causes:
- Container degradation
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Operator error
- Securing devices fail

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A

### Mitigated Frequency: A

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<tr>
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<td>P</td>
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<td>L</td>
</tr>
<tr>
<td>C</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:
- None

### Mitigative Features:
- **Engineered** (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- **Admin** (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Preventers:
- None

### Mitigators:
- **SS** Hazardous Material and Waste Management - TRU Waste Container (IC)
  - **Safety Function:** Metal TRU waste container are of sound integrity
  - **Rad:** P, C, W;

- **SMP** Radiation Protection Program
  - **Safety Function:** Evaluates radiological conditions and processes for worker protection
  - **Rad:** W;

### Notes:
None

### References:
None

### DOE 5506 Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Venting and/or Abating/Purging (10c)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)
### Hazard Evaluation Table - Event AGTRU-3-027

**Description:**
Loaded Type B TRU waste payload assembly frame collapses resulting in damage to waste containers and the release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 1,100 PEC (Mobile Loading Process Area MAR limit)

**Release Mechanisms:**
- Loss of Confinement
- Spill

**Assumptions:**
None

**Causes:**
- Corrosion
- Equipment capacity exceeded
- Equipment failure
- Improper maintenance
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td>C</td>
<td>M II</td>
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</tr>
<tr>
<td>W</td>
<td>H I NR</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Preventive Features:**
Engineered None
Admin None

**Mitigative Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</th>
</tr>
</thead>
</table>

**Engineered**
- (PSAC) MLU Payload Restriction - Lifts (MLU payloads shall not be lifted over TRU waste)
- (PSAC) MLU Payload Restrictions-MAR Limit (MLU payloads with MAR > 925 PE-Ci not lifted more than 12feet, measured from the bottom of the payload to the ground)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC MLU Payload Restriction - Lifts</td>
<td>MLU payloads shall not be lifted over TRU waste</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduces radiological consequences of limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC MLU Payload Restrictions-MAR Limit</td>
<td>MLU payloads with MAR &gt; 925 PE-Ci not lifted more than 12feet, measured from the bottom of the payload to the ground</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduces radiological consequences of limiting the source term in payload drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- MAR limit is credited as it limits the consequence to the public to moderate

**References:**
None

**DOE 5506**
- Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)

# Hazard Evaluation Table - Event AGTRU-3-029

**Description:**
TRU waste container (non-drum) collapses resulting in the release of radiological material.

**Locations:**
- Area G

**MARS:**
- 310 PEC non-metal container

**Release Mechanisms:**
- Loss of Confinement
- Spill

**Assumptions:**
None

**Causes:**
- Container degradation
- Heavy snow/ice loading
- Improper container placement or handling
- Pallet failure
- Seismic event
- Storage structure degradation
- Uneven floor/base surface

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
A

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**  | None

- Admin
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**  | None

- Admin
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

### Preventers

None

### Mitigators

- SMP
  - Emergency Preparedness Program
    - **Safety Function:**
      - The program relies on adverse conditions being recognized by workers and reported
      - Rad: P, C, W;

- SMP
  - Training and Qualification Program - Hazards Recognition
    - **Safety Function:**
      - Personnel trained to recognize specific job hazards and associated controls
      - Rad: P, C, W;

### Notes

- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References

None

### DOE 5506 Detail

- Collapse of Stacked Containers - Characterization (11a)
- Collapse of Stacked Containers - Container Handling (11b)
- Collapse of Stacked Containers - Venting and/or Abating/Purging (11c)
- Collapse of Stacked Containers - Staging and Storage (11d)
- Collapse of Stacked Containers - Waste Repackaging (11f)
- Collapse of Stacked Containers - Type B Container Loading/Unloading (11g)
- Snow/Ice/Volcanic Ash Build-up - Characterization (23a)
- Snow/Ice/Volcanic Ash Build-up - Container Handling (23b)
- Snow/Ice/Volcanic Ash Build-up - Venting and/or Abating/Purging (23c)
- Snow/Ice/Volcanic Ash Build-up - Staging and Storage (23d)
- Snow/Ice/Volcanic Ash Build-up - Waste Repackaging (23f)
- Snow/Ice/Volcanic Ash Build-up - Type B Container Loading/Unloading (23g)
- Seismic Event (Impact Only) - Characterization (24a)
- Seismic Event (Impact Only) - Container Handling (24b)
- Seismic Event (Impact Only) - Venting and/or Abating/Purging (24c)
- Seismic Event (Impact Only) - Staging and Storage (24d)
- Seismic Event (Impact Only) - Waste Repackaging (24f)

---


12/17/2013
Seismic Event (Impact Only) - Type B Container Loading/Unloading (24g)
## Hazard Evaluation Table - Event AGTRU-3-030

**Description:**
Worker replacing a TRU waste container component (e.g., ring bolt, filter vent, lid ring) results in a release of radiological contamination.

**Locations:**
- Area G

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Improper installation of filter/vent
- Improper maintenance
- Incorrect filter
- Maintenance activities
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Radon instrumentation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
A

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin:
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
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<tr>
<td>Radiation Protection Program</td>
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</tr>
<tr>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduces radiological consequences due to exposure</td>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
<table>
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</table>

### Consequence / Risk Rank

#### Methods of Detection:
- Observation

#### Unmitigated System Effects:
None

#### Unmitigated Frequency:
A

#### Mitigated Frequency:
U

### Preventive Features:

#### Engineered
- None

#### Admin
- (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Mitigative Features:

#### Engineered
- None

#### Admin
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

#### Preventers
- **Class**: PSAC
- **Control**: Prohibition on opening sealed waste packages discovered during SSSR activities
- **Attribute**: Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.
- **Safety Function**: Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.
- **Affected Receptors**: All

#### Mitigators
- **Class**: PSAC
- **Control**: Stationary Fire Watch During SSSR Activities
- **Attribute**: A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.
- **Safety Function**: Reduce the consequences of a fire event.
- **Rad**: P, C, W

#### Notes:
None

#### References:
None

#### DOE 5506
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)

---

**Details:**

- CHA Report
- TA-54, Area G
- Los Alamos National Laboratory
- Basis for Interim Operation Rev. 3.0
- November 2014

**Chapter:** Hazard and Accident Analysis

**Appendix:** 3H

**Page:** 243 of 648


**Date:** 12/17/2013
## Hazard Evaluation Table - Event AGTRU-3-032

**Description:**
Pressurized gas disperses uncontained waste during SSSR activities resulting in the release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
- None

**Causes:**
- Equipment malfunction
- Improper maintenance
- Improperly maintained equipment
- Maintenance activities
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

### Consequence / Risk Rank

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</tr>
<tr>
<td>W</td>
<td>L</td>
<td>III</td>
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</table>

**Preventive Features:**

- **Engineered**
  - None

- **Admin**
  - (PSAC) Prohibition on opening sealed waste packages discovered during SSSR activities (Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**

- **Engineered**
  - None

- **Admin**
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<tr>
<td>Preventers</td>
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<td>Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened.</td>
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<tr>
<td>Safety Function:</td>
<td>Prohibition on opening sealed inner waste packages discovered during SSSR activities protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
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**Notes:**
- None

**References:**
- None

**Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
- Waste Container Over-Pressurization - Waste Repackaging (12f)
### Hazard Evaluation Table - Event AGTRU-3-033

**Description:**
Worker handling an open TRU waste container during SSSR inadvertently tips the container over causing a release of radiological material.

**Locations:**
- Area G

**MARs:**
- < 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Improper container placement or handling
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
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**Unmitigated Frequency:**
A

**Mitigated Frequency:**
A

**Preventive Features:**
- **Engineered:** None
- **Admin:** (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**
- **Engineered:** None
- **Admin:**
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
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<tr>
<td>DOE 5506 Detail:</td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)</td>
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</table>
# Hazard Evaluation Table - Event AGTRU-3-034

**Description:**
Handling equipment used (e.g., gantry crane, manlift, scaffolding) over uncontained TRU waste in SSSR fails and results in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- \( \leq 18 \) PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Impact and spill

**Assumptions:**
- None

**Causes:**
- Crane drops load (container, canister, load)
- Equipment capacity exceeded
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Improperly maintained equipment
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
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<tr>
<th>Receptor</th>
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**Preventive Features:**

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<tbody>
<tr>
<td></td>
<td>(SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
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<tr>
<td></td>
<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
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**Mitigative Features:**

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<td>(SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)</td>
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<td>(SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
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**Credited SSCs and ACs**

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<td>References:</td>
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**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)
### Hazard Evaluation Table - Event AGTRU-3-035

**Description:**
Vehicle impacts SSSR area > 10 mph and < 35 mph resulting in a release of radiological material.

<table>
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<tr>
<th>Locations</th>
<th>MARS:</th>
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<tbody>
<tr>
<td>Area G</td>
<td>• &lt; 18 PEC equivalent combustible TRU waste, closed, staged for SSSR</td>
</tr>
<tr>
<td></td>
<td>• &lt; 18 PEC equivalent combustible TRU waste, open, in SSSR process</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
U

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<tr>
<th>Receptor</th>
<th>Method of Detection</th>
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**Consequence / Risk Rank**

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**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
None

<table>
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<tr>
<th>Credited SSCs and ACs</th>
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</table>

**Control**

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<tr>
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</table>

**Attribute**

- Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

**Safety Function:**

- The safety function is mitigative when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional...
radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
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<th>Mitigators</th>
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<tr>
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<tr>
<td>DOE 5506</td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f)</td>
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</table>
**Hazard Evaluation Table - Event AGTRU-3-036**

**Description:**
SSSR ventilation system fails resulting in a release of radiological contamination.

**Locations:**
- Area G

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Improper equipment use
- Improperly maintained equipment
- Loss of normal power
- Operator error
- Plugged HEPA filter

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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<tr>
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</table>

**Consequence / Risk Rank**

**Preventive Features:**
- Engineered: None
- Admin: (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))

**Mitigative Features:**
- Engineered: None
- Admin: (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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</table>
## Hazard Evaluation Table - Event AGTRU-3-037

**Description:**
SSSR equipment leaks free liquids during process resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Drop object on hose
- Equipment failure or operator failure (pump seals, hose not connected properly, etc.)
- Leaks/ drips
- Overflow receipt container
- Pinch hose
- Pump/ pour too quick to receipt tank or receipt tank not vented
- Siphon

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<tr>
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**Preventive Features:**
- Engineered: None
- Admin: (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<th>Control</th>
<th>Attribute</th>
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<tbody>
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</table>

| Notes:  | None |
| References: | None |

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)

---

File: CHA Report - TA-54, Area G
Los Alamos National Laboratory

Chapter 3: Hazard and Accident Analysis
Appendix 3H

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Basis for Interim Operation Rev. 3.0
November 2014


12/17/2013
### Hazard Evaluation Table - Event AGTRU-3-038

**Description:**
Vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph drives off into the Pit 9 waste face breaching containers resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Mitigated Frequency</th>
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<tbody>
<tr>
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<td>II</td>
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<tr>
<td>W</td>
<td>H</td>
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</table>

**Preventive Features:**
- **Engineered**
  - (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
  - (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

- **Admin**
  - (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

- **Admin**
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not colocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>
### Safety Function:
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

### PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers
- **Safety Function:** Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
- **Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).**

### SMP Maintenance Program - Vehicle/Equipment
- **Safety Function:** Reduce likelihood of equipment malfunction
- **Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)**

### SMP Training and Qualification Program - Qualifications
- **Safety Function:** Reduces likelihood for vehicle and equipment accidents
- **Personnel maintain applicable LANL qualifications for vehicle and equipment operation**

### Mitigators
#### SS Hazardous Material and Waste Management - TRU Waste Container (IC)
- **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
- **Metal TRU waste container are of sound integrity**
- **Rad: P, C, W;**

#### PSAC Radiological Inventory Management - Defined Area MAR Control
- **Safety Function:** Reduces the radiological consequences by limiting the MAR involved
- **Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)**
- **Rad: P, C, W;**

#### PSAC Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers
- **Safety Function:** Reduce radiological consequences by limiting MAR involved
- **The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.**
- **Rad: P, C, W;**

### Notes:
- Deleted
- Impacts a waste face of 5 containers high x 2 containers deep by 20 containers wide.
- Roadway provides access to Pit 9 entry ramp but does not approach pit wall.

### References:
None

### DOE 5506 Detail:
- Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d)
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event AGTRU-3-039

Description:
Degradation of sealed sources used for operational calibration result in a release of radiological material.

Locations:
- Area G

Release Mechanisms:
- Loss of Confinement

Assumptions:
None

Causes:
- Confinement lost
- Equipment malfunction
- Improper or no postings
- Improper storage
- Loss of shielding configuration
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: A

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<tr>
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<th>Consequence / Risk Rank</th>
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<td>C</td>
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<td>W</td>
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</table>

Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: None

Credited SSCs and ACs

Preventers: None
Mitigators: None
Notes: None
References: None

DOE 5506 Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Other (10h)
- Direct Exposure to Radiation Events - Characterization (13a)
- Direct Exposure to Radiation Events - Venting and/or Abating/Purging (13c)
- Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
- Direct Exposure to Radiation Events - Waste Repackaging (13f)
<table>
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<tr>
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<td>H</td>
<td>I</td>
<td>M</td>
<td>III</td>
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</table>

**Preventive Features:**

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<tr>
<th>Class</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for load drops resulting in release of radiological material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
</tbody>
</table>
Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

- DOE 5506

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<thead>
<tr>
<th>Detail</th>
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<tbody>
<tr>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Characterization (10a)</td>
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<tr>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)</td>
<td></td>
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<tr>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Staging and Storage (10d)</td>
<td></td>
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</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-3-041

**Description:**
TRU waste container falls from > 12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Drop
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
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<tr>
<th>Receptor</th>
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<th>Chm</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
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</table>

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

**Preventive Features:**

**Engineered**

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
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<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
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<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
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<tr>
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<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
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<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>⚫ Rad: W;</td>
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<tr>
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<td>Safety Function: Reduces radiological consequences due to exposure</td>
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<tr>
<td>Notes:</td>
<td>⚫ When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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<td>⚫ Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
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<td>⚫ Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)</td>
<td>⚫ Drop/Impact/Spill Due to Improperly Handled Container, etc. - Type B Container Loading/Unloading (10g)</td>
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### Hazard Evaluation Table - Event AGTRU-3-042

**Description:**
TRU waste containers are crushed by large mass (e.g., roll-up door) falling > 12 feet resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- 658 PEC (Statistical (all containers) 4 containers on pallet)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Crushing by roll-up door
- Equipment malfunction
- Limit switch failure
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Release Mechanism:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Mitigation Mechanism:**
None

**Unmitigated Frequency:** U

**Mitigated Frequency:** U

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**Consequence / Risk Rank**

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<tr>
<th>Admin</th>
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<tbody>
<tr>
<td>(SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))</td>
</tr>
<tr>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
</tr>
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<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums &gt; 200 PEC)</td>
</tr>
<tr>
<td>(SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)</td>
</tr>
<tr>
<td>(SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
</tr>
<tr>
<td>(SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)</td>
</tr>
</tbody>
</table>

**Credited SSCs and ACs**

<table>
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<th>Class</th>
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<tr>
<td>Preventers</td>
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<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduce likelihood of equipment malfunction</td>
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</thead>
<tbody>
<tr>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Safety Function:</td>
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<table>
<thead>
<tr>
<th>Mitigators</th>
<th>PSAC</th>
</tr>
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<tbody>
<tr>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td>Safety Function:</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
<tr>
<td>Safety Function:</td>
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<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
</tr>
</tbody>
</table>

| Notes:     | None |
| References: | None |
| **DOE 5506** | **Detail:** |
| Vehicle/Equipment Impacts Waste/Waste Containers - Characterization (9a) |
| Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b) |
| Vehicle/Equipment Impacts Waste/Waste Containers - Venting and/or Abating/Purging (9c) |
| Vehicle/Equipment Impacts Waste/Waste Containers - Staging and Storage (9d) |
| Vehicle/Equipment Impacts Waste/Waste Containers - Waste Repackaging (9f) |

those related to building/facility operations, process operations and ignition of flammables/combustibles
### Hazard Evaluation Table - Event AGTRU-3-044

**Description:**
Vehicle transporting CMPs > 10 mph and ≤ 35 mph impacts stored TRU waste containers resulting in a release of radiological material.

**Locations:**
- Along the designated route to or from a CMP Area

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Methods of Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rad</td>
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<td>Observation</td>
</tr>
<tr>
<td>W</td>
<td>M II M</td>
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</tbody>
</table>

**Preventive Features:**
- **Engineered**
  - (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
  - (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Mitigative Features:**
- **Engineered**
  - (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Safety Function</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>All</td>
</tr>
</tbody>
</table>

For more information, please refer to the full document.
The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Because there are no TRU Waste Storage Areas adjacent to or in between the areas where the CMPs are retrieved and where the CMPs are stored, the unmitigated frequency of this event is unlikely.</td>
</tr>
<tr>
<td>- The listed controls are necessary to prevent or mitigate the consequences of a release from the other (non-CMP) TRU waste containers. If CMPs were the only waste containers involved, the accident consequences would be sufficiently low that no TSR controls would be required.</td>
</tr>
<tr>
<td>- The Vehicle Barriers prevent the impact to stored TRU waste drums. The only consequences of any impact to the transported CMPs is negligible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>References:</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
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<th>Detail:</th>
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<tbody>
<tr>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event AGTRU-4-001

**Description:**
Personnel exposure to X-ray source or radiation generating device results in a direct radiation exposure.

**Locations:**  
- Area G

**Release Mechanisms:**  
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Failure of exposure control procedure mechanism
- Improper or no postings
- Loss of shielding configuration
- Operator error
- Radiation-generating device

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
EU

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<tr>
<th>Receptor</th>
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<tr>
<td>W</td>
<td>L</td>
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</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: **(DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)**

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
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<tr>
<td>Preventers</td>
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</tr>
<tr>
<td>Mitigators</td>
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</tbody>
</table>

**Notes:**
- Radiation generating devices are operated and maintained in accordance with applicable manufacturer procedures or accepted industry standards.

**References:**
None

**DOE 5506 Detail:**
- Direct Exposure to Radiation Events - Characterization (13a)
- Direct Exposure to Radiation Events - Container Handling (13b)
- Direct Exposure to Radiation Events - Staging and Storage (13d)
- Direct Exposure to Radiation Events - Waste Repackaging (13f)
- Direct Exposure to Radiation Events - Type B Container Loading/Unloading (13g)
Hazard Evaluation Table - Event AGTRU-4-001a

Description:
Personnel exposure to X-ray radiation generated by waste characterization at HE-RTR results in a direct exposure.

Locations:
- Area G

Release Mechanisms:
- N/A - Direct Exposure

Assumptions:
None

Causes:
- Equipment malfunction
- Failure of exposure control procedure mechanism
- Improper or no postings
- Loss of shielding configuration
- Operator error
- Radiation-generating device

Unmitigated System Effects:
None

Methods of Detection:
- Dosimetry

Unmitigated Frequency: EU

Mitigated Frequency: EU

Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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<td>M</td>
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</table>

Preventive Features:
- Engineered None
- Admin None

Mitigative Features:
- Engineered None
- Admin (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Control</th>
<th>Attribute</th>
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</table>

Mitigators

Notes:
- Radiation generating devices are operated and maintained in accordance with applicable manufacturer procedures or accepted industry standards.

References:
None

DOE 5506

Detail:
- Direct Exposure to Radiation Events - Characterization (13a)
Hazard Evaluation Table - Event AGTRU-4-002

**Description:**
Personnel receive direct exposure from sealed sources resulting in a direct radiation exposure.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Confinement lost
- Equipment malfunction
- Improper or no postings
- Improper storage
- Loss of shielding configuration
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry

**Unmitigated Frequency:**
BEU

**Mitigated Frequency:**
BEU

<table>
<thead>
<tr>
<th>Receptor</th>
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</table>

**Consequence / Risk Rank**

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin:
  - (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<tbody>
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**Notes:**
None

**References:**
DOE 5506 Detail:
- Direct Exposure to Radiation Events - Characterization (13a)
- Direct Exposure to Radiation Events - Container Handling (13b)
- Direct Exposure to Radiation Events - Venting and/or Abating/Purging (13c)
- Direct Exposure to Radiation Events - Staging and Storage (13d)
- Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
- Direct Exposure to Radiation Events - Waste Repackaging (13f)
- Direct Exposure to Radiation Events - Type B Container Loading/Unloading (13g)
**Hazard Evaluation Table - Event AGTRU-4-003**

**Description:**
Personnel exposure to TRU waste containers results in a direct radiation exposure.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Container misloaded or overbatched
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inadequate shielding (shine)
- Loss of shielding configuration
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
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<th>Class</th>
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<th>Attribute</th>
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<td>Mitigators</td>
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**DOE 5506 Detail:**
- Direct Exposure to Radiation Events - Characterization (13a)
- Direct Exposure to Radiation Events - Container Handling (13b)
- Direct Exposure to Radiation Events - Venting and/or Abating/Purging (13c)
- Direct Exposure to Radiation Events - Staging and Storage (13d)
- Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
- Direct Exposure to Radiation Events - Waste Repackaging (13f)
- Direct Exposure to Radiation Events - Type B Container Loading/Unloading (13g)
### Hazard Evaluation Table - Event AGTRU-4-004

**Description:**
Radiological material collected on HEPA filtration leads to direct radiation exposure.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Improper equipment use
- Incorrect filter
- Operator error
- Plugged HEPA filter

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry

**Consequence / Risk Rank**

<table>
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<th>Chm</th>
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</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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**Notes:**
None

**References:**
- DOE 5506 Detail:
  - Direct Exposure to Radiation Events - Venting and/or Abating/Purging (13c)
  - Direct Exposure to Radiation Events - Waste Repackaging (13f)
Hazard Evaluation Table - Event AGTRU-4-005

Description:
Material in TRU Waste container emits high dose during SSSR activity resulting in a direct radiation exposure.

Locations:
- Area G
- MARs: None

Release Mechanisms:
- N/A - Direct Exposure

Assumptions:
None

Causes:
- Handling high dose object
- Loss of shielding (shifting, breaching, reconfigures waste, loss of cap, etc.)
- Operator error
- Unknowingly remove shielding

Unmitigated System Effects:
None

Methods of Detection:
- Dosimetry
- Radcon instrumentation

Unmitigated Frequency: A
Mitigated Frequency: A

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
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<td>L</td>
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</tbody>
</table>

Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Mitigators</th>
<th>Notes:</th>
<th>References:</th>
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</thead>
<tbody>
<tr>
<td>None</td>
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<td>None</td>
<td>Direct Exposure to Radiation Events - Waste Repackaging (13f)</td>
</tr>
</tbody>
</table>

References:
- DOE 5506 Detail: Direct Exposure to Radiation Events - Waste Repackaging (13f)
Hazard Evaluation Table - Event AGTRU-5-001

**Description:**
Reconfiguration of multiple high FGE TRU waste containers in a close proximity array results in a criticality.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error
- Seismic event
- Storage structure collapse

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
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<tr>
<th>Receptor</th>
<th>Rad</th>
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<tr>
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</tbody>
</table>

**Consequence / Risk Rank**

**Preventive Features:**
- None

**Mitigative Features:**
- None

**Credited SSCs and ACs**

**Preventers**
- SMP Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- DID Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigators**
- None

**Notes:**
None

**References:**
- DOE 5506
- **Detail:** Criticality Events - Characterization (14a)
- Criticality Events - Container Handling (14b)
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
Hazard Evaluation Table - Event AGTRU-5-002

**Description:**
TRU waste container is retrieved from Pit 9 or Trenches A to D with high FGE material and placed within an array with other staged retrieved containers having high FGE results in a criticality.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Improper container placement or handling
- Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
<td>II</td>
<td>H</td>
<td>III</td>
</tr>
</tbody>
</table>

#### Preventive Features:
- Engineered: None
- Admin: (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))

#### Mitigative Features:
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Nuclear Criticality Program</td>
<td>Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)</td>
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| Safety Function: | Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible |

**Mitigators:**
- None

**Notes:**
- None

**References:**
- None

**DOE 5506**
- Criticality Events - Container Handling (14b)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Retrieval and Excavation (14e)
### Hazard Evaluation Table - Event AGTRU-5-003

**Description:**
Fissile material in TRU Waste container shifts during movement resulting in a criticality.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Improper container placement or handling
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

**Consequence / Risk Rank**

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**Preventive Features:**
- None

**Mitigative Features:**
- None

**Credited SSCs and ACs**

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**Notes:**
None

**References:**
- DOE 5506

**Detail:**
- Criticality Events - Characterization (14a)
- Criticality Events - Container Handling (14b)
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
# Hazard Evaluation Table - Event AGTRU-5-004

## Description:
Critical mass collects in a HEPA filter resulting in a criticality.

## Locations:
- Area G

## MARs:
- Fissile Material

## Release Mechanisms:
- N/A - Criticality

## Assumptions:
None

## Causes:
- Non-realistic accumulation of fissile material on the HEPA filter in excess of 10 kg

## Unmitigated System Effects:
None

## Methods of Detection:
- Dosimetry
- Radon instrumentation

## Unmitigated Frequency:
EU

## Mitigated Frequency:
BEU

## Methods of Detection:
Dosimetry

## Methods of Detection:
Radon instrumentation

## Consequence / Risk Rank

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## Preventive Features:

### Admin
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))

## Mitigative Features:

### Admin
None

## Credited SSCs and ACs

### Preventers
- SMP
- Nuclear Criticality Program
- Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)

### Safety Function:
Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible

### Affected Receptors
All

## Notes:
The physical process required for this event to occur is not physically plausible. Due to the Area G process life cycle, there is not sufficient fissile material > 1000 g to concentrate on a HEPA filter, form a critical mass or geometry, and become critical. Therefore, this event is considered not physically plausible.

## References:
None

### DOE 5506 Detail:
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
- Criticality Events - Other (14h)
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### Credited SSCs and ACs

**Preventers**
- **Control:** SMP Nuclear Criticality Program
- **Attribute:** Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)
- **Safety Function:** Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible
- **Affected Receptors:** All

**Mitigators**
- None

### Notes:
- None

### References:
- DOE 5506
- Detail: Criticality Events - Characterization (14a), Criticality Events - Container Handling (14b), Criticality Events - Venting and/or Abating/Purging (14c), Criticality Events - Staging and Storage (14d), Criticality Events - Waste Repackaging (14f), Criticality Events - Type B Container Loading/Unloading (14g)
### Hazard Evaluation Table - Event AGTRU-5-006

**Description:**
A TRU waste container with high Fissile Gram Equivalent (FGE) material is transported in close proximity to another high FGE container that results in a criticality.

**Locations:**
- Area G

**MARS:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

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**Consequence / Risk Rank**

**Preventive Features:**
- **Engineered** None
- **Admin** (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- **Engineered** None
- **Admin** None

**Credited SSCs and ACs**

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**Notes:**
None

**References:**
- DOE 5506
- Criticality Events - Container Handling (14b)
- Criticality Events - Staging and Storage (14d)
## Hazard Evaluation Table - Event AGTRU-5-007

**Description:**
Stationary vehicle adjacent to multiple TRU waste containing high Fissile Gram Equivalent material spills/leaks fuel in coincidence with ignition source results in a pool fire. The fire engulfs and burns the waste, mixes with fire extinguishing water and collects in an unfavorable geometry resulting in a criticality.

**Locations:**
- Area G

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Addition of moderator
- Firefighting water runoff
- Fissile material collects in critical configuration
- Ignition source
- Leaks/drips
- Reduction of waste volume
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Observation
- Radcon instrumentation

**Unmitigated Frequency:** EU

### Consequence / Risk Rank

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**Mitigated Frequency:** BEU

### Preventive Features:

**Engineered**
None

**Admin**
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

### Mitigative Features:

**Engineered**
None

**Admin**
None

### Credited SSCs and ACs

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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Criticality Events - Container Handling (14b)
- Criticality Events - Retrieval and Excavation (14e)
- Criticality Events - Other (14h)
| Description: | Critical mass exceeded during repackaging resulting in a criticality with radiological release. |
| Locations: | ● Area G  | MARs: ● Fissile Material |
| Release Mechanisms: | ● N/A - Criticality |
| Assumptions: | None |
| Causes: | ● Fissile material is redistributed  
 ● Operator error  
 ● Unknown container contents  
 ● Waste container misloaded |
| Unmitigated System Effects: | None |
| Methods of Detection: | ● Dosimetry  
 ● Radcon instrumentation |
| Unmitigated Frequency: | EU |
| Mitigated Frequency: | BEU |

### Consequence / Risk Rank

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#### Preventive Features:
- Engineered: None
- Admin: (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

#### Mitigative Features:
- Engineered: None
- Admin: None

### Credited SSCs and ACs

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### Notes:
- The containers listed in the Area G inventory that are repackaged contain only materials and items characterized as waste (i.e., low density, randomly distributed, surface contamination on metals and plastic, or embedded in concrete, varying degrees of moderation).

References: None

DOE 5506

Detail: None
### Hazard Evaluation Table - Event AGTRU-5-009

**Description:**
Intrusion of water into an over massed drum resulting in a criticality.

**Locations:**
- Area G

**MARs:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Container degradation
- Flooding
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
BEU

#### Consequence / Risk Rank

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**Mitigative Features:**
- None

**Credited SSCs and ACs**
- Preventers: SMP
- Safety Function: Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)
- Affected Receptors: All

**Notes:**
- The physical process required for this event to occur is not physically plausible. The physical process would require most of the fissile material > 1000 g segregate from waste matrix into a uniform optimally moderated system. Therefore, this event is considered not physically plausible.

**References:**
- None
- DOE 5506

12/17/2013
## Hazard Evaluation Table - Event AGTRU-5-010

**Description:**
A TRU waste container with high Fissile Gram Equivalent (FGE) material is being transported in close proximity to a storage array that results in a criticality.

**Locations:**
- Area G

**MARs:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Improper container placement or handling
- Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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### Preventive Features:

**Engineered** None

**Admin**
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

### Mitigative Features:

**Engineered** None

**Admin** None

### Credited SSCs and ACs

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### Notes:
None

### References:
None

### DOE 5506 Detail:
- Criticality Events - Characterization (14a)
- Criticality Events - Container Handling (14b)
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
### Hazard Evaluation Table - Event AGTRU-5-011

**Description:**
Critical mass exceeded with intrusion of flood water results in a criticality.

**Locations:**
- Area G

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Fissile material collects in critical configuration
- Waste container misloaded

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Consequence / Risk Rank**

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**Preventive Features:**

- Engineered: None
- Admin: (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**

- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**DOE 5506 Detail:**
- Criticality Events - Characterization (14a)
- Criticality Events - Container Handling (14b)
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Retrieval and Excavation (14e)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
Hazard Evaluation Table - Event AGTRU-5-012

**Description:**
Water is vacuumed/ drained from multiple sludge drums resulting in an accumulation of fissile material and a criticality.

**Locations:**
- Area G

**MARS:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Accumulation of liquid
- Container misloaded or overbatched
- Fissile material collects in critical configuration
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radon instrumentation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

**Consequence / Risk Rank**

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**Preventive Features:**

**Engineered**
None

**Admin**
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**

**Engineered**
None

**Admin**
None

**Credited SSCs and ACs**

**Preventers**
- SMP Nuclear Criticality Program
  - Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)
  - Safety Function: Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible

**Mitigators**
None

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
None
Hazard Evaluation Table - Event AGTRU-6-001

**Description:**
Aircraft impacts TRU waste followed by pool fire.

**Locations:**
- Area G

**MARs:**
- < 22,000 PEC (Storage Area limit, metal containers ONLY)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- High energy impact
- Impact and spill

**Assumptions:**
None

**Causes:**
- Aircraft crash

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

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<th>Receptor</th>
<th>Rad</th>
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<th>Chm</th>
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<td>II</td>
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</tbody>
</table>

**Preventive Features:**

- **Engineered**: None
- **Admin**: None

**Mitigative Features:**

- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) (IC) Waste Packaging Control (Waste is packaged)

- **Admin**
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Aircraft Impact with Fire - Characterization (15a)
- Aircraft Impact with Fire - Container Handling (15b)
- Aircraft Impact with Fire - Venting and/or Abating/Purging (15c)
- Aircraft Impact with Fire - Staging and Storage (15d)
- Aircraft Impact with Fire - Retrieval and Excavation (15e)
- Aircraft Impact with Fire - Waste Repackaging (15f)
- Aircraft Impact with Fire - Type B Container Loading/Unloading (15g)
- Aircraft Impact with Fire - Other (15h)
Hazard Evaluation Table - Event AGTRU-6-002

Description:
External fire propagates to TRU waste resulting in a release of radiological material.

Locations:
- Area G

Release Mechanisms:
- Exposure Fire
- Fire

Assumptions:
None

Causes:
- Wildland fire

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: U

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<td>M</td>
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<tr>
<td>C</td>
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<td>I</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered None

Mitigative Features:

Engineered
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Credited SSCs and ACs

Class | Control | Attribute | Affected Receptors |
Preventers | PSAC | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | All |
Mitigators | SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
Mitigators | SS | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |
Mitigators | PSAC | Fire Protection - Control of Transient Combustibles | Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.) | Rad: P, C, W; |
<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</th>
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</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Area G Site Above-Ground MAR Limits (IC)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Low Activity Area (LAA) (IC)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

Notes:  
- Combustible/flammable materials external to container  
- May include other container types

References: None

DOE 5506 Detail:  
- External Fire - Characterization (19a)  
- External Fire - Container Handling (19b)  
- External Fire - Venting and/or Abating/Purging (19c)  
- External Fire - Staging and Storage (19d)  
- External Fire - Retrieval and Excavation (19e)  
- External Fire - Waste Repackaging (19f)  
- External Fire - Type B Container Loading/Unloading (19g)  
- External Fire - Other (19h)
# Hazard Evaluation Table - Event AGTRU-7-001

**Description:**
TRU waste container is struck by lightning resulting in a release of radiological material.

**Locations:**
- Area G  
- MARS: 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Combustible material
- Lightning

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
</tr>
</thead>
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<tr>
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<td>Unmit.</td>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered:**
- (DID) Maintenance Program-LPS (LPS is maintained)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Admin:**
- (DID) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Mitigative Features:

**Engineered:**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

**Preventers**
- None

**Mitigators**
- SS Hazardous Material and Waste Management - TRU Waste Container (IC)
  - **Safety Function:**
    - Metal TRU waste container are of sound integrity
    - Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

- PSAC Radiological Inventory Management - TRU Waste Drum Doublepack
  - **Safety Function:**
    - Doublepack radiological waste drums ≥ 200 PEC
    - Reduces radiological consequences by limiting amount of MAR involved

- SMP Radiation Protection Program
  - **Safety Function:**
    - Evaluates radiological conditions and processes for worker protection
    - Reduces radiological consequences due to exposure

### Notes:
None

### References:
None

### DOE 5506 Detail:
- Lighting - Characterization (20a)
- Lighting - Container Handling (20b)
- Lighting - Venting and/or Abating/Purging (20c)
- Lighting - Staging and Storage (20d)
- Lighting - Waste Repackaging (20f)
- Lighting - Type B Container Loading/Unloading (20g)
- Lighting - Other (20h)
### Hazard Evaluation Table - Event AGTRU-7-002

**Description:**
Lightning strikes multiple unvented TRU waste containers inducing a breach resulting in release of radiological material.

**Locations:**
- Area G

**MARs:**
- 698 PEC (4 containers/pallet x 3 tiers = statistical 12 (all) containers)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Combustible material
- Lightning

**Unmitigated System Effects:**
Methods of Detection:
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- (DID) Maintenance Program-LPS (LPS is maintained)

**Admin**
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<th>Class</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for deflagration</td>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/ or over-pressurization</td>
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</tbody>
</table>

### Mitigators

**SS**
- Hazardous Material and Waste Management - TRU Waste Container (IC)
  - Metal TRU waste container are of sound integrity
  - Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
  - SMP Radiation Protection Program Evaluates radiological conditions and processes for worker protection
  - Safety Function: Reduces radiological consequences due to exposure

### Notes:
None

### References:
None

**DOE 5506**
- Lightning - Characterization (20a)
- Lightning - Container Handling (20b)
- Lightning - Venting and/or Abating/Furring (20c)

---

Chapter 3: Hazard and Accident Analysis
Appendix 3H

12/17/2013
<table>
<thead>
<tr>
<th>Lightning - Staging and Storage (20d)</th>
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</thead>
<tbody>
<tr>
<td>Lightning - Waste Repackaging (20f)</td>
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<tr>
<td>Lightning - Type B Container Loading/Unloading (20g)</td>
</tr>
<tr>
<td>Lightning - Other (20h)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-7-002a

**Description:**
Lightning strikes multiple TRU waste containers inducing a breach resulting in release of radiological material. Lightning strikes a 3-tier stack of TRU waste drums. The top four TRU waste drums experience a deflagration due to a flammable atmosphere. The other two tiers of TRU waste drums experience a low-energy impact and contained burning.

**Locations:**
- Area G

**MARs:**
- 698 PEC (4 containers/pallet x 3 tiers = statistical 12 (all) containers)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Combustible material
- Lightning

**Unmitigated System Effects:**
- Methods of Detection:
  - Observation

**Unmitigated Frequency:**
- A

**Consequence / Risk Rank**

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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**  
- (DID) Maintenance Program-LPS (LPS is maintained)

**Admin**  
- (PSAC) TRU Waste Container Management - Vented TRU Waste Drums (Above-ground outer TRU waste containers shall be passively vented)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**  
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**  
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>TRU Waste Container Management - Vented TRU Waste Drums</td>
<td>Above-ground outer TRU waste containers shall be passively vented</td>
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<tr>
<td></td>
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<td>Safety Function:</td>
<td>Reduces likelihood for build-up of internal gases which could lead to deflagration and/or over-pressurization</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<td>Safety Function:</td>
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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<td>Safety Function:</td>
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<tr>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
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<td>PSAC</td>
<td>TRU Waste Container Management - Unvented Containers are not Stacked</td>
<td>Unvented TRU waste containers are not stacked</td>
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<tr>
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<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences from a sympathetic deflagration</td>
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## SMP Radiation Protection Program

| Notes: | None |
| Safety Function: | Reduces radiological consequences due to exposure |

### Safety Function:

- Rad: W;

<table>
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<th>DOE 5506 Detail:</th>
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<tr>
<td>● Lightning - Characterization (20a)</td>
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<td>● Lightning - Type B Container Loading/Unloading (20g)</td>
</tr>
<tr>
<td>● Lightning - Other (20h)</td>
</tr>
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</table>
### Hazard Evaluation Table - Event AGTRU-7-005

**Description:**
Tornado/ high wind damages multiple TRU waste containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 100 PEC exposed MAR and ≤ 3,000 Ci exposed Tritium-contaminated waste
- 475 PEC (Statistical 2 non-metal containers)
- 690 PEC (Statistical 12 metal containers)
- ≤ 4,000,000 Ci of Tritium

**Release Mechanisms:**
- Impact and spill

**Assumptions:**
None

**Causes:**
- High wind
- Tornado/ high straight wind generated missiles

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** U

**Consequence / Risk Rank**

<table>
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<tr>
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<td>III</td>
<td>L</td>
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</tbody>
</table>

**Preventive Features:**
- none
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)

**Mitigative Features:**
- none
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Area G Site Above-Ground MAR Limits (Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.)
- (PSAC) (IC) Radiological Inventory Management - Low Activity Area (LAA) (Limit LAA MAR to ≤ 3,000 tritium Ci exposed tritium contaminated waste per LAA and total LAA exposed MAR at Area G to ≤ 100 PEC.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

**Credited SSCs and ACs**

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<tr>
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<tr>
<td>Mitigators</td>
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<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Area G Site Above-Ground MAR Limits (IC)</td>
<td>Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Low Activity Area (LAA) (IC)</td>
<td>Limit LAA MAR to ≤ 3,000 tritium Ci exposed tritium contaminated waste per LAA and total LAA exposed MAR at Area G to ≤ 100 PEC.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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**Notes:**
None

**References:**
- DOE 5506 - High Wind - Characterization (21a)
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<tr>
<td>High Wind - Container Handling (21b)</td>
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<td>High Wind - Venting and/or Abating/Purging (21c)</td>
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<td>High Wind - Staging and Storage (21d)</td>
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<tr>
<td>High Wind - Retrieval and Excavation (21e)</td>
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<tr>
<td>High Wind - Waste Repackaging (21f)</td>
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<tr>
<td>High Wind - Type B Container Loading/Unloading (21g)</td>
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<tr>
<td>Tornado - Characterization (22a)</td>
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<td>Tornado - Container Handling (22b)</td>
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<td>Tornado - Venting and/or Abating/Purging (22c)</td>
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<tr>
<td>Tornado - Waste Repackaging (22f)</td>
</tr>
<tr>
<td>Tornado - Type B Container Loading/Unloading (22g)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event AGTRU-7-006

Description:
Seismic event affects Area G resulting in a release of radiological material.

Locations:
- Area G

Release Mechanisms:
- Impact and spill

Assumptions:
- Tritium release does not occur without fire.

Causes:
- Seismic event

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: U

Consequence / Risk Rank

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<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered

Admin
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)

Mitigative Features:
Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Pole-Mounted Transformer Distance from TRU Waste Storage Areas (Pole-mounted transformers must be located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool possible from the spilled transformer flammable/combustible oil, and the associated thermal separation distance necessary to prevent the TRU non-metal containers from becoming affected by the transformer fuel pool fire. Alternatively, the pole-mounted transformer can fall at a berm, ditch, curb, or ditch, or equivalent liquid impediment, which is at a safe thermal separation distance away from a TRU waste storage area.)
- (PSAC) (IC) Radiological Inventory Management - Area G Site Above-Ground MAR Limits (Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Low Activity Area (LAA) (Limit LAA MAR to ≤ 3,000 tritium Ci exposed tritium-contaminated waste per LAA and total LAA exposed MAR at Area G to ≤ 100 PEC.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tr>
<td>Preventers</td>
<td>None</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
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<td>SS</td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers</td>
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<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<td>PSAC</td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - Area G Site Above-Ground MAR Limits (IC)</td>
<td>Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.</td>
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<td>PSAC</td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>Area MAR Control (IC)</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Low Activity Area (LAA) (IC)</td>
<td></td>
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<tr>
<td></td>
<td>Limit LAA MAR to ≤ 3,000 tritium Ci exposed tritium contaminated waste per LAA and total LAA exposed MAR at Area G to ≤ 100 PEC.</td>
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<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
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<td></td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td></td>
<td>Safety Function: Reduces radiological consequences by limiting amount of MAR involved</td>
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<td>SMP</td>
<td>Emergency Preparedness Program</td>
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<tr>
<td></td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td></td>
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<td></td>
<td>Safety Function: Reduce the consequences of an accident for the worker and collocated worker.</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
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<tr>
<td></td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: None

References: None

DOE 5506

Detail:  
- Seismic Event (Impact Only) - Characterization (24a)  
- Seismic Event (Impact Only) - Container Handling (24b)  
- Seismic Event (Impact Only) - Venting and/or Abating/Purging (24c)  
- Seismic Event (Impact Only) - Staging and Storage (24d)  
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)  
- Seismic Event (Impact Only) - Waste Repackaging (24f)  
- Seismic Event (Impact Only) - Type B Container Loading/Unloading (24g)
# Hazard Evaluation Table - Event AGTRU-7-007

**Description:**
Seismic event with fire affects Area G resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Exposure Fire
- Fire
- Impact and spill

**Assumptions:**
None

**Causes:**
Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
Observation

**Unmitigated Frequency:**
U

**Mitigated Frequency:**
EU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td></td>
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<td>H</td>
<td>I</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**
None

**Engineered Admin:**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Hazardous Material and Waste Management - Drum Banding (Multiple drums on pallets in stacked arrays are banded)

**Mitigative Features:**

**Engineered Admin:**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Pole-Mounted Transformer Distance from TRU Waste Storage Areas (Pole-mounted transformers must be located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool which is at a safe thermal separation distance away from a TRU waste storage area.) Alternatively, the pole-mounted transformer can fall at a berm, ditch, curb, or ditch, or equivalent liquid impediment, which is at a safe thermal separation distance away from a TRU waste storage area.)
- (PSAC) (IC) Radiological Inventory Management - Area G Site Above-Ground MAR Limits (Limit Area G above-ground MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Low Activity Area (LAA) (Limit LAA MAR to < 3,000 tritium Ci exposed tritium contaminated waste per LAA and total LAA exposed MAR at G to ≤ 100 PEC.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

**Credited SSCs and ACs**

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<tr>
<th>Class</th>
<th>Control</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.
- Reduces the radiological consequences as waste is agglomerated and burns as
| SS Waste Packaging Control (IC) | Waste is packaged. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers. | Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged. |
| PSAC Fire Protection - Control of Transient Combustibles | Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers. | Safety Function: Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited. |
| PSAC Pole-Mounted Transformer Distance from TRU Waste Storage Areas | Pole-mounted transformers must be located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool possible from the spilled transformer flammable/combustible oil, and the associated thermal separation distance necessary to prevent the TRU non-metal containers from becoming affected by the transformer fuel pool fire. Alternatively, the pole-mounted transformer can fall at a berm, ditch, curb, or ditch, or equivalent liquid impediment, which is at a safe thermal separation distance away from a TRU waste storage area. | Safety Function: The safety function of this SAC is to prevent pole-mounted transformers from falling onto or in close proximity to waste storage areas, to prevent a post-seismic transformer fuel pool fire from impacting waste, thereby mitigating consequences from a post-seismic fire. |
| PSAC Radiological Inventory Management - Area G Site Above-Ground MAR Limits (IC) | Limit Area G above-ground TRU MAR inventory to ≤ 57,000 PEC and above-ground tritium inventory to ≤ 4,000,000 tritium Ci. | Safety Function: Reduces the radiological consequences by limiting the MAR involved. |
| PSAC Radiological Inventory Management - Defined Area MAR Control (IC) | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) | Safety Function: Reduces the radiological consequences by limiting the MAR involved. |
| PSAC Radiological Inventory Management - Low Activity Area (LAA) (IC) | Limit LAA MAR to ≤ 3,000 tritium Ci exposed tritium contaminated waste per LAA and total LAA exposed MAR at Area G to ≤ 100 PEC. | Safety Function: Reduces the radiological consequences by limiting the MAR involved. |
| PSAC Radiological Inventory Management - TRU Waste Drum Doublepack | Doublepack radiological waste drums > 200 PEC | Safety Function: Reduce radiological consequences by limiting amount of MAR involved. |

Notes: None

References: None

DOE 5506 Detail:
* Seismic Event with Fire - Characterization (25a)
* Seismic Event with Fire - Container Handling (25b)
* Seismic Event with Fire - Venting and/or Abating/Purging (25c)
* Seismic Event with Fire - Staging and Storage (25d)
* Seismic Event with Fire - Retrieval and Excavation (25e)
* Seismic Event with Fire - Waste Repackaging (25f)
* Seismic Event with Fire - Type B Container Loading/Unloading (25g)
### Hazard Evaluation Table - Event BGTRUCMP-1-001

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph impacts CMPs. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport as well as the CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area
- MARs:
  - 400 PEC 2 CMPs (200 PEC each)
  - ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Unmitigated Frequency:**
- EU

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**Consequence / Risk Rank**

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<th>Rad</th>
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<th>Chm</th>
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<td>H</td>
<td>II</td>
<td>M</td>
<td>IV</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- (SMP) Vehicle/Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)).
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls - Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
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<th>Class</th>
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<th>Affected Receptors</th>
</tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back).</td>
</tr>
<tr>
<td></td>
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<td>All</td>
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<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<tr>
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<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the...</td>
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<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (IC)</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Safety Function: Reduce radiological consequences by limiting MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

Notes:  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- The listed controls are necessary to prevent or mitigate the consequences of a release from the other (non-CMP) TRU waste containers. If CMPs were the only waste containers involved, the accident consequences would be sufficiently low that no TSR controls would be required.
- This event bounds an accident involving vehicles/ equipment transporting a single waste container at low or moderate impact energy. This event also bounds an accident involving vehicles/ equipment not transporting waste at low or moderate impact energy.

References: None

DOE 5506 Detail: Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUCMP-1-002

Description:
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph impacts CMPs. The collision initiates a fire which involves the containers resulting in a release of radiological material.

Locations:
- CMP Area

MARS:
- 400 PEC 2 CMPs (200 PEC each)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

Assumptions:
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: EU

Consequence / Risk Rank

<table>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci) will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bidg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) [IC] Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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</table>

Safety Function:
Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.
<table>
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<tr>
<th>Mitigators</th>
<th>SS</th>
<th>Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
<th>Metal TRU waste container are of sound integrity</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
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<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (IC)</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved.</td>
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**Notes:** The listed controls are necessary to prevent or mitigate the consequences of a release from the other (non-CMP) TRU waste containers. If CMPs were the only waste containers involved, the accident consequences would be sufficiently low that no TSR controls would be required.

**References:** None

**DOE 5506 Detail:** Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event BGTRUCMP-1-003

**Description:**
A fire occurs in proximity to CMPs with the heat of the fire affecting the CMPs resulting in a release of radiological material.

**Locations:**
- **MARP:** CMP Area
- **MARS:** 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Equipment malfunction
- Ignition source
- Lightning
- Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

- Preventers: None
- Mitigators: None
- Notes: Deleted
- References:
- DOE 5506 Detail:
  - Small Fire - Retrieval and Excavation (2e)
  - Lightning - Retrieval and Excavation (20e)
  - Seismic Event with Fire - Retrieval and Excavation (25e)
**Hazard Evaluation Table - Event BGTRUCMP-1-004**

**Description:**
Combustible/flammable liquid (e.g., gasoline, diesel fuel, transient combustible liquids) adjacent to or within the staged CMPs is ignited resulting in a pool fire with a release of radiological material.

**Locations:**
- CMP Area

**MARs:**
- 11,000 PEC (158 CMPs)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Lightning
- Operator error
- Seismic event
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** U

**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- DOE 5506 Detail:
  - Fuel Pool Fire - Retrieval and Excavation (1e)
  - Lightning - Retrieval and Excavation (20e)
  - Seismic Event with Fire - Retrieval and Excavation (25e)
**Hazard Evaluation Table - Event BGTRUCMP-1-005**

**Description:**
Equipment fire (e.g., forklift, man-lift, etc.) ignites in the vicinity of CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Equipment malfunction
- Ignition source
- Lightning
- Mechanical failure
- Operator error
- Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Consequence / Risk Rank**

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

**Preventers**
- None

**Mitigators**
- None

**Notes:**
- Combustible /flammable materials external to container

**References:**
- DOE 5506 Detail:
  - Small Fire - Retrieval and Excavation (2e)
  - Lightning - Retrieval and Excavation (20e)
  - Seismic Event with Fire - Retrieval and Excavation (25e)
## Hazard Evaluation Table - Event BGTRUCMP-1-006

**Description:**
Large refueling vehicle accident results in fuel spill with subsequent pool fire engulfing CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

### Credited SSCs and ACs

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<td>Mitigators: None</td>
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<td>Notes:</td>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
<td></td>
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<tr>
<td></td>
<td>The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.</td>
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**References:**
None

**DOE 5506 Detail:**
- Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUCMP-1-007

Description:
Large refueling vehicle spills fuel during refueling operation with subsequent pool fire engulfing CMPs results in a release of radiological material.

Locations:
- CMP Area

MARs:
- 11,000 PEC (158 CMPs)

Release Mechanisms:
- Fuel pool fire release

Assumptions:
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

Causes:
- Equipment malfunction
- Ignition source
- Leaks/ drips
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: EU

Consequence / Risk Rank

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Preventive Features:
- Engineered None
- Admin None

Mitigative Features:
- Engineered None
- Admin None

Credited SSCs and ACs

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</table>

| Mitigators | None |
| Notes:     |- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool. |
|           |- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth. |

References:
- None

DOE 5506 Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUCMP-1-008

**Description:**
Stationary vehicle adjacent to CMPs spills/ leaks fuel in coincidence with ignition source resulting in pool fire releasing radiological material.

**Locations:**
- CMP Area

**MARs:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Ignition source
- Leaks/ drips

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- EU

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

- Preventers: None
- Mitigators: None

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- DOE 5506 Detail: Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event BGTRUCMP-1-009

**Description:**
Transient combustibles ignite and burn around CMPs being processed causing a fire and resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARs:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
**Hazard Evaluation Table - Event BGTRUCMP-1-010**

**Description:**
During size reduction activities, the use of electrical equipment (e.g., hydraulic shear, power tools, saws) provide an ignition source and causes a fire resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 200 PEC (1 CMP)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

**References:**
- DOE 5506 Detail: Small Fire - Retrieval and Excavation (2e)
### Hazard Evaluation Table - Event BGTRUCMP-1-011

**Description:**
During size reduction activities, support equipment (e.g., vehicle, forklift, overhead hoist) fail or overheat causing a fire resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Consequence / Risk Rank**

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**Mitigated Frequency:** A

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**
- Preventers: None
- Mitigators: None

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

**References:**
- DOE 5506 Detail: Small Fire - Retrieval and Excavation (2e)
**Hazard Evaluation Table - Event BGTRUCMP-1-012**

**Description:**
Flammable/combustible material during CMP processing ignite and cause a fire resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 200 PEC (1 CMP)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

**References:**
- None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
### Hazard Evaluation Table - Event BGTRUCMP-1-013

**Description:**
A vehicle traveling at > 10 mph and ≤ 35 mph impacts CMPs. The collision initiates a fire which involves the CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARs:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Exposure Fire
- Fire
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** U

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**Credited SSCs and ACs**

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**Notes:**
- Combustible /flammable materials external to container
- Deleted

**References:**
- DOE 5506 Detail: Small Fire - Retrieval and Excavation (2e)
## Hazard Evaluation Table - Event BGTRUCMP-1-014

**Description:**
A vehicle traveling at > 10 mph and < 35 mph impacts CMPs. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Fuel pool fire release
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/Equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

**Preventers:**
- None

**Mitigators:**
- None

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506 Detail:**
- Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUCMP-2-001

**Description:**
Flammable gas accumulates near CMPs with coincidental ignition source leads to a deflagration affecting the CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity
- Vehicle accident

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- EU

**Consequence / Risk Rank**

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**Preventive Features:**
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- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
### Hazard Evaluation Table - Event BGTRUCMP-3-001

**Description:**
A vehicle/ equipment traveling at > 10 mph and < 35 mph impacts CMPs resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 400 PEC 2 CMPs (200 PEC each)

**Release Mechanisms:**
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** A

### Consequence / Risk Rank

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**Preventive Features:**
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**Mitigative Features:**
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- Admin: None

**Credited SSCs and ACs**

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**Preventers:**
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**Mitigators:**
- None

**Notes:**
- None

**References:**
- None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUCMP-3-002

**Description:**
Worker size reducing a CMP results in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Contamination

**Assumptions:**
None

**Causes:**
- CMP size reduction (e.g., shearing, cutting, grinding, crushing)
- Improper equipment use
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

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**Preventive Features:**
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**Mitigative Features:**
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- Admin: None

**Credited SSCs and ACs**

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**References:**
- DOE 5506 Detail: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
Hazard Evaluation Table - Event BGTRUCMP-3-003

**Description:**
Vehicle impacts CMP during remediation at ≤ 10 mph resulting in a dispersal of radiological material.

**Locations:**
- CMP Area

**MARS:**
- 200 PEC (1 CMP)

**Release Mechanisms:**
- Impact and spill
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Preventive Features:**
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**Mitigative Features:**
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- Admin: None

**Credited SSCs and ACs**

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**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUCMP-3-004

**Description:**
CMP leaks free liquids during handling or remediation resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Container degradation
- Corrosion
- Leaks/ drips
- Rain water intrusion
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**Unmitigated Frequency:**
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**Preventers**
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**Mitigators**
None

**Notes**
None

**References**
- DOE 5506 Detail: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
Hazard Evaluation Table - Event BGTRUCMP-3-005

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<th>A CMP falls from &gt; 12 feet and breaches resulting in a release of radiological material.</th>
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<td>Improper container placement or handling</td>
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<td>Improper equipment use</td>
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<td>Vehicle accident</td>
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<td>Vehicle/ equipment mechanical failure (e.g., steering, brakes)</td>
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Preventive Features:
Engineered: None
Admin: None

Mitigative Features:
Engineered: None
Admin: None

Credited SSCs and ACs
Preventers: None
Mitigators: None
Notes: None
References: None
DOE 5506 Detail: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e) and High Wind - Retrieval and Excavation (21e)
### Hazard Evaluation Table - Event BGTRUCMP-3-006

**Description:**
CMP falls onto multiple CMPs at > 12 feet resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- TRU waste contained within a corrugated metal pipe (CMP) was processed into a concrete matrix.

**Causes:**
- Container toppled (human or equipment error)
- High wind
- Improper container placement or handling
- Inclement weather
- Mechanical failure
- Operator error
- Securing devices fail
- Seismic event
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

**Consequence / Risk Rank**

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**Preventive Features:**
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- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- High Wind - Retrieval and Excavation (21e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
## Hazard Evaluation Table - Event BGTRUCMP-3-007

**Description:**
Retrieved CMP is degraded resulting in release of radiological contamination.

**Locations:**
- CMP Area

**MARS:**
- Contamination

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Corrosion
- Water intrusion

**Unmitigated System Effects:**
None

**Release Mechanisms:**
- Spill

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

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**Preventive Features:**
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**Mitigative Features:**
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- Admin: None

**Credited SSCs and ACs**

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| Notes:     | None  |
| References:| None  |
| DOE 5506 Detail: | Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e) |
### Hazard Evaluation Table - Event BGTRUCMP-3-008

| Description: | Pressurized gas disperses uncontained waste during CMP remediation activity resulting in the release of radiological material. |
| Locations: | CMP Area | MARs: Contamination |
| Release Mechanisms: | Loss of Confinement |
| Assumptions: | None |
| Causes: | Equipment malfunction, Improper maintenance, Improperly maintained equipment, Maintenance activities, Operator error |
| Unmitigated System Effects: | None |
| Methods of Detection: | Observation |
| Unmitigated Frequency: | A |
| Mitigated Frequency: | A |

#### Consequence / Risk Rank

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#### Credited SSCs and ACs

| Preventers | None |
| Mitigators | None |
| Notes: | None |
| References: | None |
| DOE 5506 Detail: | Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e) |
### Hazard Evaluation Table - Event BGTRUCMP-3-009

**Description:**
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts a CMP resulting in a release of radiological material.

**Locations:**
- CMP Area

**MARs:**
- 200 PEC (1 CMP)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Gas cylinder mishandling
- Improper storage of gas cylinder
- Inadequate gas cylinder restraint
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** U

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered None
- Admin None

**Mitigative Features:**
- Engineered None
- Admin None

**Credited SSCs and ACs**

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| Notes:     |         |           |                    |

| References: |         |           |                    |

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<tr>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
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<tr>
<td>Collapse of Stacked Containers - Retrieval and Excavation (11e)</td>
<td></td>
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<tr>
<td>Description:</td>
<td>Handling equipment used (e.g., gantry crane, manlift, scaffolding) over a CMP during remediation fails and results in a release of radiological material.</td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td><strong>Locations:</strong></td>
<td></td>
</tr>
<tr>
<td>● CMP Area</td>
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<tr>
<td><strong>Release Mechanisms:</strong></td>
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<tr>
<td>● Impact and spill</td>
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<td><strong>Assumptions:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Causes:</strong></td>
<td></td>
</tr>
<tr>
<td>● Crane drops load (container, canister, load)</td>
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<tr>
<td>● Equipment capacity exceeded</td>
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</tr>
<tr>
<td>● Equipment malfunction</td>
<td></td>
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<tr>
<td>● Improper container placement or handling</td>
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<tr>
<td>● Improper equipment use</td>
<td></td>
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<tr>
<td>● Improperly maintained equipment</td>
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<tr>
<td>● Operator error</td>
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<td><strong>Unmitigated System Effects:</strong></td>
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<td>References:</td>
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<td>DOE 5506 Detail:</td>
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</table>
## Hazard Evaluation Table - Event BGTRUCMP-3-011

**Description:**
Mobile crane (manlift, boomed vehicle) falls onto CMPs in the pit causes container breach resulting in a release of radiological material.

**Locations:**
- CMP Area

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Crane drops load (container, canister, load)
- Crane topples
- High wind
- Improper equipment use
- Inclement weather
- Mechanical failure
- Operator error
- Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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<tr>
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<tr>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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<tr>
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<td>High Wind - Retrieval and Excavation (21e)</td>
<td>Seismic Event (Impact Only) - Retrieval and Excavation (24e)</td>
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<tr>
<td>Description:</td>
<td>Remediation ventilation system fails resulting in a release of radiological contamination.</td>
<td></td>
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<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------</td>
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</tbody>
</table>
| Locations:      | ● CMP Area  
|                 | MARs:  
|                 | ● Contamination  
| Release Mechanisms: | ● Loss of Confinement  
| Assumptions:    | None  
| Causes:         | ● Equipment malfunction  
|                 | ● Improper equipment use  
|                 | ● Improperly maintained equipment  
|                 | ● Loss of normal power  
|                 | ● Operator error  
|                 | ● Plugged HEPA filter  
| Unmitigated System Effects: | None  
| Methods of Detection: | ● Observation  
| Unmitigated Frequency: | A  
| Mitigated Frequency: | A  

### Consequence / Risk Rank

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</table>

### Preventive Features:
- Engineered: None  
- Admin: None  

### Mitigative Features:
- Engineered: None  
- Admin: None  

### Credited SSCs and ACs

| Preventers | None  
| Mitigators | None  
| Notes:     | None  
| References: | None  
| DOE 5506 Detail: | ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
## Hazard Evaluation Table - Event BGTRUCMP-3-013

### Description:
CMP is dropped onto multiple TRU waste containers from > 12 feet resulting in a release of radiological material.

### Locations:
- Along the designated route to or from a CMP Area

### MARS:
- 200 PEC (1 CMP)
- 877 PEC (Statistical 48 (all) containers, moderate impact release)

### Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Container toppled (human or equipment error)
- High wind
- Improper container placement or handling
- Inclement weather
- Mechanical failure
- Operator error
- Securing devices fail
- Seismic event
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: U
Mitigated Frequency: EU

### Consequence / Risk Rank

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<td>M II M III</td>
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</tbody>
</table>

### Preventive Features:
- **Engineered:** None
- **Admin:** (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
  - (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:
- **Engineered:** (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- **Admin:** (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
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<td>Safety Function:</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
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<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spiller supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as</td>
<td></td>
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</tbody>
</table>
packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

| Notes: | ● Because there are no TRU Waste Storage Areas adjacent to or in between the areas where the CMPs are retrieved and where the CMPs are stored, the unmitigated frequency of this event is unlikely.  
● The listed controls are necessary to prevent or mitigate the consequences of a release from the other (non-CMP) TRU waste containers. If CMPs were the only waste containers involved, the accident consequences would be sufficiently low that no TSR controls would be required. |
| References: | None |
| DOE 5506 Detail: | ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)  
● High Wind - Retrieval and Excavation (21e)  
● Seismic Event (Impact Only) - Retrieval and Excavation (24e) |
### Hazard Evaluation Table - Event BGTRUCMP-4-001

**Description:**
Personnel exposure to CMPs results in a direct radiation exposure.

**Locations:**
- CMP Area

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Container misloaded or overbatched
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Operator error
- Unknown container contents

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radon instrumentation

**Consequence / Risk Rank**

<table>
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<tr>
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<th>Phy</th>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

- Preventers: None
- Mitigators: None
- Notes: None
- References: None
- DOE 5506 Detail: Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
### Hazard Evaluation Table - Event BGTRUCMP-4-002

**Description:**
Radiological material collected on HEPA filtration leads to direct radiation exposure.

**Locations:**
- CMP Area

**MARS:**
None

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Improper equipment use
- Incorrect filter
- Operator error
- Plugged HEPA filter

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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| Notes:      | | | |
| References: | | | |

**References:**
- DOE 5506 Detail: Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
### Hazard Evaluation Table - Event BGTRUCMP-5-001

**Description:**
CMPs with fissile material and introduced moderator are placed in a close array resulting in a criticality.

**Locations:**
- CMP Area
- MARs: Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Flooding
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:**
BEU

**Mitigated Frequency:**
BEU

#### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

#### Credited SSCs and ACs

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<tr>
<td>Mitigators</td>
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**Notes:**
- The physical process required for this event to occur is not physically plausible. The physical process would require an extraction of > 1 kg Pu from the CMP cemented matrix, suspension of the Pu in the water stream, transference of the entire quantity of Pu by water, filtration of impurities, and concentration of sufficient Pu in an unfavorable configuration (> 30 g/ liter). Therefore, this event is considered not physically plausible.

**References:**
- None
- DOE 5506
- Criticality Events - Retrieval and Excavation (14e)

---

**Detail:**
- CHA Report
  - TA-54, Area G
  - Los Alamos National Laboratory
  - Basis for Interim Operation Rev. 3.0
  - November 2014
  - Chapter 3: Hazard and Accident Analysis
    - Appendix 3H
  - Page 328 of 648
  - 3H-371

# Hazard Evaluation Table - Event BGTRUCMP-6-001

**Description:** Aircraft impacts TRU waste followed by pool fire.

**Locations:**
- CMP Area

**MARS:** 11,000 PEC (158 CMPs)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- High energy impact
- Impact and spill

**Assumptions:** None

**Causes:** Aircraft crash

**Unmitigated System Effects:** None

**Methods of Detection:** Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

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<td>C</td>
<td>NR</td>
<td>NA</td>
<td>NR</td>
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<tr>
<td>W</td>
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**Consequence / Risk Rank**

**Preventive Features:** Engineered None

**Admin** None

**Mitigative Features:** Engineered None

**Admin** None

**Credited SSCs and ACs**

<table>
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<tr>
<th>Class</th>
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**DOE 5506 Detail:** Aircraft Impact with Fire - Retrieval and Excavation (15e)
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**Consequence / Risk Rank**

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**Preventive Features:**

- **Engineered:** None
- **Admin:** None

**Mitigative Features:**

- **Engineered:** None
- **Admin:** None

**Credited SSCs and ACs**

<table>
<thead>
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**Notes:** None

**References:** None

**DOE 5506 Detail:** Lightning - Retrieval and Excavation (20e)
### Hazard Evaluation Table - Event BGTRUCSK-1-003

**Description:**
A fire occurs in proximity to retrieved TRU waste containers with the heat of the fire affecting the waste containers resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Ignition source
- Lightning
- Seismic event

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
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</thead>
<tbody>
<tr>
<td>Receptor</td>
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</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>W</td>
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**Engineered Preventive Features:**
None

**Mitigative Features:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Doublepack TRU Waste Drums with MAR &gt; 200 PE-Ci</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
</tr>
<tr>
<td>Activities</td>
<td>Safety Function: Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
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<tr>
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<td></td>
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</tr>
<tr>
<td>PSAC</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Safety Function: Reduce radiological consequences by limiting MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiological Inventory Management - Defined Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Notes:     | ● MAR limit is credited at 1 full bin consequence reduction from H to M  
● Once containers are retrieved from the cask, containers are moved into a defined process area for further remediation (e.g., overpacking).  
● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| References:| None                                                                                                                              |
| Detail:    | ● Small Fire - Retrieval and Excavation (2e)  
● Lightning - Retrieval and Excavation (20e)  
● Seismic Event with Fire - Retrieval and Excavation (25e)  |
### Hazard Evaluation Table - Event BGTRUCSK-1-004

**Description:**
A fire occurs in proximity to a retrieved unvented TRU waste container with the heat of the fire affecting the TRU waste container resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Lightning
- Operator error
- Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>IV</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>IV</td>
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<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
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</table>

<table>
<thead>
<tr>
<th>Preventive Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineered None</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)</td>
</tr>
<tr>
<td>(SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)</td>
</tr>
<tr>
<td>(SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)</td>
</tr>
<tr>
<td>(SMP) Maintenance Program - Vehicles/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
</tr>
<tr>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigative Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineered</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
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<tbody>
<tr>
<td>(PSAC) Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)</td>
</tr>
<tr>
<td>(PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
</tr>
<tr>
<td>(PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker)</td>
</tr>
<tr>
<td>(SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</td>
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</table>

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
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<tr>
<td></td>
<td>SMP Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
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<tr>
<td></td>
<td>SMP Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>SMP Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P,</td>
</tr>
<tr>
<td>Safety Function</td>
<td>PSAC Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>-----------------</td>
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<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
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<tr>
<td>Safety Function</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td></td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
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</tr>
<tr>
<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
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<td>Rad: W;</td>
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<tr>
<td>Safety Function</td>
<td>Reduces radiological consequences due to exposure</td>
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Notes:
- Deleted

References:
- None

DOE 5506
- Small Fire - Retrieval and Excavation (2e)
- Lightning - Retrieval and Excavation (20e)
- Seismic Event with Fire - Retrieval and Excavation (25e)
**Hazard Evaluation Table - Event BGTRUCSK-1-005**

**Description:**
A small fire within a retrieved TRU waste container propagates to involve additional retrieved TRU waste containers resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Small fire event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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<td>M</td>
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**Preventive Features:**

- **Engineered None**

- **Admin**
  - (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
  - (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

**Mitigative Features:**

- **Engineered**
  - (SS) (IC) Waste Packaging Control (Waste is packaged)
    - (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
    - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
    - (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

**Credited SSCs and ACs**

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<tr>
<td></td>
<td></td>
<td>Waste Packing Control (IC)</td>
<td>Waste is packaged</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
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<td></td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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<tr>
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<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
</tr>
<tr>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
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<td></td>
<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
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<tr>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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**Notes:**
- MAR limit is credited at 1 full bin consequence reduction from H to M

**References:**
None

**DOE 5506 Detail:**
- Large Fire - Retrieval and Excavation (4e)
- Lightning - Retrieval and Excavation (20e)
- Seismic Event with Fire - Retrieval and Excavation (25e)
### Hazard Evaluation Table - Event BGTRUCSK-1-006

**Description:**
Combustible/flammable liquid (e.g., gasoline, diesel fuel, transient combustible liquids) adjacent to or within retrieved TRU waste is ignited resulting in a pool fire with a release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Lightning
- Operator error
- Seismic event
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

#### Consequence / Risk Rank

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<tr>
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<tbody>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
<th>(PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)</td>
</tr>
<tr>
<td></td>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
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<table>
<thead>
<tr>
<th>Mitigative Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered: (SS) (IC) Waste Packaging Control (Waste is packaged)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
<th>(PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(PSAC) Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)</td>
</tr>
<tr>
<td></td>
<td>(PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
</tr>
<tr>
<td></td>
<td>(PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)</td>
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</tbody>
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#### Credited SSCs and ACs

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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trenches a-D Retrieval Activities</td>
<td>Safety Function: Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
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<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
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</tr>
<tr>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
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</tr>
<tr>
<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td></td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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</tbody>
</table>

Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- MAR limit is credited at 1 full bin consequence reduction from H to M
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506
Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)
- Lightning - Retrieval and Excavation (20e)
- Seismic Event with Fire - Retrieval and Excavation (25e)
Hazard Evaluation Table - Event BGTRUCSK-1-007

Description:
Equipment fire (e.g., forklift, man-lift, etc.) ignites in the vicinity of retrieved TRU waste resulting in a release of radiological material.

Locations:
- Trenches A-D

MARS:
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

Release Mechanisms:
- Exposure Fire

Assumptions:
None

Causes:
- Equipment malfunction
- Ignition source
- Lightning
- Mechanical failure
- Operator error
- Seismic event

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: EU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered: None

Admin
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

Mitigative Features:
Engineered: None

Admin
- (SS) Waste Packaging Control (Waste is packaged)
- (SS) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches A-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. TRU Storage Areas not collocated with SSSR Areas)
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

Credited SSCs and ACs

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<tr>
<th>Class Control</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
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<td>Safety Function:</td>
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<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
</tr>
<tr>
<td></td>
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<td>Safety Function:</td>
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<tr>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional</td>
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<tr>
<td><strong>During Trenches a-D Retrieval Activities</strong></td>
<td><strong>TRU waste drum in the defined area.</strong></td>
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<td>------------------------------------------</td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
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<tr>
<td><strong>PSAC Radiological Inventory Management - Defined Area MAR Control</strong></td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td><strong>Safety Function:</strong></td>
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<td><strong>PSAC Radiological Inventory Management - Retrieval Area MAR Limit</strong></td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
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</tbody>
</table>

**Notes:**
- MAR limit is credited at 1 full bin consequence reduction from H to M
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
- Lightning - Retrieval and Excavation (20e)
- Seismic Event with Fire - Retrieval and Excavation (25e)
### Hazard Evaluation Table - Event BGTRUCSK-1-008

**Description:**
Large refueling vehicle accident results in fuel spill with subsequent pool fire adjacent to but not engulfing retrieved TRU waste resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Locations:**
- Trenches A-D

**MARs:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Methods of Detection:**
- Observation

**Unmitigated System Effects: None**

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<th>Chm</th>
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<tr>
<td>W</td>
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<td>M</td>
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</tbody>
</table>

#### Preventive Features:

**Engineered:** None

**Admin:**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

#### Mitigative Features:

**Engineered:** None

**Admin:**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

### Credited SSCs and ACs

**Preventers**
- PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G
- Safety Function: Reduces likelihood of fuel interaction with MAR

**Mitigators**
- PSAC Fire Protection - Thermal Separation Distance - Defined Area
- Safety Function: Reduce radiological consequences by limiting the amount of MAR involved

**Notes:**
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506**
- Fuel Pool Fire - Retrieval and Excavation (1e)

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12/17/2013
Hazard Evaluation Table - Event BGTRUCSK-1-009

Description:
Large refueling vehicle spills fuel during refueling operation with subsequent pool fire adjacent to but not engulfing staged TRU waste results in a release of radiological material.

Locations:
- Trenches A-D

Release Mechanisms:
- Exposure Fire
- Fuel pool fire release

Assumptions:
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

Causes:
- Equipment malfunction
- Ignition source
- Leaks/ drips
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

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<td>W</td>
<td>H</td>
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</tbody>
</table>

Preventive Features:

Engineered None
Admin
- (PSAC) Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

Mitigative Features:

Engineered None
Admin
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

Credited SSCs and ACs

Preventers

PSAC
- Vehicle/ Equipment Safety Control – Refueling Location
  - Safety Function: Refueling location will be separated from MAR in defined areas by the thermal separation distance.
  - Affected Receptors: All

Mitigators

PSAC
- Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities
  - Safety Function: TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.
- Radiological Inventory Management - Retrieval Area MAR Limit
  - Safety Function: The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.
  - Affected Receptors: Rad: P, C, W;

Notes:
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUCSK-1-010

**Description:**
A large refueling vehicle impacts a vehicle transporting multiple retrieved TRU waste containers at ≥ 10 mph and < 35 mph. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste resulting in a release of radiological material.

**Locations:**
- Trenches A-D
- MARs:
  - 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Fuel pool fire release
- Moderate energy impact

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Unmitigated Frequency:**
- EU

**Methods of Detection:**
- Observation

**Mitigated Frequency:**
- BEU

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<tr>
<td>Admin</td>
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<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/equipment with greater than the total of 100 gallon of flammable/combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)</td>
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<tr>
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<td>(SMP)</td>
<td>Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment forklift, manlift))</td>
</tr>
<tr>
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<td>(DID)</td>
<td>Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
</tr>
<tr>
<td></td>
<td>(DID)</td>
<td>Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits &lt; 15 mph)</td>
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<td>(SS) (IC)</td>
<td>Waste Packaging Control (Waste is packaged)</td>
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<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area,)</td>
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<tr>
<td></td>
<td>(PSAC)</td>
<td>Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
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<tr>
<td></td>
<td>(DID)</td>
<td>Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)</td>
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</table>

**Consequence / Risk Rank**

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**Credit SSCs and ACs**

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<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td></td>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults</td>
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| Notes:          | ● The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.  
                  | ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction  
                  | may be given based on the robustness of the programs and the individual elements |
| References:     | None                                                          |
| DOE 5506        | Fuel Pool Fire - Retrieval and Excavation (1e)               |

Notes:  The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth. When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.
Hazard Evaluation Table - Event BGTRUCSK-1-010a

Description:
A vehicle transporting multiple TRU waste containers crashes into a Retrieval Area trench at > 10 mph and < 35 mph. Fuel is leaked into the trench and ignited, causing a fuel pool fire that encircles the cask and resulting in a release of radiological material.

Locations:
- Trenches A-D

MARS:
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
- Fuel spilled near storage casks will not flow into the cask

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Consequence / Risk Rank

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</table>

Preventive Features:

Engineered
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.))
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
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<tr>
<td><strong>Mitigators</strong></td>
<td><strong>SS</strong> Hazardous Material and Waste Management - TRU Waste Container (IC) Metal TRU waste container are of sound integrity Rad: P, C, W;</td>
<td></td>
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</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SS</strong> Waste Packaging Control (IC) Waste is packaged Rad: P, C, W;</td>
<td><strong>Safety Function:</strong> Reduces the radiological consequences as waste is agglomerated and burns as packaged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC</strong> Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area. Rad: P, C, W;</td>
<td><strong>Safety Function:</strong> Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC</strong> Fire Protection - Thermal Separation Distance - Defined Area Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. Rad: P, C, W;</td>
<td><strong>Safety Function:</strong> Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC</strong> Radiological Inventory Management - Defined Area MAR Control Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) Rad: P, C, W;</td>
<td><strong>Safety Function:</strong> Reduces the radiological consequences by limiting the MAR involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSAC</strong> Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci. Rad: P, C, W;</td>
<td><strong>Safety Function:</strong> Reduce radiological consequences by limiting the MAR involved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Notes:</strong></td>
<td>● The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth. ● This event bounds an accident involving vehicles/ equipment transporting a single waste container at low or moderate impact energy. This event also bounds an accident involving vehicles/ equipment not transporting waste at low or moderate impact energy. ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>References:</strong></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DOE 5506 Detail:</strong></td>
<td>● Fuel Pool Fire - Retrieval and Excavation (1e)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUCSK-1-011

**Description:**
Stationary vehicle adjacent to retrieved TRU waste spills/leaks fuel in coincidence with ignition source resulting in pool fire releasing radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Ignition source
- Leaks/drips

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
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<tr>
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<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
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<tr>
<td>C</td>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

#### Preventive Features:

**Engineered**
None

**Admin**
- (PSAC) Vehicle/Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

#### Mitigative Features:

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

#### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Vehicle/ Equipment Safety Control – Refueling Location</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
<td>PSAC</td>
<td>Combustible/Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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</tr>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Notes:           | • The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
|                  | • The term "spill" is associated with refueling. |
| References:      | None |
| DOE 5506 Detail: | Fuel Pool Fire - Retrieval and Excavation (1e) |
Hazard Evaluation Table - Event BGTRUCSK-1-012

Description:
A vehicle/equipment fuel tank spills, leaks, or ruptures adjacent to retrieved TRU waste with a subsequent pool fire resulting in a release of radiological material. The pool is adjacent to, but does not engulf the adjacent waste.

Locations:
- Trenches A-D

MARS:
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

Release Mechanisms:
- Exposure Fire
- Fuel pool fire release

Assumptions:
None

Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Inclement weather
- Leaks/drips
- Operator error
- Vehicle accident

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>DSA Mit.</td>
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<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered: None

Admin:
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)

Mitigative Features:

Engineered: None

Admin:
- (PSAC) Combustible/Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)

Credited SSCs and ACs

Preventers

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
</tbody>
</table>

Safety Function:
Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

Mitigators

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

Safety Function:
Reduce radiological consequences by limiting amount of MAR involved

PSAC

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<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

Safety Function:
Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.

Notes:
- Deleted

References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)

| Fuel Pool Fire - Staging and Storage (1d) |
| Fuel Pool Fire - Retrieval and Excavation (1e) |
# Hazard Evaluation Table - Event BGTRUCSK-1-013

**Description:**
During remediation activities, the use of power tools (e.g., nibbler, chop saw, grinder) introduce an ignition source causing retrieved TRU waste to ignite with subsequent fire resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

**Release Mechanisms:**
- **Fire**

**Assumptions:**
- None

**Causes:**
- Equipment failure
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- U

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>Phy</th>
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<td>DSA Mit.</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>NA</td>
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<tr>
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<td>M</td>
<td>II</td>
<td>NR</td>
<td>NA</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
<td>III</td>
</tr>
</tbody>
</table>

## Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

## Mitigative Features:

**Engineered**
- (SS) IC Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

## Credited SSCs and ACs

### Preventers

**PSAC**
- Non-Sparking Equipment/Process During Venting
  - Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking
  - **Safety Function:** Reduce likelihood for ignition of flammables/ combustibles or deflagration

**SMP**
- Maintenance Program - Vehicle/ Equipment
  - Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)
  - **Safety Function:** Reduce likelihood of equipment malfunction

### Mitigators

**SS**
- Waste Packaging Control (IC)
  - Waste is packaged
  - **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged

**PSAC**
- Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities
  - TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.
  - **Safety Function:** Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.

**PSAC**
- Radiological Inventory Management - Defined Area MAR Control
  - Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)
  - **Safety Function:** Reduces the radiological consequences by limiting the MAR

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Chapter 3: Hazard and Accident Analysis

Appendix 3H

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12/17/2013
| SMP | Emergency Preparedness Program | The program relies on adverse conditions being recognized by workers and reported | Rad: P, C, W; |
| SMP | Safety Function: | Reduce the consequences of an accident for the worker and collocated worker. |
| SMP | Radiation Protection Program | Evaluates radiological conditions and processes for all receptors | Rad: P, C, W; |
| SMP | Safety Function: | Reduce radiological consequences by limiting MAR released to all receptors |
| SMP | Training and Qualification Program - Hazards Recognition | Personnel trained to recognize specific job hazards and associated controls | Rad: P, C, W; |
| SMP | Safety Function: | Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles |

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**Detail:**
- Small Fire - Waste Repackaging (2f)
### Hazard Evaluation Table - Event BGTRUCSK-1-014

#### Description:
Degraded container is discovered in cask requiring in-situ repackaging. Material in the TRU waste container self-ignites and burns resulting in a release of radiological material.

#### Locations:
- Trenches A-D

#### MARs:
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

#### Release Mechanisms:
- Fire

#### Assumptions:
None

#### Causes:
- Chemical incompatibility w/ absorption material
- Chemical reaction
- Operator error
- Pyrophorics

#### Unmitigated System Effects:
None

#### Methods of Detection:
- Observation

#### Unmitigated Frequency: BEU

#### Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<td>M</td>
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<tr>
<td>W</td>
<td>H</td>
<td>III</td>
<td>H</td>
</tr>
</tbody>
</table>

#### Preventive Features:
- Engineered: None
- Admin: None

#### Mitigative Features:
- Engineered: None
- Admin: None

#### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Mitigators | None |

#### Notes:
- A container in a storage cask in Trenches A - D requiring in-situ remediation would require review and planned process to accomplish remediation. This would require development of a plan which would require DOE approval to implement. The cask would be placed in a safe configuration (e.g., place cask lid or other means to secure cask) while restoration plan was developed and approved.

#### References:
- DOE 5506
- Small Fire - Retrieval and Excavation (2e)
- Enclosure Fire - Retrieval and Excavation (3e)
# Hazard Evaluation Table - Event BGTRUCSK-1-015

**Description:**
Transient combustibles ignite and burn a retrieved TRU waste container during remediation activities resulting in a release of radiological material.

**Locations:**
- Trenches A-D
- MARs: 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Motivation:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
U

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
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<td>M</td>
<td>I</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Mitigative Features:**
- Engineered
- (SS) Waste Packaging Control (Waste is packaged)

## Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W</td>
</tr>
<tr>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Doublepacking TRU Waste</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A</td>
<td>Rad: P, C, W</td>
</tr>
</tbody>
</table>

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CHA Report

TA-54, Area G
Los Alamos National Laboratory

Basis for Interim Operation Rev. 3.0
November 2014

Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>Through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>C, W;</td>
</tr>
<tr>
<td>SMP Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td>Rad: W;</td>
</tr>
<tr>
<td>SMP Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Notes:**
- combustible / flammable materials external to container
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

**References:**
- None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
Hazard Evaluation Table - Event BGTRUCSK-1-016

**Description:**
During drum removal activities a TRU waste container bottom fails causing the contents to spill near another stored waste container. A flammable atmosphere with a coincidental ignition source ignite the spilled waste causing a subsequent fire resulting in a release of radiological material. The fire affects both the uncontained and contained waste with the contained waste being subject to heating.

**Locations:**
- Trenches A-D
- MARS: 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

**Release Mechanisms:**
- Exposure Fire
- Fire
- Spill

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</tbody>
</table>

**Preventive Features:**
None

**Mitigative Features:**

**Engineered**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Stationary Fire Watch During Hot Work (Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

**Preventers**

**PSAC**
- Fire Protection - Control of Transient Combustibles
  - **Safety Function:** Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.
  - **Attribute:** Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.
  - **Affected Receptors:** All

**PSAC**
- Stationary Fire Watch During Hot Work
  - **Safety Function:** Reduce the likelihood of a fire event.
  - **Attribute:** Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.
  - **Affected Receptors:** All

**Mitigators**

**SS**
- Waste Packaging Control (IC)
  - **Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged.
  - **Attribute:** Waste is packaged

**PSAC**
- Doublepackaging TRU Waste Drums with MAR > 200 PE-Ci
  - TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepackaged prior to retrieval of an additional
  - **Safety Function:** Reduce the likelihood of a fire event.
  - **Attribute:** TRU waste drums ≥ 200 PE-Ci
  - **Affected Receptors:** Rad: P, C, W;
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Trenches a-D Retrieval Activities</td>
<td>TRU waste drum in the defined area.</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control (IC)</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit (IC)</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
</tr>
</tbody>
</table>

Notes: It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

References: None

DOE 5506

Detail: Small Fire - Retrieval and Excavation (2e)
## Hazard Evaluation Table - Event BGTRUCSK-1-017

### Description:
During remediation activities, support equipment (e.g. overhead hoist) fails or overheats causing waste in a retrieved TRU waste container to ignite with subsequent fire resulting in a release of radiological material.

### Locations:
- Trenches A-D

### MARs:
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

### Release Mechanisms:
- Exposure Fire
- Fire

### Assumptions:
None

### Causes:
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Release Mechanisms:
- Exposure Fire
- Fire

### Assumptions:
None

### Causes:
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Preventive Features:

#### Admin
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

#### Admin
- (SS) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
<td></td>
<td>Unmit. DSA Mit.</td>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventers

#### SMP
- Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)

**Safety Function:**
Reduces the likelihood of fire progression

#### SMP
- Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)

**Safety Function:**
Reduce likelihood for ignition of flammables/combustibles

#### SMP
- Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))

**Safety Function:**
Reduce likelihood of equipment malfunction

### Mitigators

#### SS
- Waste Packaging Control (IC) (Waste is packaged)

**Safety Function:**
Reduces likelihood for vehicle and equipment accidents

#### PSAC
- Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged

---


12/17/2013
<table>
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<tr>
<th>Safety Function:</th>
<th>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</th>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
</tr>
<tr>
<td>Safety Function:</td>
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</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Evaluates radiological conditions and processes for all receptors</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
</tr>
</tbody>
</table>

Notes:  
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506

Detail:  
- Small Fire - Retrieval and Excavation (2e)
**Hazard Evaluation Table - Event BGTRUCSK-1-018**

**Description:**
Flammable/combustible material during remediation of a retrieved TRU waste container ignite and cause a fire resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
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<tr>
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<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered:** None

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
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<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce the likelihood of fire progression</td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
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<td>Reduce likelihood for ignition of flammables/combustibles</td>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<td>Safety Function:</td>
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<td>Reduce likelihood of equipment malfunction</td>
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<td>Waste is packaged</td>
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<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns</td>
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<td>------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td></td>
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<tr>
<td></td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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<td>Safety Function:</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
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</table>

Notes: It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.

References: None

DOE 5506 Detail: Small Fire - Retrieval and Excavation (2e)
**Hazard Evaluation Table - Event BGTRUCSK-2-001**

**Description:**
Flammable gas accumulates near TRU waste with coincidental ignition source leads to a deflagration affecting TRU waste resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tbody>
<tr>
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<tr>
<td>W</td>
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<td>III</td>
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</tr>
</tbody>
</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

**Preventers**
- Class: None
- Control: None
- Attribute: None
- Affected Receptors: None

**Mitigators**
- Notes: The initial deflagration external to the containers only causes the containers to shake or be toppled causing loss of confinement. Internal container deflagration does not occur.
- References: None
- DOE 5506
- Detail: Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
Hazard Evaluation Table - Event BGTRUCSK-2-001a

Description:
Flammable gas accumulates near TRU waste with coincidental ignition source leads to a deflagration affecting TRU waste resulting in a release of radiological material.

Locations:
- Trenches A-D

MARS:
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Loss of Confinement
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity
- Vehicle accident

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: EU

Consequence / Risk Rank

<table>
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<tr>
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</tr>
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<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered None

Admin
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)

Mitigative Features:

Engineered None

Admin
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

Preventers
- PSAC Acetylene Cylinders Control
  - The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.
  - Safety Function: Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste

Mitigators
- SMP Radiation Protection Program
  - Evaluates radiological conditions and processes for worker protection
  - Safety Function: Reduces radiological consequences due to exposure

Notes:
- The initial deflagration external to the container(s) causes the containers to violently shake or be toppled resulting in secondary internal container deflagrations.
- The physical process required for this event to occur is not physically plausible. Storage and staging of TRU waste containers for all Area G operations will be conducted in areas where flammable gasses can not accumulate causing a deflagration external to the drum. Flammable gas concentrations required for a deflagration would not be sufficient to produce a flammable atmosphere. Therefore this event is considered not physically plausible.

References:
None

DOE 5506

Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
### Hazard Evaluation Table - Event BGTRUCSK-2-001prev e-1

**Description:**
Reactive or incompatible materials in an unvented TRU waste container are violently shaken during handling causing a fire within the container resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Fire

**Assumptions:**
- None

**Causes:**
- Chemical reaction
- Operator error
- Shock sensitive material
- Violent shaking

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

### Consequence / Risk Rank

<table>
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<tr>
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<tr>
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<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (PSAC) TRU Waste Container Management - Unvented Containers are not Stacked (Unvented TRU waste containers are not stacked)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

<table>
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<tr>
<td>Preventers</td>
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<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood for deflagration</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>PSAC</td>
<td>TRU Waste Container</td>
<td>Unvented TRU waste containers are handled and/ or</td>
<td>Rad: P,</td>
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<tr>
<td>Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>C, W; Phy: W;</td>
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<tr>
<td>---</td>
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<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
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</tr>
<tr>
<td><strong>Notes:</strong></td>
<td>● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating. ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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<td><strong>References:</strong></td>
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<td><strong>DOE 5506 Detail:</strong></td>
<td>● Small Fire - Retrieval and Excavation (2e) ● High Wind - Retrieval and Excavation (21e) ● Seismic Event with Fire - Retrieval and Excavation (25e)</td>
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</table>
### Hazard Evaluation Table - Event BGTRUCSK-2-002

**Description:**
An unvented TRU waste container is violently shaken causing a deflagration resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Crane toppled
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
<td></td>
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</tbody>
</table>

### Preventive Features:
**Engineered**
None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

### Mitigative Features:
**Engineered**
None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

<table>
<thead>
<tr>
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<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
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<td>Safety Function:</td>
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<td>Safety Function:</td>
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<td>PSAC</td>
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<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or</td>
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</tr>
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</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-408


12/17/2013
<table>
<thead>
<tr>
<th>Containers</th>
<th>Safety Function</th>
<th>Mitigators</th>
<th>Safety Function</th>
<th>Notes:</th>
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</thead>
<tbody>
<tr>
<td>Containers performing activities in the vicinity of the unvented container</td>
<td>Reduces likelihood for deflagration</td>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Exclude FRPs, other wooden boxes, and large metal containers (e.g., SWB, Sealand, Transportainer)</td>
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<tr>
<td>SMP Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
<td>All</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
</tr>
<tr>
<td>SMP Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
<td>Reduce likelihood for vehicle and equipment accidents</td>
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<tr>
<td>PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>All</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
</tr>
</tbody>
</table>

References: None

DOE 5506

Detail: Waste Container Deflagration - Container Handling (6b) Waste Container Deflagration - Retrieval and Excavation (6e)
## Hazard Evaluation Table - Event BGTRUCSK-2-002prev e-1

**Description:**
During miscellaneous vent and purge activities (e.g., filter or filter blank replacement, lid replacement, lid restraint installation) a TRU waste container vent gas is ignited, resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Flammable headspace
- Hot Work
- Ignition source
- Operator error

**Unmitigated System Effects:**
Methods of Detection:
- Observation

**Unmitigated Frequency:** U

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
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</tbody>
</table>

**Preventive Features:**
None

**Mitigative Features:**
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Engineered Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)
- (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

<table>
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<th>DSA Mit.</th>
<th>Chm</th>
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## Credited SSCs and ACs

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<td>Preventers</td>
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<td>All</td>
</tr>
<tr>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
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<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W; Phy: W;</td>
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<tr>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>PSAC Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
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</tr>
<tr>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
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<tr>
<td></td>
<td>PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
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<tr>
<td>Notes:</td>
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<td>References:</td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>● Small Fire - Retrieval and Excavation (2e)</td>
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</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUCSK-2-003

**Description:**
An elevated TRU waste container is violently shaken due to a fall inducing a deflagration which results in a release of radiological material.

**Locations:**
- Trenches A-D

**MARs:**
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Crane drops load (container, canister, load)
- Drop
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Operator error
- Seismic event
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
EU

<table>
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<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Mitigated Frequency</th>
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<td>W</td>
<td>C H I M III</td>
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</table>

**Preventive Features:**
None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste containing (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**
None

**Admin**
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td></td>
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<tr>
<td>Preventers</td>
<td>PSAC Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<td>Preventers</td>
<td>SMP Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<td>Safety Function:</td>
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</table>
## SMP Training and Qualification Program - Qualifications

Personnel maintain applicable LANL qualifications for vehicle and equipment operation

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<thead>
<tr>
<th>Mitigators</th>
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<tr>
<td>Safety Function:</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
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</table>

| Safety Function: | Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion |

Notes: *When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements*

References: None

DOE 5506

Detail:
- Waste Container Deflagration - Container Handling (6b)
- Waste Container Deflagration - Retrieval and Excavation (6e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
## Hazard Evaluation Table - Event BGTRUCSK-2-004

**Description:**
During retrieval of a visually suspect (e.g., significant rust, bulging) TRU waste container from a cask, a deflagration occurs within the cask resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Flammable headspace
- Ignition source
- Metal to metal contact
- Operator error
- Pyrophorics
- Shock sensitive material
- Static electricity

<table>
<thead>
<tr>
<th>Unmitigated System Effects:</th>
<th>Methods of Detection:</th>
</tr>
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<tr>
<td>None</td>
<td>Observation</td>
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### Consequence / Risk Rank

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<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
<td>III</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered None**

- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered None**

- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
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<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>Rad: P, C, W, W,</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
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<tr>
<td>------------------</td>
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<td></td>
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<tr>
<td>SMP</td>
<td>Radiation Protection Program Evaluates radiological conditions and processes for worker protection</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
- A container in a storage cask in Trenches A - D requiring in-situ remediation would require review and planned process to accomplish remediation. This would require development of a plan which would require DOE approval to implement. The cask would be placed in a safe configuration (e.g., place cask lid or other means to secure cask) while restoration plan was developed and approved.  
- Radiation Protection Program is credited for public and worker  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506  
- Waste Container Deflagration - Container Handling (6b)  
- Waste Container Deflagration - Retrieval and Excavation (6e)
Hazard Evaluation Table - Event BGTRUCSK-2-005

**Description:**
Unvented TRU waste container being removed from the cask is violently shaken due to a fall of > 4 feet inducing a deflagration to the lower stored TRU waste container which results in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
- Affects of a sympathetic drum deflagration is vertical.

**Causes:**
- Container mishandling
- Crane drops load (container, canister, load)
- Drop
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Operator error
- Seismic event
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

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<tr>
<td>C</td>
</tr>
<tr>
<td>W</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<td>Preventers</td>
<td>PSAC Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
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<td>Safety Function:</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
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<td>Preventers</td>
<td>PSAC Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Training and Qualification Program - Qualifications</td>
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<td>Safety Function:</td>
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<td>Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<td>SMP</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduces radiological consequences due to exposure</td>
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<tr>
<td>Notes:</td>
<td>• When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
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<td>References:</td>
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<tr>
<td><strong>DOE 5506 Detail:</strong></td>
<td>• Waste Container Deflagration - Retrieval and Excavation (6e)</td>
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<td></td>
<td>• Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
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<td></td>
<td>• Seismic Event (Impact Only) - Retrieval and Excavation (24e)</td>
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</table>


12/17/2013
Hazard Evaluation Table - Event BGTRUCSK-2-006

Description:
Electrical discharge ignites flammable atmosphere in a TRU waste container causing a deflagration resulting in a release of radiological material.

Locations:
- Trenches A-D

MARS:
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

Assumptions:
- A container with an internal flammable atmosphere will not deflagrate without an interaction with an external force (e.g., human or natural activity).

Causes:
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Flammable headspace

Unmitigated System Effects:
- None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

<table>
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<tr>
<th>Receptor</th>
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<th>Phy</th>
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<td>W</td>
<td>H</td>
<td>II</td>
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</tbody>
</table>

Consequence / Risk Rank

Preventive Features:
- Admin
  - (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

Mitigative Features:
- Admin
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

Credited SSCs and ACs

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<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)</td>
<td>All</td>
</tr>
</tbody>
</table>

Safety Function: Reduce likelihood for container puncture, topple, and impacts

| Preventers | SMP      | Maintenance Program - Vehicle/ Equipment | Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift) | All |

Safety Function: Reduce likelihood of equipment malfunction

| Preventers | SMP      | Training and Qualification Program - Qualifications | Personnel maintain applicable LANL qualifications for vehicle and equipment operation | All |

Safety Function: Reduces likelihood for vehicle and equipment accidents

Mitigators
- PSAC
  - Radiological Inventory Management - Defined Area MAR Control
    - Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)
      - Rad: P, C, W;

Safety Function: Reduces the radiological consequences by limiting the MAR involved

Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References:
- None

DOE 5506
- Waste Container Deflagration - Retrieval and Excavation (6e)
- Lightning - Retrieval and Excavation (20e)

Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
## Hazard Evaluation Table - Event BGTRUCSK-2-007

### Description:
A deflagration occurs in flammable (e.g., unvented) TRU waste container that causes additional sympathetic TRU waste container deflagrations resulting in a release of radiological material.

### Locations:
- Trenches A-D

### MARs:
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Chemical reaction
- Drop
- Flammable headspace
- Ignition source
- Inadequate venting
- Incompatible chemicals
- Pyrophorics
- Shock sensitive material
- Static electricity

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
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<td>II</td>
<td>M</td>
<td>IV</td>
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</table>

<table>
<thead>
<tr>
<th>Preventive Features:</th>
<th>Engineered</th>
<th>None</th>
</tr>
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</table>

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:
Engineered | None |

- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

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<th>Attribute</th>
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<td>Safety Function:</td>
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<td>Reduce likelihood for load drops resulting in release of radiological material</td>
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<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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</table>
### Safety Function:

- **PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation**
  - Reduces the radiological consequences by limiting the MAR involved.
  - Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker.
  - **Rad:** C, W;

### Notes:

- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:

- None
- DOE 5506
- **Detail:**
  - Multiple Waste Container Deflagration - Retrieval and Excavation (7e)
  - Seismic Event (Impact Only) - Retrieval and Excavation (24e)
### Hazard Evaluation Table - Event BGTRUCSK-2-008

**Description:**
Flammable gas (VOCs, hydrogen, propane cylinder etc.) accumulate above LFL into the cask leading to a deflagration impacting the TRU waste containers resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARs:**
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment failure
- Flammable gases
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
EU

**Mitigated Frequency:**
EU

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**Consequence / Risk Rank**

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**Mitigative Features:**

| Engineered | None |
| Admin      | None |

#### (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
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<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
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<tr>
<th>Mitigators</th>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
</tr>
</thead>
</table>

Safety Function:
- Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
DOE 5506

**Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
### Hazard Evaluation Table - Event BGTRUCSK-2-009

**Description:**
External heating source causes flammable gas generation within a TRU waste container with a coincidental ignition source results in a deflagration resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Characterization equipment heat sources
- Equipment malfunction
- Flammable headspace
- Inadequate venting
- Increased gas generation due to temperature increase
- Operator error
- Solar heating
- Unvented Lid

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Low energy impact
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Characterization equipment heat sources
- Equipment malfunction
- Flammable headspace
- Inadequate venting
- Increased gas generation due to temperature increase
- Operator error
- Solar heating
- Unvented Lid

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

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<tr>
<th>Receptor</th>
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</table>

**Consequence / Risk Rank**

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

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**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

---

**Mitigative Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

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**Credited SSCs and ACs**

**Preventers**

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<tr>
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<th>Control</th>
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<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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</table>

**Safety Function:**
Reduce radiological consequences by reducing the likelihood of progression of a fire between defined areas.

---

**Mitigators**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion

---

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Waste Container Deflagration - Retrieval and Excavation (6e)
## Hazard Evaluation Table - Event BGTRUCSK-2-010

### Description:
Water accumulation in a TRU waste container causes a chemical reaction producing accumulated flammable gas and with a coincidental ignition source deflagrates resulting in a release of radiological material.

### Locations:
- Trenches A-D

### MARs:
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Condensation from outside storage
- Ignition source
- Improper storage
- Incompatible chemicals
- Radiolytic decomposition or organic decomposition generates flammable gases such as hydrogen, methane, etc.
- Reactive (exothermic or pyrophoric) chemicals

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: EU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:
- Engineered: None
- Admin: None

### Mitigative Features:
- Engineered: None
- Admin: (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>None</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
</tr>
</tbody>
</table>

### Safety Function:
- Rad: P, C, W;

### Notes:
- Discovery of water accumulation in a cask would require an approved action to assess container degradation and water removal. This would require development of a plan which would require DOE approval to implement. The cask would be placed in a safe configuration (e.g., place cask lid or other means to secure cask) while restoration plan was developed and approved.

### References:
- None
- DOE 5506
- Waste Container Deflagration - Retrieval and Excavation (6e)

### Detail:
- Waste Container Deflagration - Retrieval and Excavation (6e)
Hazard Evaluation Table - Event BGTRUCSK-2-011

**Description:**
An unvented TRU waste container is affected by the heat from a fire in proximity to the TRU waste container. The fire causes a deflagration resulting in a release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenches A-D</td>
<td>750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Combustible material
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

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</tr>
<tr>
<td>W</td>
<td>H</td>
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<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))

**Mitigative Features:**

**Engineered**
None

**Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and transported using lid restraints, and blast shields or safe standoff distance of ≥ 30 feet between the unvented TRU waste container and the worker)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
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<td></td>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control (IC)</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Notes:</td>
<td>• When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
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<tr>
<td>DOE 5506</td>
<td>• Small Fire - Retrieval and Excavation (2e)</td>
<td>• Waste Container Deflagration - Retrieval and Excavation (6e)</td>
<td>• Lightning - Retrieval and Excavation (20e)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUCSK-2-012

**Description:**
Vehicle/equipment transporting TRU waste ignites accumulated flammable gas and deflagrates affecting adjacent TRU waste resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Flammable gases
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
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<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- **Engineered** None
- **Admin**
  - (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
  - (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

- **Engineered** None
- **Admin**
  - (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
  - (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
  - (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (IC)</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
<td></td>
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</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**

- DOE 5506 Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
# Hazard Evaluation Table - Event BGTRUCSK-2-013

## Description:
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts unvented TRU waste containers causing a deflagration and resulting in a release of radiological material.

## Locations:
- Trenches A-D

## MARs:
- 1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)

## Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire

## Assumptions:
None

## Causes:
- Flammable atmosphere (volatile organic compounds –VOCs or hydrogen) in a container
- Gas cylinder degradation
- Gas cylinder mishandling
- Improper storage of gas cylinder
- Vehicle accident

## Unmitigated System Effects:
None

## Methods of Detection:
- Observation

## Unmitigated Frequency: U  Mitigated Frequency: EU

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>II</td>
<td>M</td>
<td>III</td>
</tr>
</tbody>
</table>

## Preventive Features:
None

**Admin**
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/or performing activities in the vicinity of the unvented container)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

## Mitigative Features:
None

**Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

## Credited SSCs and ACs

### Preventers
- PSAC TRU Waste Container Management - Isolate Unvented Containers
- **Safety Function:** Reduces likelihood for deflagration

### Mitigators
- PSAC Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities
- **Safety Function:** Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.

### Radiological Inventory Management - Defined Area MAR Control
- **Safety Function:** Reduces the radiological consequences by limiting the MAR involved

### Radiation Protection Program
- **Safety Function:** Reduces radiological consequences due to exposure

## Notes:
None

## References:
None

## DO 5506
- Waste Container Deflagration - Retrieval and Excavation (6e)
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Table: Hazard Evaluation Table - Event BGTRUCSK-2-014

<table>
<thead>
<tr>
<th>Location</th>
<th>MARs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenches A-D</td>
<td>1,500 PEC (Two [2] Trench A-D waste containers with 20% margin)</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Basis for Interim Operation Rev. 3.0**

**Engineered Preventive Features:**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigated Features:**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function</td>
<td>PSAC</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function</td>
<td>PSAC</td>
<td>Reduce likelihood for deflagration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU)</td>
</tr>
<tr>
<td></td>
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<td>Rad: P, C, W;</td>
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**Consequence / Risk Rank**

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<tr>
<td>Control</td>
<td>Storage Areas not collocated with SSSR Areas</td>
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<td>---------</td>
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<td></td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
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**Notes:**
- This event bounds the puncture of a single TRU waste container.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
None

**DOE 5506 Detail:**
- Waste Container Deflagration - Retrieval and Excavation (6e)
Hazard Evaluation Table - Event BGTRUCSK-2-015

Description:
Flammable atmosphere released during a venting activity (single drum) with coincidental ignition source causes a deflagration and affects adjacent TRU waste containers resulting in a release of radiological material.

Locations:
- Trenches A-D

MARS:
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

Assumptions:
None

Causes:
- Equipment malfunction
- Flammable gases
- Ignition source
- Operator error
- Static electricity

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

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</tbody>
</table>

Preventive Features:
- Engineered: None
- Admin:
  - (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)

Mitigative Features:
- Engineered: None
- Admin:
  - (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
  - (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
  - (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce radiological consequences by limiting MAR involved</td>
</tr>
</tbody>
</table>

Notes:
- Residence time of a container during vent and purge is short and there is insufficient flammable gas released during this time to deflagrate.
- The physical process required for this event to occur is not physically plausible. Remote drum venting is conducted in areas where flammable gasses cannot accumulate causing a deflagration external to the drum. Flammable gas concentrations required for a deflagration would not be sufficient to produce a flammable atmosphere. Therefore this...
<table>
<thead>
<tr>
<th>References: None</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE 5506</td>
</tr>
<tr>
<td>Detail: Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)</td>
</tr>
</tbody>
</table>
**Hazard Evaluation Table - Event BGTRUCSK-2-016**

**Description:**
TRU Waste container deflagrates when penetrated by DV or drum dart resulting in the release of radiological material.

**Locations:**
- Trenches A-D
- MARs: 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Metal to metal contact
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>NR</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered:** None

**Admin:**
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered:** None

**Admin:**
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce</td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for all receptors</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Venting and/or Abating/Purging (6c)
- Waste Container Deflagration - Retrieval and Excavation (6e)
<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>DSA Mit.</th>
<th>Phy</th>
<th>DSA Mit.</th>
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<tr>
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<td>III</td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>H</td>
<td>I</td>
<td>M</td>
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<td>H</td>
<td>I</td>
<td>M</td>
<td>II</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**

- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums > 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
</tr>
</tbody>
</table>

**Safety Function:**

Reduce likelihood for load drops resulting in release of radiological material.
<table>
<thead>
<tr>
<th>PSAC</th>
<th>Elevated waste movements and critical lifts – Spotter</th>
<th>Spotter supports forklift/rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/removal (stacking/unstacking, loading/unloading) of TRU waste containers</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/equipment handling and/or performing activities in the vicinity of the unvented container</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for deflagration</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Doublepack TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
</tr>
</tbody>
</table>

Notes: • When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506 • Waste Container Deflagration - Container Handling (6b)
• Waste Container Deflagration - Retrieval and Excavation (6e)
<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A loss of forced inerting purge gas permits flammable gas buildup within a TRU waste container with coincidental ignition source deflagrates resulting in a release of radiological material.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Locations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Trenches A-D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● 750 PEC (One [1] Trench A-D waste container with &gt; 20% margin)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Release Mechanisms:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Internal deflagration, lid and debris ejection, with subsequent fire</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Causes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Equipment failure</td>
</tr>
<tr>
<td>● Flammable headspace</td>
</tr>
<tr>
<td>● Ignition source</td>
</tr>
<tr>
<td>● Incomplete or insufficient purge of container</td>
</tr>
<tr>
<td>● Insufficient inerting flow</td>
</tr>
<tr>
<td>● Loss of inert gas during purge cycle</td>
</tr>
<tr>
<td>● Operator error</td>
</tr>
<tr>
<td>● Static electricity</td>
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<tr>
<th>Unmitigated System Effects:</th>
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<tbody>
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<table>
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<tr>
<th>Methods of Detection:</th>
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<tbody>
<tr>
<td>● Observation</td>
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<tr>
<th>Consequence / Risk Rank</th>
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<td>Receptor</td>
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<tr>
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</tr>
<tr>
<td>P</td>
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<tr>
<td>C</td>
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<tr>
<td>W</td>
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</table>

<table>
<thead>
<tr>
<th>Preventive Features:</th>
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</thead>
<tbody>
<tr>
<td>Engineered</td>
</tr>
<tr>
<td>Admin</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Mitigative Features:</th>
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</thead>
<tbody>
<tr>
<td>Engineered</td>
</tr>
<tr>
<td>Admin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credited SSCs and ACs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
</tr>
<tr>
<td>Mitigators</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Residence time of a container during vent and purge is short and there is insufficient flammable gas released during this time to deflagrate.</td>
</tr>
<tr>
<td>● Vent and purge activities are not conducted on unvented containers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>References:</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>DOE 5506</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Container Deflagration - Retrieval and Excavation (6e)</td>
</tr>
</tbody>
</table>

---

Chapter 3: Hazard and Accident Analysis
Appendix 3H
Hazard Evaluation Table - Event BGTRUCSK-2-019

Description:
A flammable gas accumulates during DV activities. An ignition source is created by the activity causing a deflagration resulting in a release of radiological material.

Locations:
- Trenches A-D

Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

Assumptions:
None

Causes:
- Flammable atmosphere (volatile organic compounds –VOCs or hydrogen) in a container
- Ignition source
- Oxygen is present in container

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptor</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered None

Admin
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)

Mitigative Features:
Engineered None

Admin
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
</tbody>
</table>

| Mitigators | PSAC | Drum Venting of Unvented TRU Waste Drums | The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting. | Rad: P, C, W |

| Safety Function: | Reduce likelihood for ignition of flammables/ combustibles or deflagration |

Notes: None

References: None

DOE 5506

Detail: Enclosure Deflagration - Retrieval and Excavation (8e)
<table>
<thead>
<tr>
<th>Description:</th>
<th>A vehicle/equipment traveling at &lt; 10 mph drive into cask opening impacting a TRU waste container resulting in a release of radiological material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations:</td>
<td>Trenches A-D</td>
</tr>
<tr>
<td>MARs:</td>
<td>750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])</td>
</tr>
<tr>
<td>Release Mechanisms:</td>
<td>Low energy impact</td>
</tr>
<tr>
<td>Assumptions:</td>
<td>None</td>
</tr>
<tr>
<td>Causes:</td>
<td>Degraded/inadequate road condition (e.g., erosion, pot holes)</td>
</tr>
<tr>
<td></td>
<td>Equipment malfunction</td>
</tr>
<tr>
<td></td>
<td>Improper equipment use</td>
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<td>Inclement weather</td>
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<td></td>
<td>Operator error</td>
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<tr>
<td></td>
<td>Vehicle accident</td>
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<td></td>
<td>Vehicle/equipment mechanical failure (e.g., steering, brakes)</td>
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<td>Unmitigated System Effects:</td>
<td>None</td>
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<td>Methods of Detection:</td>
<td>Observation</td>
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### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>L</td>
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### Preventive Features:

- Engineered: None
- Admin: None

### Mitigative Features:

- Engineered: None
- Admin: SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
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### Mitigators

- SMP Radiation Protection Program
- Safety Function: Evaluates radiological conditions and processes for worker protection
- Rad: W:

### Notes:

- None

### References:

- None

### DOE 5506

- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUCSK-3-002

Description:
Worker replacing a TRU waste container object (e.g., lid, lid ring) results in a release of radiological contamination.

Locations:
- Trenches A-D

Release Mechanisms:
- Loss of Confinement

Assumptions:
None

Causes:
- Improper container placement or handling
- Improper maintenance
- Maintenance activities
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Consequence / Risk Rank

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Preventive Features:
Engineered: None
Admin: None

Mitigative Features:
Engineered: None
Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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<td>References:</td>
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References:
DOE 5506

Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
# Hazard Evaluation Table - Event BGTRUCSK-3-003

**Description:**
Free liquids leak during remediation result in a release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Container degradation
- Flooding
- Improper container placement or handling
- Leaks/ drips
- Rain water intrusion
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

## Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

## Credited SSCs and ACs

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<td>Safety Function: Reduces radiological consequences due to exposure</td>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUCSK-3-004

**Description:**
TRU waste handling equipment (e.g., parrot beak, drum grabber) damages container resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Loss of Confinement
- Spill

**Assumptions:**
None

**Causes:**
- Container degradation
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Consequence / Risk Rank**

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- Credited SSCs and ACs

**Preventers:**
- None

**Mitigators:**
- SMP Radiation Protection Program: Evaluates radiological conditions and processes for worker protection
- Safety Function: Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
DOE 5506

**Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUCSK-3-005

**Description:**
TRU waste container falls from > 4 but < 12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Trenches A-D
  - MARs: 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Drop
- Equipment malfunction
- High wind
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- High Wind - Retrieval and Excavation (21e)
# Hazard Evaluation Table - Event BGTRUCSK-3-006

**Description:**
TRU waste container falls > 12 feet to the ground breach resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARs:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container toppled (human or equipment error)
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- High wind
- Improper container placement or handling
- Inclement weather
- Mechanical failure
- Operator error
- Securing devices fail
- Seismic event
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** EU

### Consequence / Risk Rank

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**Preventive Features:**

**Engineered**

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**

- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
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<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
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<tr>
<td></td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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</table>

**Mitigators**

- (SMP) Radiation Protection Evaluates radiological conditions and processes for worker protection
  - Rad: W;

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Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
<table>
<thead>
<tr>
<th>Program protection</th>
<th>Safety Function: Reduces radiological consequences due to exposure</th>
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<tr>
<td>Notes:</td>
<td>- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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<tr>
<td>References:</td>
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<td>DOE 5506</td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
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<td>Detail:</td>
<td>High Wind - Retrieval and Excavation (21e)</td>
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<tr>
<td></td>
<td>Seismic Event (Impact Only) - Retrieval and Excavation (24e)</td>
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</table>
# Hazard Evaluation Table - Event BGTRUCSK-3-007

**Description:**
Forced inert purge gas system causes TRU waste container over pressurization resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Loss of Confinement
- Pressurized venting

**Assumptions:**
- None

**Causes:**
- Buildup of gas/ pressure inside container
- Equipment malfunction
- Improper installation of filter/ vent
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- A

## Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin:
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

## Credited SSCs and ACs

| Preventers | None |
| Mitigators | SMP Radiation Protection Program |
| Notes: | None |
| References: | None |

**DOE 5506 Detail:**
- Waste Container Over-Pressurization - Staging and Storage (12d)
### Hazard Evaluation Table - Event BGTRUCSK-3-008

**Description:**
Forklift punctures two (2) TRU waste containers resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Forklift tines
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A  
**Mitigated Frequency:** A

### Consequence / Risk Rank

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**Preventive Features:**
-Engineered: None
-Admin: None

**Mitigative Features:**
-Engineered: None
-Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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**Mitigators**
- SMP: Radiation Protection Program
  - Safety Function: Evaluates radiological conditions and processes for worker protection
  - Reduces radiological consequences due to exposure

**Notes:**
- This event bounds the puncture of a single TRU waste container.

**References:**
None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUCSK-3-009

Description:
Prohibited item in TRU waste is inadvertently punctured during remediation activity resulting in the release of radiological material.

Locations:
- Trenches A-D

Release Mechanisms:
- Pressurized venting
- Spill

Assumptions:
None

Causes:
- Equipment failure
- Leaks/ drips
- Operator error
- Pressurized canister punctured or inadvertently opened
- Uncontained liquids

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A

Mitigated Frequency: A

Consequence / Risk Rank

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Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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<td>Safety Function:</td>
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Notes:
None

References:
None

DOE 5506

Detail: Waste Container Over-Pressurization - Retrieval and Excavation (12e)
## Hazard Evaluation Table - Event BGTRUCSK-3-010

### Description:
Remediation/venting equipment system fails resulting in a release of radiological contamination.

### Locations:
- Trenches A-D

### MARS:
- Contamination

### Release Mechanisms:
- Loss of Confinement

### Assumptions:
None

### Causes:
- Equipment malfunction
- Improper equipment use
- Improperly maintained equipment
- Loss of normal power
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A

### Mitigated Frequency: A

### Consequence / Risk Rank

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### Preventive Features:
- **Engineered** None
  - (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Mitigative Features:
- **Engineered** None
  - (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
  - (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

### Credited SSCs and ACs

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<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
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</tbody>
</table>
  - Safety Function: Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion

| Notes: | None |
| References: | None |

### Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUCSK-3-011

**Description:**
TRU waste container retrieved is degraded resulting in release of radiological contamination.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Container degradation
- Corrosion
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** A

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<th>Phy</th>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
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<th>Evaluates radiological conditions and processes for worker protection</th>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUCSK-3-012

**Description:**
Pressurized gas disperses uncontained waste during remediation activities resulting in the release of radiological material.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Improper maintenance
- Improperly maintained equipment
- Maintenance activities
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

**Consequence / Risk Rank**

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**Preventive Features:**
- None

**Mitigative Features:**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<td>Safety Function:</td>
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**Notes:**
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**References:**
None

**DOE 5506**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- Waste Container Over-Pressurization - Retrieval and Excavation (12e)

---


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Hazard Evaluation Table - Event BGTRUCSK-3-013

Description:
Worker handling a TRU waste container inadvertently tips the container over causing impact with the ground resulting in a release of radiological material.

Locations:
- Trenches A-D

MARs:
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

Release Mechanisms:
- Impact and spill
- Loss of Confinement

Assumptions:
None

Causes:
- Improper container placement or handling
- Improperly installed closure ring
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: A

Consequence / Risk Rank

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Preventive Features:
- Engineered: None
- Admin: None

Mitigative Features:
- Engineered: None
- Admin: SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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<tr>
<td>Safety Function:</td>
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<td>Reduces radiological consequences due to exposure</td>
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</tbody>
</table>

Notes:
None

References:
None

DOE 5506 Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUCSK-3-014

**Description:**
Vehicle impacts remediation activity at > 10 mph and < 35 mph resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARs:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

#### Consequence / Risk Rank

<table>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**
None

**Engineered**

- (PSAC) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
None

**Engineered**

- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

#### Credited SSCs and ACs

**Preventers**

- PSAC Vehicle Barriers-High Risk Locations
  - Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.
  - Safety Function: The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

- SMP Maintenance Program - Vehicle/Equipment
  - Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)

#### SMP

- Training and Qualification
  - Personnel maintain applicable LANL qualifications for vehicle and equipment operation

---

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<table>
<thead>
<tr>
<th>Program - Qualifications</th>
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<tr>
<td>Safety Function:</td>
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<tr>
<td>Mitigators</td>
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<tr>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for all receptors</td>
</tr>
<tr>
<td></td>
<td>• Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
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<td>Notes:</td>
<td>None</td>
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<tr>
<td>References:</td>
<td>None</td>
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<tr>
<td>Detail:</td>
<td>• Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
</tr>
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</table>
## Hazard Evaluation Table - Event BGTRUCSK-3-015

**Description:** Handling equipment used (e.g., gantry crane, manlift, scaffolding) over a remediation activity fails and results in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Crane drops load (container, canister, load)
- Equipment capacity exceeded
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Improperly maintained equipment
- Operator error

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tbody>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**

- None

**Admin**

- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**

- None

- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotters support forklift/ rigger/ crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
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</table>

### Mitigators

- SMP Radiation Protection Program
  - Evaluates radiological conditions and processes for all receptors
  - Rad: P, C, W

### Safety Function:

- Reduce radiological consequences by limiting MAR released to all receptors

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUCSK-3-016

**Description:**
Worker handling an open TRU waste container during remediation inadvertently tips the container over causing a release of radiological material.

**Locations:**
- Trenches A-D

**MARs:**
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

**Release Mechanisms:**
- Impact and spill
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Improper container placement or handling
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
U

**Mitigated Frequency:**
EU

### Consequence / Risk Rank

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<tr>
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<tr>
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</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
None

**Admin**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

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<tr>
<td>SMP Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<td>Safety Function: Reduce radiological consequences by limiting MAR released to all receptors</td>
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**Notes:**
- It is not anticipated that there will be open TRU waste containers at Trenches A-D. This is considered an unlikely event.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)

---


12/17/2013
### Hazard Evaluation Table - Event BGTRUCSK-3-017

#### Description:
During venting, a pressurized TRU waste container is breached resulting in a release of radiological material.

#### Locations:
- Trenches A-D

#### MARs:
- 750 PEC (One [1] Trench A-D waste container with 20% margin [740 PEC])

#### Release Mechanisms:
- Pressurized venting

#### Assumptions:
None

#### Causes:
- Buildup of gas/ pressure inside container
- Container mishandling
- Container unvented or inadequately vented allowing the accumulation of internal pressure
- Incompatible chemicals
- Operator error
- Radiolysis/ hydrolysis in container
- Seal failure
- Thermal expansion of material/ gases
- Vent installation

#### Unmitigated System Effects:
None

#### Methods of Detection:
- Observation
- Radon instrumentation

#### Unmitigated Frequency:
A

#### Consequence / Risk Rank

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<tr>
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<td>M</td>
<td>II</td>
<td>L</td>
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#### Preventive Features:
- Engineered: None
- Admin: None

#### Mitigative Features:
- Engineered: None
- Admin:
  - SMP Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)
  - SMP Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

#### Credited SSCs and ACs

<table>
<thead>
<tr>
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<tbody>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
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</table>

#### Notes:
None

#### References:
None

#### DOE 5506 Detail:
- Waste Container Over-Pressurization - Retrieval and Excavation (12e)
**Hazard Evaluation Table - Event BGTRUCSK-4-001**

**Description:**
Personnel exposure to TRU waste containers results in a direct radiation exposure.

**Locations:**
- Trenches A-D

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Container misloaded or overbatched
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inadequate shielding (shine)
- Loss of shielding configuration
- Operator error
- Unknown container contents

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Consequence / Risk Rank**

<table>
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<tr>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

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<tr>
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<td>Direct Exposure to Radiation Events - Retrieval and Excavation (13e)</td>
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## Hazard Evaluation Table - Event BGTRUCSK-5-001

**Description:**
TRU waste containers with fissile material are placed in a close proximity array resulting in a criticality.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Trenches A-D</td>
<td>● Fissile Material</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- ● N/A - Criticality

**Assumptions:**
None

**Causes:**
- ● Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- ● Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- ● Dosimetry
- ● Radcon instrumentation

**Unmitigated Frequency:** BEU

**Mitigated Frequency:** NC

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</tbody>
</table>

**Preventive Features:**
- ● Engineered None
- ● Admin
  - (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
  - (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- ● Engineered None
- ● Admin None

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>SMP Nuclear Criticality Program</td>
<td>Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)</td>
<td>All</td>
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<tr>
<td>Mitigators</td>
<td>None</td>
<td>Safety Function: Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible</td>
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</tbody>
</table>

**Notes:**
None

**References:**
DOE 5506

**Detail:**
- ● Criticality Events - Retrieval and Excavation (14e)

---

**Chapter 3: Hazard and Accident Analysis**

**Appendix 3H**


12/17/2013
## Hazard Evaluation Table - Event BGTRUCSK-5-002

### Description:
TRU waste containers with fissile material and introduced moderator are placed in a close array resulting in a criticality.

### Locations:
- Trenches A-D

### MARs:
- Fissile Material

### Release Mechanisms:
- N/A - Criticality

### Assumptions:
None

### Causes:
- Flooding
- Improper container placement or handling
- Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- Operator error
- Water intrusion

### Unmitigated System Effects:
None

### Methods of Detection:
- Dosimetry
- Radon instrumentation

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<td>W</td>
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</tbody>
</table>

### Preventive Features:
- **Engineered** None
- **Admin** (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
  - (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

### Mitigative Features:
- **Engineered** None
- **Admin** None

### Credited SSCs and ACs

- **Preventers**
  - SMP Nuclear Criticality Program
  - Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)
  - **Safety Function:** Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible

- **Mitigators**

### Notes:
The physical process required for this event to occur is not physically plausible. The existing physical waste packages do not contain enough fissile material even under optimum conditions (i.e., > 500 g), for criticality.

### References:
None

### DOE 5506
- Criticality Events - Retrieval and Excavation (14e)
<table>
<thead>
<tr>
<th>Description:</th>
<th>Fissile material in TRU Waste container shifts during movement resulting in a criticality.</th>
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</thead>
<tbody>
<tr>
<td>Locations:</td>
<td>Trenches A-D, MARs: Fissile Material</td>
</tr>
<tr>
<td>Release Mechanisms:</td>
<td>N/A - Criticality</td>
</tr>
<tr>
<td>Assumptions:</td>
<td>None</td>
</tr>
<tr>
<td>Causes:</td>
<td>Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures, Operator error</td>
</tr>
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<td>Unmitigated System Effects:</td>
<td>None</td>
</tr>
<tr>
<td>Methods of Detection:</td>
<td>Dosimetry, Radcon instrumentation</td>
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<tr>
<td>Unmitigated Frequency:</td>
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<td>Mitigated Frequency:</td>
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### Consequence / Risk Rank

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</table>

### Preventive Features:

-Engineered: None

-Admin: (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
  - (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

### Mitigative Features:

-Engineered: None

-Admin: None

### Credited SSCs and ACs

- **Preventers**
  - SMP Nuclear Criticality Program: Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)
  - **Safety Function:** Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible
  - **Affected Receptors:** All

- **Mitigators:** None

- **Notes:** None

- **References:**

- **DOE 5506 Detail:**
  - Criticality Events - Characterization (14a)
  - Criticality Events - Container Handling (14b)
  - Criticality Events - Venting and/or Abating/Purging (14c)
  - Criticality Events - Staging and Storage (14d)
  - Criticality Events - Waste Repackaging (14f)
  - Criticality Events - Type B Container Loading/Unloading (14g)
### Hazard Evaluation Table - Event BGTRUCSK-6-001

**Description:**
Aircraft impacts TRU waste followed by pool fire.

**Locations:**
- Trenches A-D

**MARs:**
- 7,500 PEC (10 drums [750 PEC each] not overpacked removed from trench casks)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- High energy impact
- Impact and spill

**Assumptions:**
None

**Causes:**
- Aircraft crash

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** BEU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
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</table>

**Preventive Features:**
Engineered: None
Admin: None

**Mitigative Features:**
Engineered:
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin:
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

### Credited SSCs and ACs

<table>
<thead>
<tr>
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<td></td>
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<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td>Safety Function:</td>
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<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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</table>

**Notes:**
- MAR limit is credited at 1 full bin consequence reduction from H to M

**References:**
None

**DOE 5506**
- Aircraft Impact with Fire - Retrieval and Excavation (15e)

---


12/17/2013
**Hazard Evaluation Table - Event BGTRUCSK-7-001**

**Description:**
TRU waste container from cask is struck by lightning resulting in a release of radiological material.

**Locations:**
- Trenches A-D

**MARS:**
- 750 PEC (One [1] Trench A-D waste container with > 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Combustible material
- Lightning

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

## Consequence / Risk Rank

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<td>W</td>
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<td>I</td>
<td>L</td>
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</tbody>
</table>

**Preventive Features:**
- **Engineered** None
- **Admin** (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**
- **Engineered** None
- **Admin** (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<td>Mitigators</td>
<td>PSAC</td>
<td>Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
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<td>Evaluates radiological conditions and processes for worker protection</td>
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<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
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<td>DOE 5506</td>
<td>Lightning - Retrieval and Excavation (20e)</td>
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</table>
Hazard Evaluation Table - Event BGTRUPIT-1-001

**Description:**
A vehicle handling a TRU waste container at ≤ 10 mph in the pit impacts the waste face. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste being handled as well as the waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
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<tr>
<td>W</td>
<td>II</td>
<td>M</td>
<td>IV</td>
</tr>
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**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Combustible/ Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100</td>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</tbody>
</table>

**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When the Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUPIT-1-002

Description:
A vehicle transporting multiple TRU waste containers at \( \leq 10 \) mph in the pit impacts the waste face. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste being transported and the waste face resulting in a release of radiological material.

Locations:
- Pit 9
- MARs:
  - 2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)
  - 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

Release Mechanisms:
- Fuel pool fire release
- Low energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Preventive Features:

Engineered

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits \( \leq 15 \) mph)

Mitigative Features:

Engineered

Admin
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Consequence / Risk Rank

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<tr>
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</table>

Preventers PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G

Safety Function: Reduces likelihood of fuel interaction with MAR

Mitigators SS Waste Packaging Control (IC)

Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged

PSAC Radiological Inventory Management - Defined Area MAR Control (IC)

Safety Function: Reduces the radiological consequences by limiting the MAR involved

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<tr>
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<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
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</tbody>
</table>

PSAC Radiological Inventory

Safety Function: Reduces the radiological consequences by limiting the MAR involved

Mitigators SS Waste Packaging Control (IC)

Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged

PSAC Radiological Inventory Management - Defined Area MAR Control (IC)

Safety Function: Reduces the radiological consequences by limiting the MAR involved

<table>
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<td>Safety Function:</td>
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**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506**
- Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-003

**Description:**
A vehicle transporting multiple TRU Waste containers at > 10 mph and ≤ 35 mph impacts a remediation activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste being transported and uncontained waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 232 PEC (One [1] PIT 9 waste container in activity)
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** NC

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Observation</th>
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**Preventive Features:**
None

**Engineered:**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls - Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

**Class** | Control | Attribute | Affected Receptors
---|----------|-----------|------------------
Preventers | PSAC | Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G | Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles | All
| Safety Function: | Reduces likelihood of fuel interaction with MAR |
| PSAC | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | All
| Safety Function: | Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas. |
| SMP | Maintenance Program - Vehicle/ Equipment | Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift) | All
| Safety Function: | Reduce likelihood of equipment malfunction |
| SMP | Training and Qualification | Personnel maintain applicable LANL qualifications for vehicle | All

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<th>Program - Qualifications and equipment operation</th>
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<td>Waste Packaging Control (IC)</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>Radiological Inventory Management - Defined Area</td>
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<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</table>

Notes:  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506  
Detail:  
- Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-004

**Description:**
A vehicle impacts TRU waste from pit at > 10 mph and ≤ 35 mph resulting in fuel tank leak/ rupture with ignition source resulting in fuel pool fire releasing radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Ignition source
- Inclement weather
- Leaks/ drips
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
None

**Mitigated Frequency:**
BEU

**Consequence / Risk Rank**

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<th>Receptor</th>
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<tr>
<td>W</td>
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<td>II</td>
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</table>

**Preventive Features:**
None

**Engineered**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
None

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tbody>
<tr>
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<td>SS</td>
<td>Vehicle Barriers- High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
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</table>

**Safety Function:**
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the...
material-at-risk (MAR) in transport, and no additional radiological waste is involved.

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SS Waste Packing Control (IC)</th>
<th>Waste is packaged</th>
<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
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<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

Notes: The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References: None

DOE 5506 Detail: Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-005

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 mph and < 35 mph impacts remediation activities. The collision event initiates a fire resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARs:**
- 232 PEC (One [1] PIT 9 waste container in activity)
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
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</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

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<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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12/17/2013
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<th>Safety Function:</th>
<th>Reduces the radiological consequences by limiting the MAR involved</th>
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<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</table>

**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
Hazard Evaluation Table - Event BGTRUPIT-1-006

**Description:**
A vehicle traveling at \( \leq 10 \text{ mph} \) and transporting multiple Pit 9 TRU waste containers is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material. No additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Pit 9
- MARs:
  - 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

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**Preventive Features:**

**Engineered:** None

**Admin:**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits \( < 15 \text{ mph} \))

**Mitigative Features:**

**Engineered:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums \( > 200 \text{ PEC} \))
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Training and Qualification Program - Qualifications</td>
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<td>Waste is packaged</td>
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<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ( &gt; 200 \text{ PEC} )</td>
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**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged

**Safety Function:** Reduces the radiological consequences by limiting the MAR involved

**Safety Function:** Reduces radiological consequences by limiting amount of MAR involved

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
None

DOE 5506 • Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-007

**Description:**
A vehicle traveling at ≤ 10 mph and transporting multiple TRU waste containers from Pit 9 impacts a remediation activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and in remediation resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 106 PEC (Pit 9 Statistical MAR of 48 drums in transport excluding high MAR)
- 232 PEC (One (1) Pit 9 waste container in activity)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

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**Preventive Features:**

**Engineered**
- None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Radiological Inventory Management - Defined Area MAR Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
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<th>Class</th>
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<tr>
<td>Preventers</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
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<td>DOE 5506</td>
<td>• Fuel Pool Fire - Retrieval and Excavation (1e)</td>
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<td>Detail:</td>
<td>• Fuel Pool Fire - Waste Repackaging (1f)</td>
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Hazard Evaluation Table - Event BGTRUPIT-1-008

Description:
A vehicle traveling at ≤ 10 mph and transporting a TRU waste container from Pit 9 impacts a remediation activity. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and in remediation resulting in a release of radiological material. No additional waste is sufficiently close to be affected by heating.

Locations:
- Pit 9

MARS:
- 196 PEC (One [1] PIT 9 waste container in transport: 2nd highest)
- 232 PEC (One [1] PIT 9 waste container in activity)

Release Mechanisms:
- Fuel pool fire release
- Low energy impact

Assumptions:
None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

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<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered
- None

Admin
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<td><strong>Safety Function:</strong> Reduce likelihood of equipment malfunction</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<td><strong>Safety Function:</strong> Reduces likelihood for vehicle and equipment accidents</td>
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<table>
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<tr>
<th>Mitigators</th>
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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>P, C, W</td>
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<td></td>
<td><strong>Safety Function:</strong> Reduces radiological consequences by limiting amount of MAR involved</td>
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Notes:
The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUPIT-1-009

**Description:**
A vehicle traveling at \( \leq 10 \text{ mph} \) and transporting multiple TRU waste containers from Pit 9 is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material. The waste face is sufficiently close to the fire to be affected by heating.

**Locations:**
- Pit 9

**MARS:**
- 300 PEC (Pit 9 Statistical MAR of 200 [1.5] drums in pit stack face excluding 4 high MAR drums)
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chn</th>
<th>Phy</th>
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**Preventive Features:**

- **Admin**
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits \( < 15 \text{ mph} \))

**Mitigative Features:**

- **Admin**
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums \( > 200 \text{ PEC} \))
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
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<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ( &gt; 200 \text{ PEC} )</td>
</tr>
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</table>
| Notes: | ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
| References: | None  
| DOE 5506 | ● Fuel Pool Fire - Retrieval and Excavation (1e) |
### Hazard Evaluation Table - Event BGTRUPIT-1-010

**Description:**
Two (2) vehicles, each transporting multiple TRU waste containers from Pit 9 impact at ≤ 10 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Statistical MAR of 48 drums [1.5] in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Methods of Detection:**
- Observation

**Methods of Detection:**

**Receptor** | **Consequence / Risk Rank** | **Unmit.** | **Phy**
--- | --- | --- | ---
P | M | III | M | IV
C | M | III | M | IV
W | H | II | H | III

### Preventive Features:

**Engineered**
- None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)
  
**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)

### Credited SSCs and ACs

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<td>Waste is packaged</td>
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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).
<table>
<thead>
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<tr>
<td>DOE 5506</td>
<td>● Fuel Pool Fire - Retrieval and Excavation (1e)</td>
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</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H
### Hazard Evaluation Table - Event BGTRUPIT-1-011

**Description:**
Two (2) vehicles, each transporting a single TRU waste container from Pit 9 impact at ≤ 10 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 196 PEC (One [1] PIT 9 waste container in transport: 2nd highest)
- 232 PEC (One [1] PIT 9 waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Consequence / Risk Rank**

<table>
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<tr>
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<th>Phy</th>
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<td>W</td>
<td>H</td>
<td>II</td>
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</tbody>
</table>

**Preventive Features:**

- **Engineered**
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

- **Engineered**
  - (SS) (IC) Waste Packaging Control (Waste is packaged)
  - (SMP) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<td><strong>Safety Function:</strong></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

**Notes:**
The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).

**References:**
None

**DOE 5506 Detail:**
- Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event BGTRUPIT-1-012

### Description:
A vehicle traveling at $\leq 10$ mph and transporting a TRU waste container is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 278 PEC (One [1] Pit 9 waste container in transport with 20% margin)

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU
Mitigated Frequency: BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
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</tbody>
</table>

### Preventive Features:

Engineered: None

Admin:
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits $\leq 15$ mph)

### Mitigative Features:

Engineered:
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums $> 200$ PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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</table>

### Preventers:
- SMP: Maintenance Program - Vehicle/ Equipment
  - Safety Function: Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)
  - All Receptors

- SMP: Training and Qualification Program - Qualifications
  - Safety Function: Personnel maintain applicable LANL qualifications for vehicle and equipment operation
  - All Receptors

### Mitigators:
- SS: Waste Packaging Control (IC)
  - Safety Function: Waste is packaged
  - Rad: P, C, W

- PSAC: Radiological Inventory Management - TRU Waste Drum Doublepack
  - Safety Function: Doublepack radiological waste drums $> 200$ PEC
  - Rad: P, C, W

### Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

### References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)

Chapter 3: Hazard and Accident Analysis
Appendix 3H

Basis for Interim Operation Rev. 3.0
November 2014


12/17/2013
### Hazard Evaluation Table - Event BGTRUPIT-1-013

**Description:**
A vehicle traveling at ≤ 10 mph and transporting a TRU waste container from Pit 9 is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material. The waste face is sufficiently close to the fire to be affected by heating.

**Locations:**
- Pit 9

**MARS:**
- 232 PEC (One [1] PIT 9 waste container in transport)
- 334 PEC (Pit 9 Statistical MAR of 200 drums in pit stack face excluding high MAR drum)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<td>W</td>
<td>H</td>
<td>II</td>
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</tbody>
</table>

### Preventive Features:

**Engineered**
None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<td>Training and Qualification Program - Qualifications</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>
| Notes:  | ● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
         | ● The waste face is sufficiently close to the fire to be affected by heating. |
| References: | None  |
| DOE 5506 Detail: | ● Fuel Pool Fire - Retrieval and Excavation (1e) |
### Hazard Evaluation Table - Event BGTRUPIT-1-014

**Description:**
A vehicle impacts retrieved TRU waste from Pit 9 at > 10 mph and < 35 mph resulting in fuel tank leak/ rupture with coincidental ignition source resulting in fuel pool fire releasing radiological material. No additional waste is sufficiently close to be affected by heating.

**Locations:**
- Pit 9

**MARs:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Ignition source
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU
**Mitigated Frequency:** BEU

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</table>

**Preventive Features:**
- Engineered: None
- Admin: (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- Admin: (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- Admin: (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- Admin: (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- Engineered: (SS) IC Waste Packaging Control (Waste is packaged)
- Admin: (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- Admin: (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)

### Credited SSCs and ACs

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<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<td>SMP</td>
<td>Safety Function</td>
<td>Reduce likelihood for vehicle and equipment accidents</td>
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<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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</tbody>
</table>

**Safety Function:**
- Reduces the radiological consequences by limiting the amount of MAR involved

**Notes:**
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
None

**DOE 5506**
- Fuel Pool Fire - Retrieval and Excavation (1e)

---


12/17/2013
Hazard Evaluation Table - Event BGTRUPIT-1-015

Description:
A vehicle transporting multiple TRU waste containers from Pit 9 at ≤ 10 mph impacts other Pit 9 retrieved TRU waste. The collision event initiates a fire which involves contained waste resulting in a release of radiological material.

Locations:
- Pit 9

MARS:
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 70 PEC (Pit 9 Statistical MAR for 24 average drums excluding high MAR)

Release Mechanisms:
- Fire
- Low energy impact

Assumptions:
None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: EU

Consequence / Risk Rank

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<tr>
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<tr>
<td>W</td>
<td>H I M III</td>
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</tbody>
</table>

Preventive Features:

Engineered None

Admin
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Affected Receptors</th>
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<td>Mitigators</td>
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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker</td>
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<tr>
<td>Protection</td>
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</table>
|-----------------
| **Safety Function:** Reduces radiological consequences due to exposure |

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Small Fire - Retrieval and Excavation (2e)
# Hazard Evaluation Table - Event BGTRUPIT-1-016

**Description:**
Combustible/flammable liquid (e.g., diesel fuel, gasoline) leaks fuel adjacent to pit after excavation of a pit cell in coincidence with an ignition source ignites into a fuel pool fire involving exposed waste resulting in a release of radiological material.

**Locations:**
- Pit 9
- MARs:
  - 2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** U

**Mitigated Frequency:** BEU

<table>
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<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<tr>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>W</td>
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</tbody>
</table>

**Preventive Features:**
- None

**Mitigative Features:**
- (PSAC) Control of Liquid Run-On (Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.)

**Credited SSCs and ACs**

<table>
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<tr>
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<th>Affected Receptors</th>
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<td>Control of Liquid Run-On</td>
<td>Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.</td>
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<td>Safety Function:</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>PSAC</td>
<td>Combustible/flammable Liquid Packaging Control (IC)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>Flammable Liquids Control</td>
<td>Gallons of unattended flammable/combustible liquids and up to a total of 100 gallons of attended liquid/flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
<td>C, W;</td>
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<tr>
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<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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<tr>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Rad: P; C, W;</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>Notes:</td>
<td>• The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
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<td>References:</td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>• Fuel Pool Fire - Retrieval and Excavation (1e)</td>
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</table>
**Hazard Evaluation Table - Event BGTRUPIT-1-017**

**Description:**
Combustibles (e.g., plywood, FRPs, transient combustibles) within the pit are ignited. The fire involves metal and non-metal containers resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Collapse of retrieval/ excavation site
- Combustible material
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment failure
- Equipment malfunction
- Ignition source
- Operator error
- Transient combustibles
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** A

<table>
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**Methods of Detection:**
- Observation

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<td>I</td>
<td>M</td>
<td>III</td>
<td></td>
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</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- (SS (IC) Waste Packaging Control (Waste is packaged)

<table>
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<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
</tr>
<tr>
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<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
</tbody>
</table>

**Credited SSCs and ACs**

- Safety Function: Reduces likelihood for ignition of flammables/ combustibles
- Safety Function: Reduces likelihood for vehicle and equipment accidents

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Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-492
<table>
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<tr>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
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<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
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Notes: Combustible /flammable materials external to container

References: None

DOE 5506

Detail: Small Fire - Retrieval and Excavation (2e)
Hazard Evaluation Table - Event BGTRUPIT-1-018

Description:
A vehicle traveling at > 10 mph and < 35 mph and transporting a TRU waste container from Pit 9 impacts the waste face. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and the waste face resulting in a release of radiological material.

Locations: Pit 9
MARs:
- 232 PEC (One [1] PIT 9 waste container in transport)
- 334 PEC (Pit 9 Statistical MAR of 200 drums in pit stack face excluding high MAR drum)

Release Mechanisms:
- Exposure Fire
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions: None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU
Mitigated Frequency: BEU

Consequence / Risk Rank

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<th>Receptor</th>
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<tr>
<td>W</td>
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<td>II</td>
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</tbody>
</table>

Preventive Features:

Engineered
None

Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAAS, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
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<td>PSAC</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
</tbody>
</table>

Safety Function:
- Reduces the radiological consequences as waste is agglomerated and burns as packaged.
- Reduces the radiological consequences by limiting the MAR involved

Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

References:
None

DOE 5506

Detail:
- Fuel Pool Fire - Retrieval and Excavation (1e)


12/17/2013
**Hazard Evaluation Table - Event BGTRUPIT-1-019**

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting multiple TRU waste containers from Pit 9 impacts the waste face. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and the waste face resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 300 PEC (Pit 9 Statistical MAR of 200 [1.5] drums in pit stack face excluding 4 high MAR drums)
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

**Consequence / Risk Rank**

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<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered** None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Maintenance Program - Vehicle/ Equipment</td>
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<td>Safety Function: Reduce likelihood of equipment malfunction</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>All</td>
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<td></td>
<td>Safety Function: Reduces likelihood for vehicle and equipment accidents</td>
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<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>● Rad: P, C, W;</td>
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<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>● Rad: P, C, W;</td>
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<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
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<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
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<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
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<td>Notes:</td>
<td>The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
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<tr>
<td>Pit 9</td>
<td>2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Description:
Construction equipment leaks fuel into pit during excavation activities in coincidence with an ignition source. Fuel is ignited resulting in a fuel pool fire engulfing the exposed waste resulting in a release of radiological material.

### Locations:
- Pit 9

### Release Mechanisms:
- Fuel pool fire release

### Assumptions:
None

### Causes:
- Collapse of retrieval/excavation site
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
Observation

### Unmitigated Frequency: U
Mitigated Frequency: EU

### Preventive Features:
Engineered: None
Admin: (PSAC) Control of Liquid Run-On (Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.)

### Mitigative Features:
Engineered: (SS) (IC) Waste Packaging Control (Waste is packaged)

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<tr>
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<tr>
<td>C</td>
<td>H</td>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
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</tbody>
</table>

### Preventers

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Control of Liquid Run-On</td>
<td>Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.</td>
<td>All</td>
</tr>
</tbody>
</table>

### Safety Function:
Prevent fuel spills from the liquid fueled retrieval equipment from entering the pit or trench and thereby prevent the radiant heat flux from a potential fuel pool fire from impacting waste containers at a lower elevation within the pit or trench

### Mitigators

<table>
<thead>
<tr>
<th>Class</th>
<th>Control (IC)</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>Waste Packaging Control</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

### Safety Function:
Reduces the radiological consequences as waste is agglomerated and burns as packaged

<table>
<thead>
<tr>
<th>Class</th>
<th>Control (IC)</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>

### Safety Function:
Reduce radiological consequences by limiting MAR involved

### Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
None

DOE 5506

- Fuel Pool Fire - Retrieval and Excavation (1e)

Chapter 3: Hazard and Accident Analysis
Appendix 3H

Basis for Interim Operation Rev. 3.0
November 2014
## Hazard Evaluation Table - Event BGTRUPIT-1-021

### Description:
Combustibles ignite during remediation activity causing a fire and resulting in a release of radiological material. Adjacent retrieved waste is sufficiently close to be affected by heating.

### Locations:
- Pit 9

### MARs:
- 232 PEC (One [1] PIT 9 waste container in activity)
- 70 PEC (Pit 9 Statistical MAR for 24 average drums excluding high MAR)

### Release Mechanisms:
- Exposure Fire
- Fire

### Assumptions:
None

### Causes:
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Improper equipment use
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:
Engineered None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**
- (SS) Waste Packaging Control (Waste is packaged)

### Preventers
- **PSAC Fire Protection - Thermal Separation Distance - Defined Area**
  - Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.

### Mitigators
- **SS Waste Packaging Control (IC)**
  - Waste is packaged

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Radiological Inventory</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA,</td>
</tr>
<tr>
<td>Management - Defined Area MAR Control</td>
<td>Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>W:</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rad: W:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Combustible /flammable materials external to container</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>▪ Deleted</td>
<td></td>
<td></td>
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<td>References:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DOE 5506</td>
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<td></td>
<td></td>
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<tr>
<td>Detail:</td>
<td>▪ Small Fire - Retrieval and Excavation (2e)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Enclosure Fire - Retrieval and Excavation (3e)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-1-022

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting a TRU waste container from Pit 9 impacts a remediation activity. Fuel is leaked and ignited into a fuel pool fire engulfing the waste in transport and uncontained waste in remediation resulting in a release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pit 9</td>
<td>• 196 PEC (One [1] PIT 9 waste container in transport: 2nd highest)</td>
</tr>
<tr>
<td></td>
<td>• 232 PEC (One [1] PIT 9 waste container in activity)</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inadequate road condition (e.g., erosion, pot holes)
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:** None

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Mitigated Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rad</td>
<td>DSA Mit.</td>
</tr>
<tr>
<td>P</td>
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<tr>
<td>C</td>
<td>M</td>
<td>III</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- **Engineered None**
- **Admin**
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- **Engineered**
  - (SS) [IC] Waste Packaging Control (Waste is packaged)
  - (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

### Notes:
The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

### References:
- None
- DOE 5506

### Details:
- Fuel Pool Fire - Retrieval and Excavation (1e)
# Hazard Evaluation Table - Event BGTRUPIT-1-023

**Description:**
A vehicle transporting multiple TRU waste containers from pit at ≤ 10 mph impacts pit remediation activity. A fire starts which involves both uncontained and contained waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 106 PEC (Pit 9 Statistical MAR of 48 drums in transport excluding high MAR)
- 232 PEC (One [1] PIT 9 waste container in activity)

**Release Mechanisms:**
- Fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>DSA Mit.</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**  
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Notes:</strong></td>
<td>● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
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<td><strong>References:</strong></td>
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<tr>
<td><strong>DOE 5506</strong></td>
<td>Small Fire - Retrieval and Excavation (2e)</td>
<td></td>
<td></td>
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</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-1-024

**Description:**
Characterization equipment overheats and ignites a fire during characterization activities affects the TRU waste container being processed resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container in activity with 20% margin)

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Ignition source

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<td>Unmit.</td>
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<tr>
<td>C</td>
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<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

**Consequence / Risk Rank**

**Preventive Features:**

**Engineered None**

- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**

**Engineered**

- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces likelihood for deflagration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>● Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td>● Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce the consequences of an accident for the worker and collocated worker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>● Rad: W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>● Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Notes:
- Combustible /flammable materials external to container
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References:
- None

<table>
<thead>
<tr>
<th>DOE 5506</th>
<th>Small Fire - Retrieval and Excavation (2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detail</td>
<td></td>
</tr>
</tbody>
</table>


12/17/2013
### Hazard Evaluation Table - Event BGTRUPIT-1-027

**Description:**
A small fire within retrieved TRU waste propagates to involve additional retrieved TRU waste containers resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
Small fire event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Mitigated Frequency:** U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rad</td>
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<td>P</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)

**Mitigative Features:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduces the likelihood of fire progression

| SMP   | Fire Protection Program - Hot Work and Ignition Source Control | Ignition source control within defined areas. | All |

**Safety Function:** Reduce likelihood for ignition of flammables/combustibles

| SS     | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |

**Safety Function:** Reduces the radiological consequences as waste is agglomerated and burns as packaged

| PSAC   | Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | Rad: P, C, W; |

**Safety Function:** Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.


**Safety Function:** Reduces the radiological consequences by limiting the MAR involved

| PSAC   | Radiological Inventory Management - Retrieval Area MAR Limit | The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci. | Rad: P, C, W; |

**Safety Function:** Reduces radiological consequences by limiting the MAR involved

| SMP    | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; |

**Safety Function:** Reduces radiological consequences due to exposure

<p>| SMP    | Training and Qualification Program - Hazards | Personnel trained to recognize specific job hazards and associated controls | Rad: P, C, W; |</p>
<table>
<thead>
<tr>
<th>Recognition</th>
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<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles</td>
</tr>
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</table>

| Notes: | Deleted |
| References: | None |

| References: | None |
| Large Fire - Retrieval and Excavation (4e) |
| Lightning - Retrieval and Excavation (20e) |
| Seismic Event with Fire - Retrieval and Excavation (25e) |
Hazard Evaluation Table - Event BGTRUPIT-1-028

**Description:**
Two (2) vehicles, one transporting a single TRU waste container from pit and the other transporting multiple TRU waste containers from pit, impact at > 10 mph and < 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 106 PEC (Pit 9 Statistical MAR of 48 drums in transport excluding high MAR)
- 232 PEC (One [1] PIT 9 waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
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</table>

**Preventive Features:**

**Engineered:** None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<td>Reduce likelihood of equipment malfunction</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces likelihood for vehicle and equipment accidents</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers</td>
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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Rad: P, C, W; Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
<td>Rad: P, C, W; Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>
| Notes:      | • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
• The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle). | References: None                                                                                                                                  | DOE 5506 Detail: Fuel Pool Fire - Retrieval and Excavation (1e)                                                                 |
### Hazard Evaluation Table - Event BGTRUPIT-1-029

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting multiple TRU waste containers from Pit 9 is involved in an accident (no impacts to any additional waste). Fuel is leaked and ignites into a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material. Additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Statistical MAR of 48 drums in staging at 1.5 PEC per container: excluding 4 high MAR)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

#### Consequence / Risk Rank

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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered None**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Safety Function:</td>
<td>SMP</td>
<td>Reduce likelihood of equipment malfunction</td>
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<td>Safety Function:</td>
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<td>Reduces likelihood for vehicle and equipment accidents</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

### Additional Information

- Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

---


12/17/2013
**SS Waste Packaging Control (IC)**

| Safety Function: | Reduces the radiological consequences as waste is agglomerated and burns as packaged. |

**PSAC Fire Protection - Thermal Separation Distance - Defined Area**

| Safety Function: | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. |

**PSAC Radiological Inventory Management - Defined Area MAR Control**

| Safety Function: | Reduce radiological consequences by limiting the amount of MAR involved. |

**PSAC Radiological Inventory Management - TRU Waste Drum Doublepack**

| Safety Function: | Reduce radiological consequences by limiting the amount of MAR involved. |

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:** None

**DOE 5506 Detail:** Fuel Pool Fire - Retrieval and Excavation (1e)
Hazard Evaluation Table - Event BGTRUPIT-1-030

**Description:**
Exposed face of Non-metal TRU waste containers (FRPs) are ignited and burned resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Lightning
- Operator error
- Seismic event

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
U

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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<th>Phy</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
<td>III</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces the likelihood of fire progression</td>
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<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>Rad: P, C, W;</td>
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<tr>
<td>Safety Function:</td>
<td></td>
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<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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</table>
### Safety Function:
Reduces the radiological consequences by limiting the MAR involved

<table>
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<tr>
<th>SMP Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
<th>Rad: W;</th>
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### Safety Function:
Reduces radiological consequences due to exposure

### Notes:
- Deleted
- The waste face is sufficiently close to the fire to be affected by heating.

### References:
- None
- DOE 5506
- Detail:
  - Small Fire - Retrieval and Excavation (2e)
  - Lightning - Retrieval and Excavation (20e)
  - Seismic Event with Fire - Retrieval and Excavation (25e)
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<th>Hazard Evaluation Table - Event BGTRUPIT-1-031</th>
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<td><strong>Description:</strong> Two (2) vehicles, each transporting a single TRU waste container from pit, impact at &gt; 10 mph and &lt; 35 mph. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.</td>
</tr>
<tr>
<td><strong>Locations:</strong> Pit 9</td>
</tr>
<tr>
<td><strong>MARS:</strong></td>
</tr>
<tr>
<td>- 196 PEC (One [1] PIT 9 waste container in transport: 2nd highest)</td>
</tr>
<tr>
<td>- 232 PEC (One [1] PIT 9 waste container in transport)</td>
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<tr>
<td><strong>Release Mechanisms:</strong> Fuel pool fire release, Impact and spill, Moderate energy impact</td>
</tr>
<tr>
<td><strong>Assumptions:</strong> None</td>
</tr>
<tr>
<td><strong>Causes:</strong> Disposal pit configuration (entrance grade, uneven surface), Equipment malfunction, Inclement weather, Operator error, Vehicle accident, Vehicle/equipment mechanical failure (e.g., steering, brakes)</td>
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<tr>
<td><strong>Unmitigated System Effects:</strong> None</td>
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<td><strong>Methods of Detection:</strong> Observation</td>
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<td><strong>Unmitigated Frequency:</strong> EU</td>
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<td><strong>Mitigated Frequency:</strong> BEU</td>
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### Consequence / Risk Rank

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### Preventive Features:

**Engineered** None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls - Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).

**References:** None

**DOE 5506 Detail:** Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event BGTRUPIT-1-032

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting an unvented TRU waste container from Pit 9 is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container in transport with 20% margin)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- None

**Engineered**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**
- (SS) (IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>reduce physical consequences by limiting debris dispersion</td>
<td></td>
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<td>-----------------------------------------------------------</td>
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<tr>
<td>Notes:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
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<tr>
<td>References:</td>
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<tr>
<td>● Fuel Pool Fire - Retrieval and Excavation (1e)</td>
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</table>
### Hazard Evaluation Table - Event BGTRUPIT-1-033

**Description:**
Large refueling vehicle accident results in fuel spill with subsequent pool fire engulfing exposed TRU waste resulting in a release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
</tr>
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<tbody>
<tr>
<td>Pit 9</td>
<td>2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)</td>
</tr>
</tbody>
</table>

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Locations:**
Pit 9

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<th>Chm</th>
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<td>DSA Mit.</td>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
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</tbody>
</table>

**Preventive Features:**

- **Engineered**
  - (PSAC) Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

- **Admin**

**Mitigative Features:**

- **Engineered**
  - None

- **Admin**
  - None

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Vehicle/ Equipment Safety Control – Refueling Location</td>
<td>Refueling location will be separated from MAR in defined areas by the thermal separation distance.</td>
<td>All</td>
</tr>
</tbody>
</table>

**Mitigators**
- None

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506**
- Fuel Pool Fire - Retrieval and Excavation (1e)
## Hazard Evaluation Table - Event BGTRUPIT-1-034

**Description:**
Large refueling vehicle spills fuel during refueling operation with subsequent pool fire adjacent to but not engulfing retrieved TRU waste results in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 564 PEC (Pit 9 200 Statistical waste face containers including high MAR)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Equipment malfunction
- Ignition source
- Leaks/ drips
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
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<tr>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- Engineered: None
- Admin: (PSAC) Vehicle/ Equipment Safety Control – Refueling Location (Refueling location will be separated from MAR in defined areas by the thermal separation distance.)

**Mitigative Features:**

- Engineered: None
- Admin: None

### Credited SSCs and ACs

**Preventers**
- Class: PSAC
- Control: Vehicle/ Equipment Safety Control – Refueling Location
- Attribute: Refueling location will be separated from MAR in defined areas by the thermal separation distance.

**Safety Function:**
- Reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.

**Mitigators**
- None

**Notes:**
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506 Detail:**
- Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-035

**Description:**
Large refueling vehicle traveling at > 10 mph and ≤ 35 mph impacts waste face causing fuel to leak and ignite into a fuel pool engulfing the waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
- The quantity of fuel on the large refueling vehicle is < 5,000 gallons.

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<td>C</td>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Radiological Inventory Management - Defined Area MAR Control (Define MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. TRU Storage Areas not collocated with SSSR Areas)
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The fuel pool is assumed to consist of less than five thousand (5000) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction
may be given based on the robustness of the programs and the individual elements

<table>
<thead>
<tr>
<th>References:</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE 5506</td>
<td></td>
</tr>
<tr>
<td>Detail:</td>
<td>Fuel Pool Fire - Retrieval and Excavation (1e)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-1-036

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting multiple TRU waste containers from Pit 9 is involved in an accident (no impacts to any additional waste). Fuel is leaked and ignites into a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material. No additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- High wind
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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<th>Phy</th>
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<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>C</td>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered None**

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) Rad Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
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<tr>
<td>Mitigators</td>
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<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</tr>
</tbody>
</table>

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.


12/17/2013
The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

<table>
<thead>
<tr>
<th>References</th>
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<tbody>
<tr>
<td>DOE 5506</td>
<td>• Fuel Pool Fire - Retrieval and Excavation (1e)</td>
</tr>
<tr>
<td>Detail:</td>
<td>• High Wind - Retrieval and Excavation (21e)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event BGTRUPIT-1-037

Description:
A vehicle traveling at > 10 mph and ≤ 35 mph and transporting an unvented TRU waste container from Pit 9 is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignites into a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material. Additional waste is sufficiently close to the fire to be affected by heating.

<table>
<thead>
<tr>
<th>Locations:</th>
<th>MARs:</th>
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</thead>
<tbody>
<tr>
<td>• Pit 9</td>
<td>• 106 PEC (Pit 9 Statistical MAR of 48 drums excluding high MAR)</td>
</tr>
<tr>
<td></td>
<td>• 232 PEC (One [1] PIT 9 waste container in transport)</td>
</tr>
</tbody>
</table>

Release Mechanisms:
• Fuel pool fire release
• Impact and spill
• Moderate energy impact

Assumptions:
None

Causes:
• Disposal pit configuration (entrance grade, uneven surface)
• Equipment malfunction
• Inclement weather
• Operator error
• Vehicle accident
• Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects: None

Methods of Detection:
• Observation

Unmitigated Frequency: EU

Mitigated Frequency: EU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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Preventive Features:
Engineered: None
Admin: None

Mitigative Features:
Engineered: None
Admin: None

Credited SSCs and ACs

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<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<td>Mitigators</td>
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</table>

DOE 5506 Detail:
• Fuel Pool Fire - Retrieval and Excavation (1e)
### Hazard Evaluation Table - Event BGTRUPIT-1-038

**Description:**
A vehicle traveling at > 10 mph and < 35 mph and transporting a TRU waste container from Pit 9 impacts retrieved waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and the retrieved waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARs:**
- 106 PEC (Pit 9 Statistical MAR of 48 drums excluding high MAR)
- 232 PEC (One [1] PIT 9 waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

**Consequence / Risk Rank**

<table>
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<tr>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

<table>
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<th>Control</th>
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<td>Mitigators</td>
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## Hazard Evaluation Table - Event BGTRUPIT-1-039

### Description:
A vehicle traveling at > 10 mph and < 35 mph and transporting multiple TRU waste containers from Pit 9 impacts retrieved waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport and the retrieved waste resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Stack of 48 average drums at 1.5 PEC each)

### Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Unmitigated Frequency:
EU

### Mitigated Frequency:
BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
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<td>M</td>
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<tr>
<td>C</td>
<td>M</td>
<td>III</td>
<td>M</td>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

### Preventive Features:

#### Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

#### Admin
- (SS) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packed</td>
</tr>
</tbody>
</table>

### Notes:
The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
<table>
<thead>
<tr>
<th>References:</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE 5506 Detail</td>
<td>● Fuel Pool Fire - Retrieval and Excavation (1e)</td>
</tr>
</tbody>
</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
## Hazard Evaluation Table - Event BGTRUPIT-1-040

**Description:**
A stationary vehicle/ equipment fuel tank spills, leaks, or ruptures adjacent to retrieved TRU waste with a subsequent pool fire. The fuel pool engulfs the adjacent waste resulting in a release of radiological material. The pool fire affects the adjacent retrieval site exposed face.

**Locations:**
- Pit 9

**MARS:**
- 564 PEC (Pit 9 200 Statistical waste face containers including high MAR)

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Fuel spills/ leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
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<td>II</td>
<td>M</td>
<td>IV</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces likelihood of fuel interaction with MAR</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SS</th>
<th>Waste Packaging Control</th>
<th>Waste is packaged</th>
<th>Rad: P, C, W;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>Rad: P, C, W;</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
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<tr>
<td>MAR Control collocated with SSSR Areas)</td>
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<td>----------------------------------------</td>
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</tr>
<tr>
<td><strong>Safety Function:</strong> Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| Notes: | The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth. |
| References: | None |
| DOE 5506 Detail: | Fuel Pool Fire - Retrieval and Excavation (1e) |
### Hazard Evaluation Table - Event BGTRUPIT-2-001

**Description:**
Flammable gas accumulates near TRU waste containers with coincidental ignition source leads to a deflagration affecting TRU waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 877 PEC (Statistical 48 (all) containers)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment failure
- Flammable gases
- Hot Work
- Ignition source
- Maintenance/ construction activity
- Mechanical failure
- Operator error
- Static electricity
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

#### Preventive Features:

**Engineered None**

**Admin**
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (PSAC) Combustible/ Flammable Liquids Control (Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.)
- (PSAC) Control of Liquid Run-On (Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

#### Mitigative Features:

**Engineered None**

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)

### Credited SSCs and ACs

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<tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Combustible/ Flammable Liquids Control</td>
<td>Defined areas containing only TRU metal containers are permitted up to 7 gallons of unattended flammable/ combustible liquids and up to a total of 100 gallons of attended liquid/ flammable combustibles. All flammable/combustible liquids in defined areas containing non-metal container storage areas shall be attended, and limited to a total of 100 gals.</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Control of Liquid Run-On</td>
<td>Liquid impediments shall be established between liquid fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during operation and warm standby, except during relocation of the retrieval equipment.</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Prevent fuel spills from the liquid fueled retrieval equipment from entering the pit or trench, and thereby prevent the radiant heat flux from a potential fuel pool fire from impacting waste containers at a lower elevation within the pit or trench</td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source</td>
<td>Ignition source control within defined areas.</td>
</tr>
<tr>
<td>Control</td>
<td>Safety Function: Reduce likelihood for ignition of flammables/ combustibles</td>
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<tr>
<td>Mitigators</td>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control</td>
<td></td>
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<tr>
<td></td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td>References:</td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)</td>
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<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-2-002

**Description:**
An unvented TRU waste container is violently shaken causing a deflagration resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Crane topples
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material
- Vehicle impact

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<td>W</td>
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<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
- None

**Admin**
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

### Credited SSCs and ACs

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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td>Mitigators</td>
<td>PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
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<td>-----------------------------------------------------------------------------------------</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
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<tr>
<td></td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
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<td>Rad: P, C, W;</td>
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</table>

**Safety Function:** Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion

**Notes:** When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:** Waste Container Deflagration - Container Handling (6b)

Waste Container Deflagration - Retrieval and Excavation (6e)
**Hazard Evaluation Table - Event BGTRUPIT-2-003**

**Description:**
During miscellaneous venting activities (e.g., lid replacement, lid restraint installation) a TRU waste container deflagrates resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Equipment failure
- Flammable headspace
- Ignition source
- Mechanical failure
- Metal to metal contact
- Operator error
- Static electricity

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
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<tr>
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<td>M</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered** None

**Admin**
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/tool design controls and processes used to penetrate/breach an unvented TRU waste container must minimize frictional sparking)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered** None

**Admin**
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

**Credited SSCs and ACs**

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<td>Equipment/tool design controls and processes used to penetrate/breach an unvented TRU waste container must minimize frictional sparking</td>
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<tr>
<td></td>
<td>Safety Function: Reduce likelihood for ignition of flammables/combustibles or deflagration</td>
<td></td>
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</tr>
<tr>
<td>SMP Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<tr>
<td></td>
<td>Safety Function: Reduce likelihood of equipment malfunction</td>
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<tr>
<td>Mitigators</td>
<td>PSAC Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP Radiation Protection</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Chm: P;</td>
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<tr>
<td>Program</td>
<td>Safety Function: Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
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<tr>
<td>---------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td>Vent and purge activities are not conducted on unvented containers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
<td></td>
<td></td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>Waste Container Deflagration - Retrieval and Excavation (6e)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-2-004

**Description:**
Propane or other gas cylinder leaks gas near TRU waste leads to a deflagration impacting a TRU waste container resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment failure
- Flammable gases
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</thead>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
</tr>
<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood for ignition of flammables/combustibles</td>
</tr>
</tbody>
</table>

**Mitigators**
- None

**Notes:**
- None

**References:**
- None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)

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*CHA Report*  
*TA-54, Area G*  
*Los Alamos National Laboratory*  
*Basis for Interim Operation Rev. 3.0*  
*November 2014*
## Hazard Evaluation Table - Event BGTRUPIT-2-005

**Description:**
Unvented TRU waste containers that fall from the top 4 tiers are violently shaken resulting in multiple deflagrations with a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- Pit 9 - 384 PEC (Statistical 4 at 270 PEC and 76 at 1.50 PEC)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Equipment malfunction
- Mechanical failure
- Operator error
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<tr>
<td>W</td>
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<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
</tbody>
</table>

### Safety Function

- Reduces likelihood for load drops resulting in release of radiological material
- Reduce likelihood for container puncture, topple, and impacts
- Reduces likelihood of equipment malfunction
- Reduces likelihood for vehicle and equipment accidents
- Reduces the radiological consequences by limiting the MAR involved

---


12/17/2013
<table>
<thead>
<tr>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
<th>Rad: W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
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</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Retrieval and Excavation (6e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
### Hazard Evaluation Table - Event BGTRUPIT-2-006

**Description:**
Electrical discharge ignites flammable atmosphere in a TRU waste container causing a deflagration resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Flammable headspace
- Improper equipment use
- Lightning

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigating Frequency:**
- NC

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
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</tr>
</tbody>
</table>

**Preventive Features:**
- **Engineered:** None
- **Admin**
  - (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**
- **Engineered:** None
- **Admin**
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Non-Sparking Equipment/Process During Venting</td>
<td>Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles or deflagration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Retrieval and Excavation (6e)
- Lightning - Retrieval and Excavation (20e)
### Hazard Evaluation Table - Event BGTRUPIT-2-007

#### Description:
A deflagration occurs in TRU waste container that causes an additional sympathetic TRU waste container deflagration resulting in a release of radiological material.

#### Locations:
- Pit 9

#### MARs:
- 428 PEC (232 highest in Pit 9, 196 second highest)

#### Release Mechanisms:
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

#### Assumptions:
- A container with an internal flammable atmosphere will not deflagrate without an interaction with an external force (e.g., human or natural activity).
- Affects of a sympathetic drum deflagration is vertical.
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

#### Causes:
- Chemical reaction
- External heat source (sparks, fire, thermal radiation, solar, lightning)
- Flammable headspace
- Ignition source
- Incompatible chemicals
- Lightning
- Pyrophorics
- Shock sensitive material
- Static electricity
- Unvented Lid

#### Unmitigated System Effects:
- None

#### Methods of Detection:
- Observation

#### Unmitigated Frequency: BEU

#### Mitigated Frequency: BEU

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>W</td>
<td>H</td>
<td>III</td>
<td>H</td>
</tr>
</tbody>
</table>

#### Preventive Features:
- Engineered: None
- Admin: None

#### Mitigative Features:
- Engineered: None
- Admin: None

#### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

#### Preventers
- None

#### Mitigators
- None

#### Notes:
- None

#### References:
- None

#### DOE 5506 Detail:
- Multiple Waste Container Deflagration - Retrieval and Excavation (7e)
Hazard Evaluation Table - Event BGTRUPIT-2-008

**Description:**
TRU Waste container deflagrates when penetrated by drum dart or inadvertently breached resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

**Causes:**
- Chemical reaction
- Equipment malfunction
- Flammable headspace
- Mechanical failure
- Metal to metal contact
- Operator error
- Static electricity

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
<th>Rad</th>
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<tr>
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<td>L</td>
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</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Non-Sparking Equipment/Process During Venting (Equipment/ tool design controls and processes used to penetrate/ breach an unvented TRU waste container must minimize frictional sparking)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered**
- None

**Admin**
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized.
Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration.
A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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</table>
| Mitigators | PSAC | Drum Venting of Unvented TRU Waste Drums | The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized.
Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration. A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting. | Rad: P, C, W; Phy: W; |
<table>
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<tr>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Safety Function: Reduces radiological consequences due to exposure</th>
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<tr>
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<td>References:</td>
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<td>DOE 5506</td>
<td>Waste Container Deflagration - Venting and/or Abating/Purging (6c)</td>
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<tr>
<td>Detail:</td>
<td>Waste Container Deflagration - Retrieval and Excavation (6e)</td>
<td></td>
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</table>
### Hazard Evaluation Table - Event BGTRUPIT-2-009

**Description:**
External heating source causes flammable gas generation within a TRU waste container in coincidence with an ignition source resulting in a deflagration resulting in a release of radioisotopes.

**Locations:**
- Pit 9

**M ARs:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
- None

**Causes:**
- Characterization equipment heat sources
- Equipment malfunction
- Increased gas generation due to temperature increase
- Operator error
- Radiant heating
- Solar heating
- Unvented Lid

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

#### Consequence / Risk Rank

<table>
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<tr>
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<th>Phy</th>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- **Engineered**
  - None

**Admin**
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)

**Mitigative Features:**
- **Engineered**
  - None

**Admin**
- None

### Credited SSCs and ACs

<table>
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<tr>
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<tbody>
<tr>
<td><strong>Preventers</strong></td>
<td>PSAC</td>
<td>TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for deflagration</td>
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<tr>
<td><strong>SMP</strong></td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
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**Mitigators**
- None

**Notes:**
- None

**References:**
- None

**DOE 5506**
- Waste Container Deflagration - Retrieval and Excavation (6e)
### Hazard Evaluation Table - Event BGTRUPIT-2-010

**Description:**
Unvented TRU waste containers are punctured by equipment (e.g., forklift tines, backhoe) and deflagrate resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Flammable headspace
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>DSA Mit.</th>
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<tbody>
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<td>II</td>
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<tr>
<td>W</td>
<td>H</td>
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</tbody>
</table>

**Mitigated Frequency:**
EU

### Preventive Features:

**Engineered**
None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

**Preventers**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tbody>
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<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
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<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
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<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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</table>

**Mitigators**

<p>| PSAC  | Radiological Inventory Management - Defined Area MAR Control | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) | Rad: W; Phy: Pa |
| SMP   | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; Phy: Pa |</p>
<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduces radiological consequences due to exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td>● This event bounds the puncture of a single TRU waste container.</td>
</tr>
<tr>
<td></td>
<td>● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
</tr>
<tr>
<td>DOE 5506 Detail:</td>
<td>● Waste Container Deflagration - Retrieval and Excavation (6e)</td>
</tr>
</tbody>
</table>
## Hazard Evaluation Table - Event BGTRUPIT-2-011

### Description:
Flammable atmosphere develops during in-situ remediation activity in coincidence with an ignition source causing a deflagration resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

### Release Mechanisms:
- Deflagration external to container with subsequent fire
- Low energy impact

### Assumptions:
- FRP and cargo containers (Sealand) and other miscellaneous non-metal containers do not accumulate hydrogen or VOCs.

### Causes:
- Equipment malfunction
- Flammable gases
- Ignition source
- Operator error
- Static electricity

### Unmitigated System Effects:
No

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: EU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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</tr>
<tr>
<td>W</td>
<td>H II</td>
<td>M III</td>
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</tbody>
</table>

### Preventive Features:

#### Engineered
None

#### Admin
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

#### Engineered
None

#### Admin
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers PSAC Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
<td>All</td>
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<td>Safety Function:</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
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<tr>
<td>Mitigators SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for all receptors</td>
<td>Rad: W;</td>
<td></td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR released to all receptors</td>
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</table>

### Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
None

### DOE 5506 Detail:
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)
**Hazard Evaluation Table - Event BGTRUPIT-2-012**

**Description:**
Vehicle/equipment transporting multiple TRU waste containers ignites accumulated flammable gas and deflagrates affecting adjacent TRU waste resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Stack of 48 average drums at 1.5 PEC each)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Flammable gases
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

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<td>H</td>
<td>Phy</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**
- **Engineered** None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**
- **Engineered** None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<thead>
<tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Retrieval and Excavation (5e)

---


12/17/2013
Hazard Evaluation Table - Event BGTRUPIT-2-013

**Description:**
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts a TRU waste container causing it to deflagrate and resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Flammable atmosphere (volatile organic compounds –VOCs or hydrogen) in a container
- Gas cylinder degradation
- Gas cylinder mishandling
- Ignition source
- Improper storage of gas cylinder
- Vehicle accident

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
U

**Consequence / Risk Rank**

<table>
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<tr>
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<th>Chm</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**
Engineered

**Admin**
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (PSAC) TRU Waste Container Management - Isolate Unvented Containers (Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

**Mitigative Features:**
Engineered

**Admin**
- (PSAC) Doublepacking TRU Waste Drums with MAR > 200 PE-Ci During Trenches a-D Retrieval Activities (TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Acetylene Cylinders Control</td>
<td>The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSAC TRU Waste Container Management - Isolate Unvented Containers</td>
<td>Isolate unvented containers to prevent inadvertent interaction between personnel/ equipment handling and/ or performing activities in the vicinity of the unvented container</td>
<td>All</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces likelihood for deflagration</td>
<td></td>
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<tr>
<td>Mitigators</td>
<td>PSAC Doublepacking TRU Waste Drums with MAR &gt; 200 PE-Ci During Trenches a-D Retrieval Activities</td>
<td>TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D are doublepacked prior to retrieval of an additional TRU waste drum in the defined area.</td>
<td>Rad: P, C, W;</td>
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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.</td>
<td></td>
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<tr>
<td></td>
<td>PSAC Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Rad: W;</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for</td>
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<td>Safety Function</td>
<td>worker protection</td>
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<td>Notes</td>
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<td>References</td>
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<tr>
<td>DOE 5506</td>
<td>Waste Container Deflagration - Retrieval and Excavation (6e)</td>
<td></td>
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</tbody>
</table>

Reduces radiological consequences due to exposure
Hazard Evaluation Table - Event BGTRUPIT-2-025prev e-1

**Description:**
Reactive, incompatible, self-igniting materials in a TRU waste container are violently shaken during handling resulting in a fire within the container resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Crane drops load (container, canister, load)
- Equipment malfunction
- High wind
- Improper container placement or handling
- Operator error
- Seismic event
- Shock sensitive material
- Violent shaking

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
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<th>Receptor</th>
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</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation</td>
<td>Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
<tr>
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</table>

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- DOE 5506

**Detail:**
- Small Fire - Retrieval and Excavation (2e)
- High Wind - Retrieval and Excavation (21e)
- Seismic Event with Fire - Retrieval and Excavation (25e)
Hazard Evaluation Table - Event BGTRUPIT-2-026prev e-1

Description:
During miscellaneous venting activities (e.g., vent replacement, lid replacement) a TRU waste container venting flammable gas is ignited resulting in a release of radiological material.

Locations:
- Pit 9

MARs:
- 278 PEC (One [1] Pit 9 waste container in activity with 20% margin)

Release Mechanisms:
- Fire

Assumptions:
None

Causes:
- Flammable headspace
- Hot Work
- Ignition source
- Improper installation of filter/ vent
- Lightning
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: U

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<td>L</td>
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</tbody>
</table>

Preventive Features:

Engineered: None

Admin:
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

Mitigative Features:

Engineered: (SS) Waste Packaging Control (Waste is packaged)

Admin:
- (PSAC) Drum Venting of Unvented TRU Waste Drums (The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized.
  Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration
  A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Radiation Protection Program - Contamination Controlled Environment (Venting of unvented drums will be performed within a contamination-controlled environment in accordance with Radiation Protection contamination control requirements.)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
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<th>Attribute</th>
<th>Affected Receptors</th>
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<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
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<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>The venting process used to penetrate the drum is conducted so that the potential for sparks is minimized. Lid restraints, doublepack, a blast-confining device, or other blast-mitigation device shall be designed to prevent lid ejection due to a deflagration A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce physical consequences to workers due to injury resulting from deflagration when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration when venting is required. Reduce radiological consequences to all receptors resulting from deflagration during drum venting.</td>
<td></td>
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<table>
<thead>
<tr>
<th>PSAC</th>
<th>Radiological Inventory Management - TRU Waste Drum Doublepack</th>
<th>Doublepack radiological waste drums &gt; 200 PEC</th>
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<tr>
<td>Safety Function:</td>
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<td>Rad: P, C, W;</td>
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<table>
<thead>
<tr>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Evaluates radiological conditions and processes for worker protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Rad: W;</td>
</tr>
</tbody>
</table>

Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References:
- None

DOE 5506
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Retrieval and Excavation (2e)
### Hazard Evaluation Table - Event BGTRUPIT-2-027

**Description:**
A single unvented TRU waste container from Pit 9 is violently shaken during drum washing causing a deflagration resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 278 PEC (One [1] Pit 9 waste container in activity with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Container toppled (human or equipment error)
- Drop
- Flammable headspace
- Incompatible chemicals
- Mechanical failure
- Operator error
- Pyrophorics
- Shock sensitive material

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>Phy</th>
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<td>II</td>
<td>L</td>
<td>III</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
<td>III</td>
</tr>
</tbody>
</table>

**Consequence / Risk Rank**

**Preventive Features:**

- Engineered: None
- Admin: None

**Mitigative Features:**

- Engineered: None
- Admin: (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- Admin: (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

**Preventers:** None

**Mitigators:**

- PSAC: Radiological Inventory Management - TRU Waste Drum Doublepack
  - Doublepack radiological waste drums ≥ 200 PEC
  - Safety Function: Reduce radiological consequences by limiting amount of MAR involved

- PSAC: TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation
  - Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker
  - Safety Function: Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion

- SMP: Radiation Protection Program
  - Evaluates radiological conditions and processes for worker protection
  - Safety Function: Reduces radiological consequences due to exposure

**Notes:** None

**References:** None

- DOE 5506
- Detail: Waste Container Deflagration - Container Handling (6b)
- Detail: Waste Container Deflagration - Type B Container Loading/Unloading (6g)

Chapter 3: Hazard and Accident Analysis
Appendix 3H

| Description: |
| A vehicle/equipment traveling at ≤ 10 mph impacts TRU waste containers (drums) from Pit 9 resulting in a release of radiological material. |
| Locations: |
| Pit 9 |
| MARs: |
| 336 PEC (Pit 9 Statistical MAR of 48 drums) |
| Release Mechanisms: |
| Low energy impact |
| Assumptions: |
| None |
| Causes: |
| Disposal pit configuration (entrance grade, uneven surface) |
| Equipment malfunction |
| Improper equipment use |
| Inclement weather |
| Operator error |
| Vehicle accident |
| Vehicle/equipment mechanical failure (e.g., steering, brakes) |
| Unmitigated System Effects: |
| None |
| Methods of Detection: |
| Observation |
| Unmitigated Frequency: A |
| Mitigated Frequency: A |
| Consequence / Risk Rank |
| Receptor | Rad | Chm | Phy |
| Unmit. | DSA Mit. | Unmit. | DSA Mit. | Unmit. | DSA Mit. |
| P | L | III | L | III |
| C | L | III | L | III |
| W | M | II | L | III |
| Preventive Features: |
| Engineered: None |
| Admin: None |
| Mitigative Features: |
| Engineered: None |
| Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection) |
| Credited SSCs and ACs |
| Class | Control | Attribute | Affected Receptors |
| Preventers: None |
| Mitigators: |
| SMP: Radiation Protection Program | Evaluates radiological conditions and processes for worker protection |
| Safety Function: | Reduces radiological consequences due to exposure |
| Notes: None |
| References: None |
| DOE 5506 Detail: |
| Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e) |
### Hazard Evaluation Table - Event BGTRUPIT-3-002

**Description:**
A vehicle traveling < 10 mph impacts TRU waste containers (FRPs) from Pit 9 resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 353 PEC (1 FRP at 350 PEC and 3 at 1 PEC)

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

<table>
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<tr>
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<td>C</td>
<td>M</td>
<td>II L III</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I L III</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered:** None

- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered:** None

- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td>Safety Function</td>
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<td></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
</tr>
<tr>
<td>Safety Function</td>
<td></td>
<td></td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td></td>
<td></td>
<td>Reduces radiological consequences due to exposure</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td></td>
<td></td>
<td>Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles</td>
</tr>
</tbody>
</table>

**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- None

**DOE 5506**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUPIT-3-003

Description:
A vehicle/ equipment traveling at > 10 and < 35 mph impacts TRU waste containers from Pit 9 results in a release of radiological material.

Locations:
- Pit 9

MARS:
- 336 PEC (Pit 9 Statistical MAR of 48 drums)

Release Mechanisms:
- Loss of Confinement
- Moderate energy impact
- Spill

Assumptions:
None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
- Loss of Containment
- Moderate energy impact
- Spill

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: A

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

Preventive Features:
Engineered None
Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:
Engineered None
Admin
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
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<tbody>
<tr>
<td>Preventers SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
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</table>

Mitigators SMP
- Emergency Preparedness Program
  - The program relies on adverse conditions being recognized by workers and reported
  - Safety Function: Reduce the consequences of an accident for the worker and collocated worker.
- Radiation Protection Program
  - Evaluates radiological conditions and processes for worker protection
  - Safety Function: Reduces radiological consequences due to exposure
- Training and Qualification Program - Hazards Recognition
  - Personnel trained to recognize specific job hazards and associated controls
  - Safety Function: Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles

Notes:
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None
DOE 5506
Detail:
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUPIT-3-004

**Description:**
A vehicle/ equipment traveling at > 10 mph and ≤ 35 mph impacts TRU waste containers from Pit 9 being transported results in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Loss of Confinement
- Moderate energy impact
- Spill

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** A

<table>
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<td>H</td>
<td>I</td>
<td>L</td>
<td>III</td>
</tr>
</tbody>
</table>

**Preventive Features:**

Engineered None

Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

Engineered None

Admin
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

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<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
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<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
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<td>Safety Function:</td>
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<tr>
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<td></td>
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**Notes:**
None

**References:**
None

**DOE 5506**

**Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUPIT-3-005

**Description:**
TRU waste container (drum) from Pit 9 falls from >12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Drop
- Equipment malfunction
- High wind
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
EU

### Consequence / Risk Rank

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<th>Receptor</th>
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<th>Phy</th>
</tr>
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<tr>
<td>C</td>
<td>M</td>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be >12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
- None

**Admin**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt;12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>SMP</th>
<th>Radiation Protection Program</th>
<th>Reduces radiological consequences due to exposure</th>
</tr>
</thead>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction
may be given based on the robustness of the programs and the individual elements

<table>
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<tr>
<th>References:</th>
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<tr>
<td>DOE 5506</td>
<td>Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
</tr>
<tr>
<td>Detail:</td>
<td>High Wind - Retrieval and Excavation (21e)</td>
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</table>
**Hazard Evaluation Table - Event BGTRUPIT-3-006**

**Description:**
Multiple TRU waste containers in Pit 9 fall from > 12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container toppled (human or equipment error)
- Disposal pit configuration (entrance grade, uneven surface)
- High wind
- Improper container placement or handling
- Inclement weather
- Mechanical failure
- Operator error
- Seismic event
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U  
**Mitigated Frequency:** EU

### Consequence / Risk Rank

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<thead>
<tr>
<th>Receptor</th>
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<tr>
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<td>Unmit.</td>
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<tr>
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**Preventive Features:**

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<th>PSAC Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))</th>
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<td></td>
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**Mitigative Features:**

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<th>SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)</th>
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**Credited SSCs and ACs**

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<td>SMP Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>SMP Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>Reduce likelihood for vehicle and equipment accidents</td>
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<tr>
<td>Mitigators</td>
<td>SMP Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W; Phy: C; Chm: E</td>
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<tr>
<td></td>
<td>Safety Function: Reduces radiological consequences due to exposure</td>
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</table>

**Notes:**
The event is considered unlikely due to the stair step retrieval operation

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- High Wind - Retrieval and Excavation (21e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
# Hazard Evaluation Table - Event BGTRUPIT-3-007

**Description:**
FRP container in Pit 9 falls from >12 feet and breaches resulting in a release of radiological material.

**Locations:**
- Pit 9
  - MARs: 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
Observation

**Unmitigated Frequency:** A

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<th>Phy</th>
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**Consequence / Risk Rank**
- Unmit.
- DSA Mlt.
- Unmit.
- DSA Mlt.

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<td>W</td>
<td>H</td>
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**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - FRPs with MAR > 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci)
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
None

**Admin**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

DOE 5506
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)

---


12/17/2013
Hazard Evaluation Table - Event BGTRUPIT-3-008

Description:
Forklift punctures two (2) TRU waste containers in Pit 9 resulting in a release of radiological material.

Locations:
- Pit 9

MARS:
- 196 PEC (One [1] PIT 9 waste container: 2nd highest)
- 232 PEC (One [1] PIT 9 waste container)

Release Mechanisms:
- Impact and spill
- Loss of Confinement

Assumptions:
None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Forklift tines
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: A

Consequence / Risk Rank

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<tr>
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Preventive Features:

Engineered

Admin
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

Mitigative Features:

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

Credited SSCs and ACs

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12/17/2013
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<th>Safety Function:</th>
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<td>Safety Function:</td>
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<td></td>
</tr>
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</table>

Notes: ● This event bounds the puncture of a single TRU waste container.

References: None

DOE 5506

Detail: ● Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
## Hazard Evaluation Table - Event BGTRUPIT-3-009

**Description:**
Multiple TRU waste containers from Pit 9 are breached/ crushed resulting in a release of radiological material.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Collapse of retrieval/ excavation site
- Crane drops load (container, canister, load)
- Crane topples
- Drop
- Equipment malfunction
- High wind
- Mechanical failure
- Operator error
- Seismic event
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
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<th>Chm</th>
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**Mitigated Frequency:** EU

**Preventive Features:**

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**Mitigative Features:**

| Admin | (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection) |

### Credited SSCs and ACs

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**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
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### Preventive Features:

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Admin**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<tr>
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### Notes:
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
- None

### DOE 5506
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
- Collapse of Stacked Containers - Retrieval and Excavation (11e)
# Hazard Evaluation Table - Event BGTRUPIT-3-011

**Description:**
Vehicle transporting multiple Pit 9 TRU waste containers at ≤ 10 mph impacts TRU waste containers resulting in a release of radiological material.

**Locations:**
- **Pit 9**

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Statistical MAR of 48 drums in staging at 1.5 PEC per container: excluding 4 high MAR)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
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**Preventive Features:**

- **Engineered None**
- **Admin**
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

- **Engineered None**
- **Admin**
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
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**Credited SSCs and ACs**

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**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

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Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-568

http://sb-apps/insight/rpt_0after'sport_portrait.php?ea=&et=

12/17/2013
| Detail: | Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e) |
### Hazard Evaluation Table - Event BGTRUPIT-3-012

**Description:**
Pit 9 waste face collapses resulting in a release of radiological material.

**Locations:**
Pit 9

**MARS:**
- 564 PEC (Pit 9 200 Statistical waste face containers including high MAR)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Container degradation
- Disposal pit configuration (entrance grade, uneven surface)
- Flooding
- Heavy snow/ice loading
- High wind
- Improper container placement or handling
- Seismic event
- Vehicle impact

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
U

**Mitigated Frequency:**
U

#### Consequence / Risk Rank

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<tr>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

#### Credited SSCs and ACs

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<td>SMP Emergency Preparedness Program</td>
<td>Reduce the consequences of an accident for the worker and collocated worker.</td>
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<td>SMP Radiation Protection Program</td>
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<td>SMP Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Rad: P, C, W;</td>
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**Safety Function:**
- Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles

**Notes:**
None

**References:**
- None
- DOE 5506

**Detail:**
- Collapse of Stacked Containers - Retrieval and Excavation (11e)
- High Wind - Retrieval and Excavation (21e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
### Description:
Vehicle transporting multiple Pit 9 TRU waste containers > 10 and ≤ 35 mph impacts Pit 9 TRU waste resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)
- 72 PEC (Pit 9 Statistical MAR of 48 drums in staging at 1.5 PEC per container: excluding 4 high MAR)

### Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
A

### Mitigated Frequency:
A

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### Preventive Features:
- **Engineered**: None
  - (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
  - (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
- **Engineered**: None
  - (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
  - (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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### Notes:
None

### References:
None

### DOE 5506 Detail:
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUPIT-3-014

#### Description:
Vehicle impacts a Pit 9 remediation activity at ≤ 10 mph resulting in a release of radiological material.

#### Locations:
- **Pit 9**
- **MARS:** 278 PEC (One [1] Pit 9 waste container in activity with 20% margin)

#### Release Mechanisms:
- Impact and spill
- Low energy impact

#### Assumptions:
None

#### Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

#### Unmitigated System Effects:
None

#### Methods of Detection:
- Observation

#### Unmitigated Frequency: A

#### Mitigated Frequency: A

### Consequence / Risk Rank

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#### Preventive Features:
- **Engineered:** None
- **Admin:** None

#### Mitigative Features:
- **Engineered:** None
- **Admin:** (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

#### Credited SSCs and ACs

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#### Notes:
None

#### References:
None

#### DOE 5506
Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUPIT-3-015

**Description:**
Worker handling a Pit 9 TRU waste container inadvertently tips the container over causing impact with the ground resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container in transport with 20% margin)

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Improper container placement or handling
- Improperly installed closure ring
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A  
**Mitigated Frequency:** A

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**Preventive Features:**
- None

Admin
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.)

**Mitigative Features:**
- None

Admin
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)


12/17/2013
## Hazard Evaluation Table - Event BGTRUPIT-3-016

### Description:
Mobile crane (manlift, boomed vehicle) topples with a load into Pit 9 TRU waste containers causing a breach resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 106 PEC (Pit 9 Statistical MAR of 48 drums excluding high MAR)
- 232 PEC (One [1] PIT 9 waste container in transport)

### Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Crane topples
- Equipment capacity exceeded
- High wind
- Improper equipment use
- Inclement weather
- Mechanical failure
- Operator error
- Seismic event

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- A

### Mitigated Frequency:
- EU

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### Consequence / Risk Rank

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### Preventive Features:

| Admin     | PSAC Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
| Admin     | PSAC Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
| Admin     | SMP Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
| Admin     | SMP Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
| Admin     | DID Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

| Admin     | SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
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<td>Safety Function:</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
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<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
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<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<td>Safety Function:</td>
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</table>
**Safety Function:** Reduces radiological consequences due to exposure

| Notes: | When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| References: | None |
| Detail: | DOE 5506 |
| | Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e) |
| | Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e) |
| | High Wind - Retrieval and Excavation (21e) |
| | Seismic Event (Impact Only) - Retrieval and Excavation (24e) |
## Hazard Evaluation Table - Event BGTRUPIT-3-017

**Description:**
Vehicle impacts a Pit 9 remediation activity at > 10 mph and < 35 mph resulting in a release of radiological material.

**Locations:**
- Pit 9
  - MARs: 278 PEC (One [1] Pit 9 waste container in transport with 20% margin)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** EU

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**Preventive Features:**

**Engineered**
None

**Admin**
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
None

**Admin**
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

**Credited SSCs and ACs**

**Preventers**

- **SMP**
  - **Safety Function:** Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)
  - **Control:** Maintenance Program - Vehicle/Equipment
  - **Attribute:** Reduce likelihood of equipment malfunction
  - **Affected Receptors:** All

- **SMP**
  - **Safety Function:** Personnel maintain applicable LANL qualifications for vehicle and equipment operation
  - **Control:** Training and Qualification Program - Qualifications
  - **Attribute:** Reduce likelihood for vehicle and equipment accidents
  - **Affected Receptors:** All

**Mitigators**

- **SMP**
  - **Safety Function:** Evaluates radiological conditions and processes for all receptors
  - **Control:** Radiation Protection Program
  - **Attribute:** Rad: P, C, W

**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
Hazard Evaluation Table - Event BGTRUPIT-3-018

Description:
Large crane drops Pit 9 TRU waste container from >12 feet onto TRU waste in Pit 9 resulting in a release of radiological material.

Locations:
- Pit 9

MARs:
- 106 PEC (Pit 9 Statistical MAR of 48 drums excluding high MAR)
- 232 PEC (One [1] PIT 9 waste container in transport)

Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

Assumptions:
None

Causes:
- Crane drops load (container, canister, load)
- Equipment failure
- High wind
- Mechanical failure
- Operator error
- Securing devices fail

Unmitigated System Effects:
None

Methods of Detection:
Observation

Unmitigated Frequency: A
Mitigated Frequency: EU

Consequence / Risk Rank

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Preventive Features:

Engineered None

Admin:
- (PSAC) Elevated Waste Movements and Critical Lifts - FRPs with MAR > 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci)
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

Mitigative Features:

Engineered None

Admin:

Credited SSCs and ACs

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<td>A critical lift plan will be used for planned crane lifts of FRPs with MAR &gt; 150 PE-Ci</td>
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<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
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<tr>
<td>Safety Function:</td>
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<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
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<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Safety Function:</td>
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<td>Reduces likelihood for vehicle and equipment accidents</td>
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Mitigators None

Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOD 5506

Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
## Hazard Evaluation Table - Event BGTRUPIT-3-019

### Description:
Handling equipment used (e.g., gantry crane, manlift, scaffolding) for Pit 9 remediation activity fails and results in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

### Release Mechanisms:
- Impact and spill
- Low energy impact

### Assumptions:
None

### Causes:
- Crane drops load (container, canister, load)
- Equipment capacity exceeded
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Improperly maintained equipment
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Consequence / Risk Rank

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### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - FRPs with MAR > 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci)
- (PSAC) Elevated waste movements and critical lifts - Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

### Mitigative Features:

**Engineered**
- None

**Admin**
- None

### Credited SSCs and ACs

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### Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
- None

### DOE 5506 Detail:
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUPIT-3-020

**Description:**
Pit 9 TRU waste containers are breached by excavation equipment resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 196 PEC (One [1] PIT 9 waste container; 2nd highest)
- 232 PEC (One [1] PIT 9 waste container)

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Container degradation
- Equipment malfunction
- Improper equipment use
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

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**Preventive Features:**
- None

**Mitigative Features:**
- None

**Credited SSCs and ACs**

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**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)
### Hazard Evaluation Table - Event BGTRUPIT-3-021

**Description:**
Compressed gas cylinder falls and causes the valve to break. The cylinder is propelled by the release of compressed gas creating a missile that impacts Pit 9 TRU waste resulting in the collapse of waste face. The impacted and collapsed containers are breached resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARs:**
- 564 PEC (Pit 9 200 Statistical waste face containers including high MAR)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Gas cylinder mishandling
- Improper storage of gas cylinder
- Inadequate gas cylinder restraint
- Operator error
- Securing devices fail

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** U

#### Consequence / Risk Rank

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**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Acetylene Cylinders Control (The storage or use of acetylene cylinders is prohibited inside or within 50-feet of defined areas where MAR is present.)
- (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)
- (SMP) Maintenance Program - Vehicle / Equipment (Periodic inspection and maintenance of LANL vehicles / equipment (forklift, manlift))

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

**Credited SSCs and ACs**

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<td>Reduces likelihood of an accident involving a flammable compressed gas cylinder explosion impacting TRU waste</td>
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**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
- DOE 5506
- Vehicle / Equipment Impacts Waste / Waste Containers - Retrieval and Excavation (9e)
| Detail | Collapse of Stacked Containers - Retrieval and Excavation (11e) |
### Hazard Evaluation Table - Event BGTRUPIT-3-022

**Description:**
A pressurized Pit 9 TRU waste container inadvertently breaches resulting in a release of radiological material.

**Locations:**
- Pit 9
- MARs: 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Pressurized venting

**Assumptions:**
None

**Causes:**
- Buildup of gas/pressure inside container
- Container mishandling
- Container unvented or inadequately vented allowing the accumulation of internal pressure
- Incompatible chemicals
- Operator error
- Radiolysis/ hydrolysis in container
- Seal failure
- Thermal expansion of material/ gases

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- A

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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**Safety Function:**
- Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
None

**Detail:**
- Waste Container Over-Pressurization - Retrieval and Excavation (12e)
### Hazard Evaluation Table - Event BGTRUPIT-3-023

**Description:**
Pressurized gas disperses uncontained Pit 9 TRU waste during remediation activity resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- Contamination

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
- None

**Causes:**
- Equipment malfunction
- Improper maintenance
- Improperly maintained equipment
- Maintenance activities
- Operator error

**Unmitigated System Effects:**
- None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Consequence / Risk Rank**

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

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**Credited SSCs and ACs**

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**Notes:**
- None

**References:**
- None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- Waste Container Over-Pressurization - Retrieval and Excavation (12e)
## Hazard Evaluation Table - Event BGTRUPIT-3-024

**Description:**
Pit 9 TRU waste container retrieved is degraded resulting in release of radiological contamination.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Corrosion
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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### Preventive Features:
- **Engineered** None
- **Admin** None

### Mitigative Features:
- **Engineered** None
- **Admin** (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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### Notes:
None

### References:
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUPIT-3-025

**Description:**
Prohibited item in Pit 9 TRU waste container is punctured during remediation activity resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- Contamination

**Release Mechanisms:**
- Pressurized venting
- Spill

**Assumptions:**
None

**Causes:**
- Equipment failure
- Leaks/ drips
- Operator error
- Pressurized canister punctured or inadvertently opened

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** A

#### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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**Details:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- Waste Container Over-Pressurization - Retrieval and Excavation (12e)
## Hazard Evaluation Table - Event BGTRUPIT-3-026

### Description:
TRU waste handling equipment (e.g., parrot beak, drum grabber) damages Pit 9 container resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

### Release Mechanisms:
- Loss of Confinement
- Low energy impact
- Spill

### Assumptions:
None

### Causes:
- Container degradation
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Operator error
- Securing devices fail

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
A

### Mitigated Frequency:
U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
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<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

### Mitigative Features:

**Engineered**
- None

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)

### Credited SSCs and ACs

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<tr>
<td></td>
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<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
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<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Reduce the consequences of an accident for the worker and colocated worker.</td>
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<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
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<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
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</table>
|       | Safety Function: | Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and...
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<tr>
<td><strong>DOE 5506 Details:</strong></td>
</tr>
<tr>
<td>• Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BGRUPIT-3-027

**Description:**
Worker replacing or installing a TRU waste container object (e.g., lid, drum dart, lid ring) in Pit 9 results in a release of radiological contamination.

**Locations:**
- Pit 9

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Improper installation of filter/vent
- Improper maintenance
- Maintenance activities
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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<tr>
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<td>M</td>
<td>II</td>
<td>L</td>
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</tbody>
</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: 
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
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<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
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</table>

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
**Hazard Evaluation Table - Event BGTRUPIT-3-028**

**Description:**
Free liquids leak during Pit 9 remediation activities result in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Spill

**Assumptions:**
None

**Causes:**
- Accumulation of liquid
- Equipment failure or operator failure (pump seals, hose not connected properly, etc.)
- Flooding
- Leaks/drips

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

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**Consequence / Risk Rank**

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<td>II</td>
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</tbody>
</table>

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**Preventive Features:**

- Engineered: None
- Admin: None

**Mitigative Features:**

- Engineered: None
- Admin: (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

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**Credited SSCs and ACs**

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<td>SMP</td>
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<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W; Safety Function: Reduces radiological consequences due to exposure</td>
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</table>

**Notes:** None

**References:** None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Waste Repackaging (10f)

---

## Hazard Evaluation Table - Event BGTRUPIT-3-029

**Description:**
Pit 9 TRU waste container (non-drum) collapses resulting in the release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Loss of Confinement

**Assumptions:**
None

**Causes:**
- Container degradation
- Disposal pit configuration (entrance grade, uneven surface)
- Heavy snow/ice loading
- Improper container placement or handling
- Seismic event
- Uneven floor/base surface

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

### Consequence / Risk Rank

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<tr>
<td>W</td>
<td>M</td>
<td>II</td>
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</tr>
</tbody>
</table>

**Preventive Features:**

- **Engineered**
- None

- **Admin**
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

- **Engineered**
- None

- **Admin**
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

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<td>Radiation Protection Program</td>
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<tr>
<td></td>
<td>Safety Function:</td>
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**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
- Collapse of Stacked Containers - Retrieval and Excavation (11e)
- Snow/ice/Volcanic Ash Build-up - Retrieval and Excavation (23e)
- Seismic Event (Impact Only) - Retrieval and Excavation (24e)
## Hazard Evaluation Table - Event BGTRUPIT-3-030

### Description:
A vehicle/equipment traveling at \( \leq 10 \) mph impacts Pit 9 TRU waste containers (drums) being transported resulting in a release of radiological material.

### Locations:
- Pit 9

### MARs:
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

### Release Mechanisms:
- Loss of Confinement
- Low energy impact

### Assumptions:
None

### Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A

### Mitigated Frequency: A

### Consequence / Risk Rank

<table>
<thead>
<tr>
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</table>

### Preventive Features:
- None

#### Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
- None

#### Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<td>Safety Function: Reduce likelihood of equipment malfunction</td>
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| Mitigators | PSAC | Radiological Inventory Management - Defined Area MAR Control | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) | • Rad: P, C, W; |
|            |      | Safety Function: Reduces the radiological consequences by limiting the MAR involved |      |

| SMP | Emergency Preparedness Program | The program relies on adverse conditions being recognized by workers and reported | • Rad: P, C, W; |
|     | Safety Function: Reduce the consequences of an accident for the worker and collocated worker |     |

| SMP | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | • Rad: W; |
|     | Safety Function: Reduces radiological consequences due to exposure |     |

<p>| SMP | Training and Qualification Program - Hazards Recognition | Personnel trained to recognize specific job hazards and associated controls | • Rad: P, C, W; |
|     | Safety Function: Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/combustibles |     |</p>
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<td>DOE 5506 Detail:</td>
<td>● Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
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</tbody>
</table>
### Hazard Evaluation Table - Event BGTRUPIT-3-031

**Description:**
A vehicle traveling ≤ 10 mph impacts Pit 9 TRU waste containers (FRPs) being transported resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 353 PEC (1 FRP at 350 PEC and 3 at 1 PEC)

**Release Mechanisms:**
- Low energy impact

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

#### Consequence / Risk Rank

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<tr>
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<td>W</td>
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<td>I</td>
<td>L III</td>
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</table>

**Preventive Features:**

**Engineered:** None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered:** None

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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</table>

**Safety Function:**
- Reduce likelihood of equipment malfunction


**Safety Function:**
- Reduces the radiological consequences by limiting the MAR involved

| SMP | Emergency Preparedness Program | The program relies on adverse conditions being recognized by workers and reported | Rad: P, C, W; |

**Safety Function:**
- Reduce the consequences of an accident for the worker and colocated worker.

| SMP | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | Rad: W; |

**Safety Function:**
- Reduces radiological consequences due to exposure

| SMP | Training and Qualification Program - Hazards Recognition | Personnel trained to recognize specific job hazards and associated controls | Rad: P, C, W; |

**Safety Function:**
- Reduce likelihood and/ or consequence for job hazard related accidents including those related to building/facility operations, process operations and ignition of flammables/ combustibles

**Notes:**
- When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of...
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<td>Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
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</table>

Reduction may be given based on the robustness of the programs and the individual elements.
Hazard Evaluation Table - Event BGTRUPIT-3-032

Description:
A vehicle/ equipment traveling at > 10 and < 35 mph impacts Pit 9 TRU waste containers (FRPs) being transported results in a release of radiological material.

Locations:
- Pit 9

MARS:
- 353 PEC (1 FRP at 350 PEC and 3 at 1 PEC)

Release Mechanisms:
- Loss of Confinement
- Moderate energy impact
- Spill

Assumptions:
None

Causes:
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

Methods of Detection:
- Observation

Unmitigated Frequency: A

Mitigated Frequency: A

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Preventive Features:

Admin
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<td>Safety Function: Reduce likelihood of equipment malfunction</td>
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Mitigators PSAC Radiological Inventory Management - Defined Area MAR Control

| Safety Function: Reduces the radiological consequences by limiting the MAR involved |

SMP Emergency Preparedness Program

| Safety Function: Reduce the consequences of an accident for the worker and collocated worker. |
| Safety Function: Evaluates radiological conditions and processes for worker protection |
| Safety Function: Reduces radiological consequences due to exposure |

SMP Training and Qualification Program - Hazards Recognition

<p>| Safety Function: Personnel trained to recognize specific job hazards and associated controls |
| Safety Function: Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and |</p>
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<tr>
<td>● When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
</tr>
<tr>
<td>References:</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>DOE 5506</td>
</tr>
<tr>
<td>Detail:</td>
</tr>
<tr>
<td>● Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
</tr>
</tbody>
</table>
# Hazard Evaluation Table - Event BGTRUPIT-3-033

**Description:**
A vehicle/equipment traveling at > 10 and < 35 mph impacts multiple Pit 9 TRU waste containers (drums) being transported results in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Disposal pit configuration (entrance grade, uneven surface)
- Equipment malfunction
- Improper equipment use
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A
**Mitigated Frequency:** A

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
</tr>
</tbody>
</table>

**Preventive Features:**

- **Engineered** None

#### Admin
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

- **Engineered** None

#### Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Emergency Preparedness Program (The program relies on adverse conditions being recognized by workers and reported)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (SMP) Training and Qualification Program - Hazards Recognition (Personnel trained to recognize specific job hazards and associated controls)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

---

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Emergency Preparedness Program</td>
<td>The program relies on adverse conditions being recognized by workers and reported</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce the consequences of an accident for the worker and collocated worker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Hazards Recognition</td>
<td>Personnel trained to recognize specific job hazards and associated controls</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce likelihood and/or consequence for job hazard related accidents including those related to building/facility operations, process operations and...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignition of flammables/combustibles</td>
<td>Notes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td><strong>When Emergency Preparedness Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Hazard Evaluation Table - Event BGTRUPIT-3-034

## Description:
During Pit 9 FRP loading operation, the crane drops the container resulting in a release of radiological material.

<table>
<thead>
<tr>
<th>Locations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit 9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>310 PEC non-metal container</td>
</tr>
</tbody>
</table>

## Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

## Assumptions:
None

## Causes:
- Equipment failure
- Mechanical failure
- Operator error
- Vehicle accident

## Unmitigated System Effects:
None

## Methods of Detection:
- Observation

## Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
<tr>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
<td>DSA Mit.</td>
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<tr>
<td>P</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>L</td>
<td>III</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

## Preventive Features:

<table>
<thead>
<tr>
<th>Admin</th>
<th>Engineered None</th>
</tr>
</thead>
</table>

- (PSAC) Elevated Waste Movements and Critical Lifts - FRPs with MAR > 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci)
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

## Mitigative Features:

<table>
<thead>
<tr>
<th>Admin</th>
<th>Engineered None</th>
</tr>
</thead>
</table>

- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

## Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - FRPs with MAR &gt; 150 PE-Ci</td>
<td>A critical lift plan will be used for planned crane lifts of FRPs with MAR &gt; 150 PE-Ci</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

## References:
- DOE 5506

## Detail:

- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)

---

**Chapter 3: Hazard and Accident Analysis**

**Appendix 3H**

**3H-599**
## Hazard Evaluation Table - Event BGTRUPIT-3-035

### Description:
During Pit 9 FRP loading operation, the crane drops the FRP in movement onto another FRP resulting in release of radiological material.

### Locations:
- Pit 9

### MARs:
- 196 PEC (One [1] PIT 9 waste container: 2nd highest)
- 310 PEC non-metal container

### Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Crane topples
- Equipment malfunction
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

### Frequency:
- Unmitigated: A
- Mitigated: EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
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<td>II</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

| Admin  | (PSAC) Elevated Waste Movements and Critical Lifts - FRPs with MAR > 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR > 150 PE-Ci)  
|        | (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers)  
|        | (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))  
|        | (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)  
|        | (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc)) |

### Mitigative Features:

| Admin  | (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection) |

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts - FRPs with MAR &gt; 150 PE-Ci</td>
<td>A critical lift plan will be used for planned crane lifts of FRPs with MAR &gt; 150 PE-Ci</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
</tr>
</tbody>
</table>

### Safety Function:

- Reduce likelihood for load drops resulting in release of radiological material
- Reduce likelihood for container puncture, topple, and impacts
- Reduce likelihood of equipment malfunction
- Reduces likelihood for vehicle and equipment accidents
- Reduces radiological consequences due to exposure

### Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
- None

### DOE 5506
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
Hazard Evaluation Table - Event BGTRUPIT-3-036

Description:
A Pit 9 FRP is dropped from the crane during movement onto 4 TRU waste containers (drums) in Pit 9, resulting in release of radiological material.

Locations:
- Pit 9

MARS:
- 310 PEC non-metal container
- 40 PEC (Pit 9 Statistical 4 containers excluding high MAR)

Release Mechanisms:
- Impact and spill
- Loss of Confinement
- Moderate energy impact

Assumptions:
None

Causes:
- Equipment failure
- Mechanical failure
- Operator error
- Vehicle accident

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: EU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

<table>
<thead>
<tr>
<th>Class Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Elevated Waste Movements and Critical Lifts -- FRPs with MAR &gt; 150 PE-Ci (A critical lift plan will be used for planned crane lifts of FRPs with MAR &gt; 150 PE-Ci)</td>
</tr>
</tbody>
</table>

Safety Function: Reduce likelihood for load drops resulting in release of radiological material

| Preventers     | PSAC      | Elevated waste movements and critical lifts -- Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste containers) | All |

Safety Function: Reduce likelihood for container puncture, topple, and impacts

| SMP            | Maintenance Program - Vehicle/ Equipment | Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift) | All |

Safety Function: Reduce likelihood of equipment malfunction

| SMP            | Training and Qualification Program - Qualifications | Personnel maintain applicable LANL qualifications for vehicle and equipment operation | All |

Mitigative Features:

| SMP            | Radiation Protection Program | Evaluates radiological conditions and processes for worker protection | ● Rad: W; |

Safety Function: Reduces radiological consequences due to exposure

Notes:
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References:
None

DOE 5506

Detail:
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUPIT-3-037

**Description:**
During unvented drum handling activities with a crane, the crane drops the container onto 4 TRU containers (drums) in Pit 9 resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 232 PEC (One [1] PIT 9 waste container in transport)
- 40 PEC (Pit 9 Statistical 4 containers excluding high MAR)

**Release Mechanisms:**
- Loss of Confinement
- Low energy impact

**Assumptions:**
None

**Causes:**
- Container mishandling
- Crane drops load (container, canister, load)
- Equipment malfunction
- Improper container placement or handling
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>P</td>
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<td>L</td>
<td>IV</td>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>L</td>
<td>IV</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
<td>III</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste container)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered**
- None

**Admin**
- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Elevated Waste Movements and Critical Lifts - critical lifts</td>
<td>A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be &gt; 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
<td></td>
</tr>
<tr>
<td>PSAC Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated (greater than 4 to less than or equal to 12 feet) placement/ removal (stacking/ unstacking, loading/ unloading) of TRU waste container</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
<td></td>
</tr>
<tr>
<td>SMP Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
</tr>
<tr>
<td>SMP Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC TRU Waste Container Management - Unvented TRU</td>
<td>Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Waste Drum Handling and Transportation</td>
<td>standoff distance of &gt; 30 feet between the unvented TRU waste container and the worker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by ensuring contained burning and reduce physical consequences by limiting debris dispersion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506**
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
- Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)
### Hazard Evaluation Table - Event BGTRUPIT-3-038

**Description:**
During Pit 9 unvented drum handling activities with a crane, the crane drops the drum resulting in a release of radiological material.

**Locations:**
- Pit 9
  - MARs: 232 PEC (One [1] PIT 9 waste container)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:** None

**Causes:**
- Equipment failure
- Mechanical failure
- Operator error
- Vehicle accident

**Unmitigated System Effects:** None

**Methods of Detection:** Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad Chm Phy</th>
<th>Consequence / Risk Rank</th>
</tr>
</thead>
<tbody>
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<td>P</td>
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<td>C</td>
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<td>W</td>
<td>M II L IV</td>
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</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered None**

- (PSAC) Elevated Waste Movements and Critical Lifts - critical lifts (A critical lift plan is required for planned lifts where the bottom surface of the waste container is planned to be > 12 feet above the ground surface directly below the waste container (excluding MLU payload lifts))
- (PSAC) Elevated waste movements and critical lifts – Spotter (Spotter supports forklift/ rigger/crane operations during elevated [greater than 4 to less than or equal to 12 feet] placement/ removal [stacking/ unstacking, loading/ unloading] of TRU waste containers)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))

**Mitigative Features:**

**Engineered None**

- (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)

**Credited SSCs and ACs**

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<tbody>
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</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood for load drops resulting in release of radiological material</td>
</tr>
<tr>
<td>PSAC</td>
<td>Elevated waste movements and critical lifts – Spotter</td>
<td>Spotter supports forklift/ rigger/crane operations during elevated [greater than 4 to less than or equal to 12 feet] placement/ removal [stacking/ unstacking, loading/ unloading] of TRU waste containers</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood for container puncture, topple, and impacts</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
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</table>

**Mitigators**

- PSAC TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker)
  - Safety Function: Reduce radiological consequences by ensuring contained burning and
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<tr>
<td>DOE 5506  ● Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)</td>
</tr>
<tr>
<td>Detail:  ● Vehicle/Equipment Impacts Waste/Waste Containers - Retrieval and Excavation (9e)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event BGTRUPIT-3-039

**Description:**
During a Pit 9 unvented drum loading operation, the crane drops the container onto an FRP resulting in release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 196 PEC (One [1] PIT 9 waste container: 2nd highest)
- 278 PEC (One [1] Pit 9 waste container with 20% margin)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Crane topples
- Equipment malfunction
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- A

**Mitigated Frequency:**
- EU

**Consequence / Risk Rank**

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<tr>
<th>Receptor</th>
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**Preventive Features:**

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**Mitigative Features:**

| Admin | (PSAC) TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation (Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker) |

**Credited SSCs and ACs**

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|   | PSAC    | TRU Waste Container Management - Unvented TRU Waste Drum Handling and Transportation | Unvented TRU waste containers are handled and/ or transported using lid restraints, and blast shields or safe standoff distance of > 30 feet between the unvented TRU waste container and the worker | P, C, W;
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<td>Fuel Pool Fire - Type B Container Loading/Unloading (1g)</td>
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<tr>
<td>Detail:</td>
<td>* Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)</td>
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<tr>
<td></td>
<td>* Drop/Impact/Spill Due to Improperly Handled Container, etc. - Retrieval and Excavation (10e)</td>
</tr>
</tbody>
</table>
Hazard Evaluation Table - Event BGTRUPIT-4-001

**Description:**
Personnel exposure to TRU waste containers results in a direct radiation exposure.

**Locations:**
- Pit 9

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Container misloaded or overbatched
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inadequate shielding (shine)
- Loss of shielding configuration
- Operator error
- Unknown container contents

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** U

**Mitigated Frequency:** U

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

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</table>

| Notes: | None |

| References: | None |

**DOE 5506 Detail:**
- Direct Exposure to Radiation Events - Retrieval and Excavation (13e)
## Hazard Evaluation Table - Event BGTRUPIT-4-002

**Description:**
Material in TRU Waste container emits high dose during remediation resulting in a direct radiation exposure.

**Locations:**
- Pit 9

**Release Mechanisms:**
- N/A - Direct Exposure

**Assumptions:**
None

**Causes:**
- Handling high dose object
- Loss of shielding (shifting, breaching, reconfigures waste, loss of cap, etc.)
- Unknowingly remove shielding
- Unknown container contents

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U

**Mitigated Frequency:** U

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

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<tr>
<td>Direct Exposure to Radiation Events - Waste Repackaging (13f)</td>
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</table>
### Hazard Evaluation Table - Event BGTRUPIT-5-001

**Description:**
TRU waste containers with fissile material are retrieved and reconfigured in an array resulting in a criticality.

**Locations:**
- Pit 9

**MARS:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:** BEU

**Mitigated Frequency:** NC

### Consequence / Risk Rank

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**Preventive Features:**
- None

**Admin**
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- None

**Credited SSCs and ACs**

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<tr>
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</table>

**DOE 5506**

**Detail:**
- Criticality Events - Retrieval and Excavation (14e)
### Hazard Evaluation Table - Event BGTRUPIT-5-002

**Description:**
TRU waste containers with fissile material and introduced moderator are placed in a close array resulting in a criticality.

**Locations:**
- Pit 9

**MARS:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Flooding
- Improper container placement or handling
- Non-compliance with historical LANL waste packaging requirements, criticality limits, and implementing programs and procedures
- Operator error
- Water intrusion

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radon instrumentation

## Consequence / Risk Rank

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### Preventive Features:
- None

**Admin**
- (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
- (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

### Mitigative Features:
- None

### Credited SSCs and ACs

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<td>Safety Function:</td>
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</table>

- The physical process required for this event to occur is not physically plausible. The existing physical waste packages do not contain enough fissile material even under optimum conditions (i.e., > 500 g), for criticality.

**References:**
None

**DOE 5506 Detail:**
- Criticality Events - Retrieval and Excavation (14e)
### Hazard Evaluation Table - Event BGTRUPIT-5-003

**Description:**
Fissile material in TRU Waste container shifts during movement resulting in a criticality.

**Locations:**
- Pit 9

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Non-compliance with LANL WAC and implementing programs and procedures
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Radcon instrumentation

**Unmitigated Frequency:**
BEU

**Mitigated Frequency:**
NC

### Consequence / Risk Rank

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**Preventive Features:**
- Engineered: None
  - (SMP) Nuclear Criticality Program (Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits))
  - (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- Engineered: None

**Credited SSCs and ACs**

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**Safety Function:**
Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible

**Notes:**
The physical process required for this event to occur is not physically plausible. The physical process would require most of the fissile material > 500 g segregate from waste matrix into a uniform optimally moderated system.

**References:**
- DOE 5506

**Detail:**
- Criticality Events - Characterization (14a)
- Criticality Events - Container Handling (14b)
- Criticality Events - Venting and/or Abating/Purging (14c)
- Criticality Events - Staging and Storage (14d)
- Criticality Events - Waste Repackaging (14f)
- Criticality Events - Type B Container Loading/Unloading (14g)
## Hazard Evaluation Table - Event BGTRUPIT-6-001

### Description:
Aircraft impacts TRU waste followed by pool fire.

### Locations:
- Pit 9

### MARs:
- 2,055 PEC (1 Cell: 70 non-metal [e.g., FRPs] at 1.5 PEC each and 1,300 metal containers at 1.5 PEC each)

### Release Mechanisms:
- Exposure Fire
- Fuel pool fire release
- High energy impact
- Impact and spill

### Assumptions:
None

### Causes:
Aircraft crash

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- EU

### Mitigated Frequency:
- EU

## Consequence / Risk Rank

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<td>M</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:
- None

### Mitigative Features:
- None

#### Engineered
- (SS) [IC] Waste Packaging Control (Waste is packaged)

#### Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Retrieval Area MAR Limit (The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Retrieval Area MAR Limit</td>
<td>The MAR inventory in a Retrieval Area does not exceed 1,500 PE-Ci.</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- MAR limit is credited at 1 full bin consequence reduction from H to M

### References:
- None

### DOE 5506
- Aircraft Impact with Fire - Retrieval and Excavation (15e)
### Hazard Evaluation Table - Event BGTRUPIT-7-001

**Description:**
TRU waste container from pit is struck by lightning resulting in a release of radiological material.

**Locations:**
- Pit 9

**MARS:**
- 278 PEC (One [1] Pit 9 waste container in activity with 20% margin)

**Release Mechanisms:**
- Internal deflagration, lid and debris ejection, with subsequent fire

**Assumptions:**
None

**Causes:**
- Combustible material
- Lightning

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** A

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>L</td>
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</table>

**Preventive Features:**
None

**Mitigative Features:**
None

**Preventers:**
None

**Mitigators:**
- PSAC Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- SMP Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs:**
- Radiological Inventory Management - TRU Waste Drum Doublepack
- Radiation Protection Program

**Safety Function:**
- Reduce radiological consequences by limiting amount of MAR involved
- Evaluates radiological conditions and processes for worker protection
- Reduces radiological consequences due to exposure

**Notes:**
None

**References:**
None

**DOE 5506 Detail:**
- Lightning - Retrieval and Excavation (20e)
<table>
<thead>
<tr>
<th>Description:</th>
<th>Lightning strikes multiple TRU waste containers from pit inducing impact/breach resulting in release of radiological material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations:</td>
<td>Pit 9</td>
</tr>
<tr>
<td>MARs:</td>
<td>428 PEC (232 highest in Pit 9, 196 second highest)</td>
</tr>
<tr>
<td>Release Mechanisms:</td>
<td>Internal deflagration, lid and debris ejection, with subsequent fire</td>
</tr>
<tr>
<td>Assumptions:</td>
<td>None</td>
</tr>
<tr>
<td>Causes:</td>
<td>Combustible material, Improper storage, Lightning</td>
</tr>
<tr>
<td>Unmitigated System Effects:</td>
<td>None</td>
</tr>
<tr>
<td>Methods of Detection:</td>
<td>Observation</td>
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<tr>
<td>Unmitigated Frequency: U</td>
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<table>
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<tr>
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<th>Admin</th>
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<tr>
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<table>
<thead>
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<th>Mitigative Features:</th>
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<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
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</tr>
<tr>
<td>Mitigators</td>
<td>None</td>
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<tr>
<td>Notes:</td>
<td>None</td>
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<td></td>
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<tr>
<td>References:</td>
<td>None</td>
<td></td>
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<tr>
<td>DOE 5506 Detail:</td>
<td>Lightning - Retrieval and Excavation (20e)</td>
<td></td>
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</tbody>
</table>
## Hazard Evaluation Table - Event BLDG412-1-001

### Description:
Equipment (e.g., forklift) traveling at ≤ 10 mph and handling TRU waste impacts stored waste. Fuel is leaked and ignites into a fuel pool fire engulfing the waste being handled as well as the stored waste resulting in a release of radiological material.

### Locations:
- Building 412

### MARs:
- < 56 PEC limit for Bldg 54-412

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: EU

### Mitigated Frequency: EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<td>C</td>
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<td>IV</td>
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<tr>
<td>W</td>
<td>M</td>
<td>III</td>
</tr>
</tbody>
</table>

### Preventive Features:
- Engineered: None
- Admin: None

### Mitigative Features:
- Engineered: None
- Admin: None

### Credited SSCs and ACs

<table>
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<th>Class</th>
<th>Control</th>
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<td>Preventers: None</td>
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<td></td>
</tr>
<tr>
<td>Mitigators: None</td>
<td></td>
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</tbody>
</table>

### Notes:
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

### References:
- DOE 5506 Detail: Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
### Hazard Evaluation Table - Event BLDG412-1-002

**Description:**
Radiant heating equipment in use during SSSR processing of TRU waste ignites and burns uncontained waste resulting in the release of radiological material. The fire affects both the uncontained and contained waste.

**Locations:**
- Building 412

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, closed, staged for SSSR
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process
- ≤ 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Ignition source
- Operator error
- Radiant heating

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
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<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>L</td>
</tr>
</tbody>
</table>

### Preventive Features:
- **Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**
- **Engineered**
  - (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (DID) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
</tr>
<tr>
<td></td>
<td>PSAC</td>
<td>Stationary Fire Watch During SSSR Activities</td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduce the consequences of a fire event.</td>
</tr>
</tbody>
</table>

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
## References

None

<table>
<thead>
<tr>
<th>References</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE 5506</td>
<td><strong>Small Fire - Waste Repackaging (2f)</strong></td>
</tr>
</tbody>
</table>


12/17/2013
## Hazard Evaluation Table - Event BLDG412-1-003

**Description:**
Equipment (e.g., forklift) traveling at ≤ 10 mph and handling TRU waste impacts an SSSR activity. Fuel is leaked and ignited resulting in a pool fire engulfing the waste being handled and uncontained SSSR waste resulting in a release of radiological material.

### Locations:
- Building 412

### MARs:
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process
- ≤ 56 PEC limit for Bldg 54-412

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

#### Unmitigated System Effects:
None

#### Unmitigated Frequency:
EU

#### Mitigated Frequency:
BEU

### Methods of Detection:
- Observation

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
<td>C</td>
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<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>III</td>
<td>L</td>
</tr>
</tbody>
</table>

#### Preventive Features:
- **Engineered**
  - (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- **Admin**
  - (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
  - (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
  - (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
  - (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
  - (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

#### Mitigative Features:
- **Engineered**
  - (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
  - (SS) Waste Packaging Control (Waste is packaged)
- **Admin**
  - (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 3 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
  - (PSAC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
  - (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
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<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>

**Safety Function:**
The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the...
<table>
<thead>
<tr>
<th>PSAC</th>
<th>Fire Protection - Thermal Separation</th>
<th>Reduce radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
<td>Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239. The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
</tr>
<tr>
<td>DOE 5506 Detail:</td>
<td></td>
<td>Fuel Pool Fire - Container Handling (1b)</td>
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<tr>
<td></td>
<td></td>
<td>Fuel Pool Fire - Waste Repackaging (1f)</td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event BLDG412-1-004

**Description:**
Equipment (e.g., forklift) traveling at ≤ 10 mph and handling TRU waste is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste being handled resulting in a release of radiological material. Additional waste is sufficiently close to the fire to be affected by heating.

**Locations:**
- Building 412

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Conditions:**
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

<table>
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<tr>
<th>Receptor</th>
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<th>Chm</th>
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**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

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<tbody>
<tr>
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**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Preventers</th>
<th>Mitigators</th>
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<tbody>
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**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit forPu-239.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
None

**DOE 5506 Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
### Hazard Evaluation Table - Event BLDG412-1-005

**Description:**
Equipment (e.g., forklift) handling TRU waste at ≤10 mph impacts TRU waste. The collision event initiates a fire which results in a release of radiological material. Additional waste is sufficiently close to be affected by heating.

**Locations:**
- Building 412

**MARS:**
- < 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Exposure Fire
- Fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Operator error
- Transient combustibles
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** EU

### Consequence / Risk Rank

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<tr>
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<td>II</td>
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</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce likelihood of equipment malfunction

| SMP | Training and Qualification Program - Qualifications | Person maintain applicable LANL qualifications for vehicle and equipment operation | All |

**Safety Function:**
Reduces likelihood for vehicle and equipment accidents

| Mitigators | SS | Waste Packaging Control (IC) | Waste is packaged | ● Rad: P, C, W |

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged


**Safety Function:**
Reduces the radiological consequences by limiting the MAR involved

**Notes:**
- Deleted
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)

---

**Chapter 3: Hazard and Accident Analysis**

Appendix 3H

3H-622


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12/17/2013
## Hazard Evaluation Table - Event BLDG412-1-006

### Description:
Equipment (e.g., forklift) handling TRU waste catches on fire adjacent to TRU waste resulting in a release of radiological material. The heat of the fire affects the TRU waste being handled and containers in proximity to the vehicle.

### Locations:
- Building 412

### Release Mechanisms:
- Exposure Fire
- Fire

### Assumptions:
None

### Causes:
- Electrical short
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
U

### Mitigated Frequency:
EU

### Consequence / Risk Rank

<table>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
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</table>

### Preventive Features:

#### Engineered
None

#### Admin
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

#### Engineered
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

#### Preventers
<table>
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<tr>
<th>Class</th>
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<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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#### Mitigators
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<th>Class</th>
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<th>Attribute</th>
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<tbody>
<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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</tbody>
</table>

### Notes:
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
None

### DOE 5506 Details:
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)

---

### Hazard Evaluation Table - Event BLDG412-1-007

**Description:**
Equipment (e.g., forklift) handling TRU waste at ≤ 10 mph impacts SSSR activities. The collision event initiates a fire that results in a release of radiological material.

**Locations:**
- Building 412

**Release Mechanisms:**
- Fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
U

**Mitigated Frequency:**
EU

#### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Phy</th>
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<td>C</td>
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<td>IV</td>
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</table>

#### Preventive Features:

**Engineered**
- (SS) Vehicle Barriers—High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SSMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

#### Mitigative Features:

**Engineered**
- (SS)(IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS)(IC) Waste Packaging Control (Waste is packaged)
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC)(IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for all receptors)

### Credited SSCs and ACs

<table>
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<tr>
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<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers—High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection</td>
<td>Reduce the frequency of the propagation of fire between defined areas by</td>
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<td>Thermal Separation Distance - Defined Area</td>
<td>limiting the heat flux to radiological waste containers.</td>
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<tr>
<td>------------------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
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</tr>
<tr>
<td><strong>Safety Function:</strong> Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
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</table>

<table>
<thead>
<tr>
<th>Mitigators</th>
<th>PSAC Fire Protection - Control of Transient Combustibles</th>
<th>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce the likelihood of a fuel package being involved in a fire. Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.</td>
<td></td>
</tr>
</tbody>
</table>

| Notes: | • It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating. • Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239. |
| References: | None |
| DOE 5506 Detail: | • Small Fire - Container Handling (2b) • Small Fire - Waste Repackaging (2f) |

References: None

DOE 5506

Detail:

- Small Fire - Container Handling (2b)
- Small Fire - Waste Repackaging (2f)
## Hazard Evaluation Table - Event BLDG412-1-008

**Description:**
Reactive or incompatible materials in TRU waste container are violently shaken during handling resulting in a fire within the container resulting in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- < 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Chemical reaction
- Shock sensitive material
- Violent shaking

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- U

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<thead>
<tr>
<th>Preventive Features:</th>
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<tbody>
<tr>
<td>Engineered: None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admin</th>
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<tbody>
<tr>
<td>(SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))</td>
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<tr>
<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
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<tr>
<th>Mitigative Features:</th>
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<tbody>
<tr>
<td>Engineered: (SS) (IC) Waste Packaging Control (Waste is packaged)</td>
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<tbody>
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<td>(PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
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### Credited SSCs and ACs

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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
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<td>Mitigators</td>
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<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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<td>Safety Function:</td>
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<td></td>
<td></td>
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</table>

### Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
None

### DOE 5506 Detail:
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
- Seismic Event (Impact Only) - Characterization (24a)
- Seismic Event (Impact Only) - Container Handling (24b)
- Seismic Event (Impact Only) - Venting and/or Abating/Purging (24c)
- Seismic Event (Impact Only) - Staging and Storage (24d)
- Seismic Event (Impact Only) - Waste Repackaging (24f)
Hazard Evaluation Table - Event BLDG412-1-009

Description:
During size reduction activities in the SSSR, support equipment (e.g., vehicle, forklift, overhead hoist) fail or overheat causing TRU waste to ignite with subsequent fire resulting in a release of radiological material.

Locations:
- Building 412

MARS:
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

Release Mechanisms:
- Exposure Fire
- Fire

Assumptions:
None

Causes:
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: A
Mitigated Frequency: U

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<tr>
<th>Receptor</th>
<th>Rad</th>
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<tr>
<td>W</td>
<td>M II L III</td>
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</table>

Preventive Features:
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

Mitigative Features:
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
</tr>
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<tbody>
<tr>
<td>Preventers</td>
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<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td></td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Safety Function: Reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
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<tr>
<td></td>
<td></td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
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<td>Reduces the consequences of a fire event.</td>
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<td>Safety Function: A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
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<td>Rad: P, C, W;</td>
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<tr>
<td></td>
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<td>Reduces the consequences of a fire event.</td>
</tr>
</tbody>
</table>

Notes:
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.

References:
- None

DOE 5506

Detail:
- Small Fire - Waste Repackaging (2f)

Chapter 3: Hazard and Accident Analysis
Appendix 3H

## Hazard Evaluation Table - Event BLDG412-1-010

**Description:**
A fire occurs in proximity to TRU waste with the heat of the fire affecting the TRU waste container that results in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- ≤ 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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<td>L</td>
</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:

**Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Fire Protection Program - Hot Work and Ignition Source Control (Ignition source control within defined areas.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

### Mitigative Features:

**Engineered**
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

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<tr>
<td>Preventers</td>
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<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
<td>Reduce the likelihood of progression of a fire between defined areas.</td>
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<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the likelihood of fire progression</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Fire Protection Program - Hot Work and Ignition Source Control</td>
<td>Ignition source control within defined areas.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood for ignition of flammables/ combustibles</td>
<td></td>
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<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td></td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control</td>
<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>P, C, W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
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</tr>
</tbody>
</table>

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.

**References:**
None

**DOE 5506**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
**Hazard Evaluation Table - Event BLDG412-1-011**

**Description:**
During size reduction activities in the SSSR, the use of electrical equipment (e.g., wet vac, power drill) provide an ignition source and causes TRU waste to ignite with subsequent fire resulting in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Electrical short
- Equipment failure
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
U

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Phy</th>
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<tr>
<td>W</td>
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<td>II</td>
<td>L</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Mitigative Features:**

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
- (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

**Credited SSCs and ACs**

**Preventers**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce radiological consequences by limiting the amount of MAR involved.

**Mitigators**

<table>
<thead>
<tr>
<th>Class</th>
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<tr>
<td>PSAC</td>
<td>Fire Protection - Control of Transient Combustibles</td>
<td>Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.</td>
<td>P, C, W;</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce the likelihood of a fuel package being involved in a fire, Reduce the likelihood of fire progression within a defined area so that MAR involvement is limited.

<table>
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<tr>
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<tbody>
<tr>
<td>PSAC</td>
<td>Stationary Fire Watch During SSSR Activities</td>
<td>A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.</td>
<td>P, C, W;</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduce the consequences of a fire event.

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.

**References:**
None

**DOE 5506 Detail:**
- Small Fire - Waste Repackaging (2f)
### Description:
Non-metal TRU waste containers (e.g., FRPs) are ignited and burned resulting in a release of radiological material.

### Locations:
- Building 412
- MARs: < 56 PEC limit for Bldg 54-412

### Release Mechanisms:
- Fire

### Assumptions:
None

### Causes:
- Equipment malfunction
- Hot Work
- Ignition source
- Operator error
- Small fire event

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A
Mitigated Frequency: EU

### Consequence / Risk Rank

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<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>M</td>
<td>II</td>
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</table>

### Preventive Features:

**Engineered**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

**Admin** (PSAC) Fire Protection - Thermal Separation Distance - Defined Area

### Mitigative Features:

**Engineered**
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Admin** None

### Credited SSCs and ACs

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<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
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<tr>
<td>SMP Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>SMP Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
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<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
<td></td>
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</table>

### Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
None

### DOE 5506
- Large Fire - Characterization (4a)
- Large Fire - Container Handling (4b)
- Large Fire - Staging and Storage (4d)
- Large Fire - Waste Repackaging (4f)
### Hazard Evaluation Table - Event BLDG412-1-013

**Description:**
Equipment fire (e.g., forklift, man-lift, etc.) ignites in the vicinity of stored waste resulting in a release of radiological material.

**Locations:**
- Building 412

**Release Mechanisms:**
- Exposure Fire

**Assumptions:**
None

**Causess:**
- Equipment malfunction
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
A

**Mitigated Frequency:**
EU

### Consequence / Risk Rank

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<tr>
<td>W</td>
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</tbody>
</table>

### Preventive Features:

**Engineered**
None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)

### Mitigative Features:

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

**Class**
- Preventers
  - PSAC
    - Fire Protection - Thermal Separation Distance - Defined Area
      - **Safety Function:** Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
        - **Attribute:** Reduce the likelihood of progression of a fire between defined areas.
        - **Affected Receptors:** All
  - SMP
    - Maintenance Program - Vehicle/Equipment
      - **Safety Function:** Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)
    - Training and Qualification Program - Qualifications
      - **Safety Function:** Personnel maintain applicable LANL qualifications for vehicle and equipment operation
        - **Attribute:** Reduces likelihood for vehicle and equipment accidents
        - **Affected Receptors:** All

**Mitigators**
- SS
  - Waste Packaging Control (IC)
    - **Safety Function:** Waste is packaged
      - **Attribute:** Rad: P, C, W

**Mitigators**
- PSAC
  - Radiological Inventory Management - Defined Area MAR Control
    - **Safety Function:** Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)
      - **Attribute:** Rad: P, C, W

**Notes:**
- Combustible/flammable materials external to container
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

### References:
None

**DOE 5506 Detail:**
- Small Fire - Characterization (2a)
- Small Fire - Container Handling (2b)
- Small Fire - Venting and/or Abating/Purging (2c)
- Small Fire - Staging and Storage (2d)
- Small Fire - Waste Repackaging (2f)
**Hazard Evaluation Table - Event BLDG412-1-014**

**Description:**
A vehicle/ equipment fuel tank spills, leaks, or ruptures adjacent to stored TRU waste with a subsequent pool fire. The pool is adjacent to, but does not engulf the adjacent waste resulting in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- < 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Exposure Fire
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Fuel spills/ leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Leaks/ drips
- Operator error
- Vehicle accident

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (SMP) Fire Protection Program - Good Housekeeping and Inspections (Transmit combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))

**Mitigative Features:**

**Engineered**
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

**Credited SSCs and ACs**

<table>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Fire Protection - Thermal Separation Distance - Defined Area</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
<td></td>
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<tr>
<td>SMP</td>
<td>Fire Protection Program - Good Housekeeping and Inspections</td>
<td>Transient combustible controls (housekeeping, vegetation control, and periodic inspections), to include quarterly inspection by LANL FPE</td>
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<tr>
<td>Safety Function</td>
<td>Reduces the likelihood of fire progression</td>
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<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<td>Safety Function</td>
<td>Reduce likelihood of equipment malfunction</td>
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<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
<td></td>
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</tr>
<tr>
<td>Safety Function</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
<td></td>
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</table>

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506**

**Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)

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12/17/2013
## Hazard Evaluation Table - Event BLDG412-1-015

**Description:**
A vehicle/equipment fuel tank spills, leaks, or ruptures adjacent to stored TRU waste with a subsequent pool fire. The fuel pool engulfs the adjacent waste resulting in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- < 56 PEC limit for Bldg 54-412

**Release Mechanisms:**
- Fuel pool fire release

**Assumptions:**
None

**Causes:**
- Equipment malfunction
- Fuel spills/leaks during fuel transfer in coincidence with ignition source (e.g., static discharge, heat source)
- Ignition source
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- EU

### Consequence / Risk Rank

<table>
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<th>Receptor</th>
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</table>

**Preventive Features:**
- Engineered: None
- Admin: None

**Mitigative Features:**
- Engineered: None
- Admin: None

**Credited SSCs and ACs**
- Preventers: None
- Mitigators: None

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:**
- None

**DOE 5506**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)

---


12/17/2013
# Hazard Evaluation Table - Event BLDG412-1-016

**Description:**
Self-igniting material in TRU waste container being processed ignites and burns during SSSR repackaging activities resulting in a fire and a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- ≤ 18 PEC equivalent combustible TRU waste, open, in SSSR process

**Release Mechanisms:**
- Fire

**Assumptions:**
None

**Causes:**
- Chemical incompatibility w/ absorption material
- Chemical reaction
- Operator error
- Pyrophorics

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
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<tr>
<th>Receptor</th>
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</tbody>
</table>

**Consequence / Risk Rank**

**Preventive Features:**
None

**Mitigative Features:**
None

**Class**
- PSAC

**Control**
- Fire Protection - Control of Transient Combustibles
- Fire Protection - Thermal Separation Distance - Defined Area

**Attribute**
Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.

**Safety Function:**
Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.

**Affected Receptors**
All

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.
### Hazard Evaluation Table - Event BLDG412-1-017

**Description:**
Transient combustibles ignite and burn TRU waste being processed in SSSR causing a fire and resulting in a release of radiological material.

**Locations:**
- Building 412

**Release Mechanisms:**
- Exposure Fire
- Fire

**Assumptions:**
None

**Causes:**
- Electrical (wiring, motors, power tools, pumps, cords, electric utilities)
- Hot Work
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

**Mitigated Frequency:** U

### Consequence / Risk Rank

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<tr>
<td>W</td>
<td>M</td>
<td>II</td>
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</tbody>
</table>

**Preventive Features:**
- **Engineered:** None
  - (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
  - (DID) Hazardous Material and Waste Management - Waste Acceptance Criteria (LANL WAC ensures that controls for packaging/ repackaging of new or legacy radiological waste are performed in accordance with current or accepted standards)

**Mitigative Features:**
- **Engineered:** None
  - (PSAC) Fire Protection - Control of Transient Combustibles (Within defined areas, each fuel package shall be ≤ 100 lb of transient combustible material or attended. Fuel packages shall be ≥ 9 ft away from non-metal waste containers and other fuel packages. Fuel packages shall be ≥ 3 ft away from metal containers.)
  - (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control - SSSR (Limit the Equivalent Combustible MAR in an SSSR Area)
  - (PSAC) Stationary Fire Watch During SSSR Activities (A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.)
  - (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)

### Credited SSCs and ACs

#### Preventers
- **PSAC**
  - Fire Protection - Thermal Separation Distance - Defined Area
    - **Safety Function:** Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.
    - **Affected Receptors:** All

#### Mitigators
- **PSAC**
  - Fire Protection - Control of Transient Combustibles
    - **Safety Function:** Reduce the likelihood of progression of a fire between defined areas.
  - Stationary Fire Watch During SSSR Activities
    - **Safety Function:** A stationary fire watch is required in the SSSR process area whenever TRU waste is exposed.
      - **Rad:** P, C, W;

### Notes:
- Combustible/flammable materials external to container
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.

### References:
- None

**DOE 5506 Detail:**
- Small Fire - Waste Repackaging (2f)
Hazard Evaluation Table - Event BLDG412-2-001

**Description:**
Flammable vapors/ gasses (e.g., Propane, flammable gasses, hydrogen) accumulates leading to a deflagration impacting contained and uncontained TRU waste resulting in a release of radiological material.

**Locations:**
- Building 412

**MARS:**
- \(< 18\) PEC equivalent combustible TRU waste, open, in SSSR process
- \(38\) PEC Contained Waste (Bldg limit minus unconfined SSSR MAR)

**Release Mechanisms:**
- Deflagration external to container with subsequent fire
- Low energy impact

**Assumptions:**
None

**Causes:**
- Flammable gases
- Ignition source
- Mechanical failure
- Operator error

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** EU

**Consequence / Risk Rank**

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</tbody>
</table>

**Preventive Features:**
- Engineered None
- Admin
  - (SMP) Hazardous Material and Waste Management Program (Compressed Gas Cylinder Control) (Pressurized flammable and non-flammable industrial gas cylinders and propane tanks are stored in a designated storage area when not in use, secured during storage, use, and transport, and be closed with a valve cap installed or valve protected by a guard when not in use.)

**Mitigative Features:**
- Engineered None
- Admin None

**Credited SSCs and ACs**

**Preventers**
- None

**Mitigators**
- None

**Notes:**
- Since Building 412 is not PC-2 qualified it has a MAR limit of less than or equal to the HAZCAT-3 limit for Pu-239.

**References:**
- None

**DOE 5506 Detail:**
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Characterization (5a)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Container Handling (5b)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Venting and/or Abating/Purging (5c)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Staging and Storage (5d)
- Ignition of Fumes Results in a Deflagration/Detonation (external to container) - Waste Repackaging (5f)
## Hazard Evaluation Table - Event RANTTOG-1-001

### Description:
A vehicle traveling at > 10 mph and < 35 mph and transporting multiple TRU waste containers between RANT and Area G is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material.

### Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

### MARs:
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

### Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency:
- EU

### Mitigated Frequency:
- BEU

### Consequence / Risk Rank

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<tr>
<td>W</td>
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<td>I</td>
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</table>

### Preventive Features:

#### Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

#### Admin
- (PSAC) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
<td>All</td>
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<tr>
<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W</td>
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<tr>
<td></td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W</td>
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Chapter 3: Hazard and Accident Analysis
Appendix 3H


12/17/2013
<table>
<thead>
<tr>
<th>Safety Function</th>
<th>PSAC</th>
<th>Radiological Inventory Management - Defined Area MAR Control (IC)</th>
<th>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</th>
<th>• Rad: P, C, W;</th>
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</thead>
<tbody>
<tr>
<td>Safety Function</td>
<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (IC)</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>• Rad: P, C, W;</td>
</tr>
<tr>
<td>Safety Function</td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>• Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:** • Fuel Pool Fire - Container Handling (1b)
## Hazard Evaluation Table - Event RANTTOG-1-002

**Description:**
A vehicle traveling at < 10 mph and transporting multiple TRU waste containers between RANT and Area G is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARS:**
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

### Consequence / Risk Rank

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<tr>
<td>W</td>
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</tbody>
</table>

### Preventive Features:
**Engineered**
- None

**Admin**
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:
**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) (IC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

**Preventers**
- PSAC Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)

**Safety Function:**
- Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.

**Mitigators**
- SS Hazardous Material and Waste Management - TRU Waste Container (IC)

**Safety Function:**
- Metal TRU waste container are of sound integrity

**Affected Receptors:**
- Rad: P, C, W;

- SS Waste Packaging Control (IC)

**Safety Function:**
- Waste is packaged

**Affected Receptors:**
- Rad: P, C, W;
<table>
<thead>
<tr>
<th>Safety Function</th>
<th>Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
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<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - Defined Area MAR Control (IC)</td>
</tr>
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<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
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<td>Safety Function</td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (IC)</td>
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<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
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<td>Safety Function</td>
<td>Reduce radiological consequences by limiting MAR involved</td>
</tr>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
</tr>
<tr>
<td></td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

Notes:  
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References:  
- DOE 5506  
- Detail: Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event RANTTOG-1-003

Description:
A vehicle traveling at > 10 mph and < 35 mph and transporting a TRU waste container between RANT and Area G is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing the waste in transport resulting in a release of radiological material.

Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

MARS:
- 553 PEC (One [1] TRU waste container)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Unmitigated Frequency: EU

Consequence / Risk Rank

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<tr>
<th>Receptor</th>
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<tr>
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</table>

Preventive Features:

Engineered
- None

Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
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<td>Safety Function:</td>
<td></td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
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<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<td>Mitigators</td>
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<td>Waste Packaging Control (IC)</td>
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<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td>Mitigators</td>
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<td>Radiological Inventory Management - TRU</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<tr>
<td>Waste Drum Doublepack</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
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<tr>
<td>Notes:</td>
<td>● 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste</td>
<td></td>
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<tr>
<td></td>
<td>● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
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<td>● The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
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<td>● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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| References:          | None |
| DOE 5506             | Fuel Pool Fire - Container Handling (1b) |

Basis for Interim Operation Rev. 3.0  
November 2014

Chapter 3: Hazard and Accident Analysis  
Appendix 3H
### Hazard Evaluation Table - Event RANTTOG-1-004

**Description:**
A vehicle traveling at \( \leq 10 \) mph and transporting a TRU waste container between RANT and Area G is involved in an accident. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in a release of radiological material.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
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<tr>
<th>Receptor</th>
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<th>Chm</th>
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<td>W</td>
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<td>II</td>
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</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
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<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
<td>All</td>
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<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td></td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
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<td>---------------------</td>
<td>---------------------------------------------------------------</td>
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</table>
| **Notes:**          | • 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste  
                        • The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
                        • When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| **References:**     | None |
| **DOE 5506**       | Fuel Pool Fire - Container Handling (1b) |

References:
- DOE 5506

Detail:
- Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event RANTTOG-1-005

Description:
Two (2) vehicles, each transporting multiple TRU Waste containers, impact at > 10 mph and ≤ 35 mph between RANT and Area G. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

MARS:
- 1,096 PEC (Statistical 96 metal containers: 48 containers per vehicle)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Mitigated Frequency: BEU

Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
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Preventive Features:

Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

Mitigative Features:

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
<td></td>
</tr>
<tr>
<td>Mitigators</td>
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<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduces the radioactive consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
<td></td>
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<tr>
<td>------------------</td>
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<td></td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rad: P, C, W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Safety Function: | Reduce radiological consequences by limiting amount of MAR involved |

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Fuel Pool Fire - Container Handling (1b)
### Hazard Evaluation Table - Event RANTTOG-1-006

**Description:**
Two (2) vehicles, each transporting a single TRU waste container, impact at > 10 mph and < 35 mph between RANT and Area G. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire engulfing all the waste in transport resulting in the release of radiological material.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARs:**
- 553 PEC (One [1] TRU waste container in transport)
- 56 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
- None

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
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<th>DSA Mit.</th>
<th>Unmit.</th>
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<td>II</td>
<td>M</td>
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</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

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</table>

**Safety Function:**
Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.

| Mitigators | SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W |

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

| SS | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W |

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged.

| PSAC | Radiological Inventory Management - TRU | Doublepack radiological waste drums > 200 PEC | Rad: P, C, W |

Chapter 3: Hazard and Accident Analysis
Appendix 3H
<table>
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<tr>
<th>Waste Drum Doublepack</th>
<th>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td>- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
</tr>
<tr>
<td></td>
<td>- The fuel pool is assumed to consist of two hundred (200) gallons of fuel (100 gallons each vehicle).</td>
</tr>
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<td>- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
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<tr>
<td>References:</td>
<td>None</td>
</tr>
<tr>
<td>DOE 5506</td>
<td>- Fuel Pool Fire - Container Handling (1b)</td>
</tr>
<tr>
<td>Detail:</td>
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</tbody>
</table>

References: None

DOE 5506

Detail:

- Fuel Pool Fire - Container Handling (1b)
Hazard Evaluation Table - Event RANHTG-1-007

Description:
A vehicle transporting multiple TRU waste containers at > 10 mph and ≤ 35 mph between RANT and Area G is involved in an accident with subsequent fire resulting in a release of radiological material. The accident involves no additional waste.

Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

MARS:
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Mitigated System Effects: U

Mitigated Frequency: BEU

Consequence / Risk Rank

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<th>Phy</th>
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<tr>
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Preventive Features:

Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Mitigative Features:

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<td>Preventers</td>
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<td>Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift)</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
<td></td>
<td></td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns</td>
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as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

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<td>Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas)</td>
<td>Safety Function: Reduces the radiological consequences by limiting the MAR involved</td>
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<td>PSAC</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Safety Function: Reduce radiological consequences by limiting MAR involved</td>
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Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References:
- None

DOE 5506

Detail:
- Small Fire - Container Handling (2b)
Hazard Evaluation Table - Event RAN\text{T}{\text{O}G}-1-008

Description:
A vehicle transporting multiple TRU waste containers at $> 10$ mph and $\leq 35$ mph between RANT and Area G is involved in an accident with subsequent fire resulting in a release of radiological material. The accident involves no additional waste.

Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

MARS:
- $\leq 1,100$ PEC (MAR limit for single transport vehicle)

Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:
None

Methods of Detection:
- Observation

Unmitigated Frequency: U
Mitigated Frequency: BEU

Consequence / Risk Rank

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Preventive Features:
Engineered

Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits $< 15$ mph)

Mitigative Features:
Engineered

Admin
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits - compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums $> 200$ PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<td>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns</td>
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</table>

Chapter 3: Hazard and Accident Analysis
Appendix 3H

3H-652

http://sb-apps/insight/rpt_\text{chareport}\_portrait.php?ca=&et=

12/17/2013
as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

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<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
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<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers</td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
<td>Safety Function: Reduce radiological consequences by limiting MAR involved</td>
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Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506

Detail: Small Fire - Container Handling (2b)
### Hazard Evaluation Table - Event RANTTOG-1-009

**Description:**
A vehicle transporting a TRU waste container at > 10 mph and < 35 mph between RANT and Area G is involved in an accident with subsequent fire resulting in a release of radiological material. The accident involves no additional waste.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARS:**
- 553 PEC (One [1] TRU waste container)

**Release Mechanisms:**
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U  
**Mitigated Frequency:** EU

### Consequence / Risk Rank

<table>
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</table>

**Preventive Features:**

**Engineered**

- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/equipment forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**

- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**

- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<td>Waste is packaged</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
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<td>Doublepack radiological waste drums &gt; 200 PEC</td>
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<td>Management - TRU Waste Drum Doublepack</td>
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<td>----------------------------------------</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Safety Function:</strong></td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
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</tbody>
</table>

**Notes:**
- 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste.
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DOE 5506 Detail:**
- Small Fire - Container Handling (2b)
## Hazard Evaluation Table - Event RANTTOG-1-010

### Description:
A vehicle transporting a TRU waste container at ≤ 10 mph between RANT and Area G is involved in an accident with subsequent fire resulting in a release of radiological material. The accident involves no additional waste.

### Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

### MARs:
- 553 PEC (One [1] TRU waste container)

### Release Mechanisms:
- Fire
- Low energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: U

### Mitigated Frequency: EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
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<tbody>
<tr>
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<td>I</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

### Preventive Features:
- Engineered: None
- Admin: (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- Admin: (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- Admin: (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- Admin: (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- Admin: (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits ≤ 15 mph)

### Mitigative Features:
- Engineered: (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- Admin: (SS) (IC) Waste Packaging Control (Waste is packaged)

### Credited SSCs and ACs

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<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
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<td>Waste is packaged</td>
</tr>
<tr>
<td>Safety Function:</td>
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<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<tr>
<td>Mitigators</td>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
</tr>
<tr>
<td>Waste Drum Doublepack</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
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</table>
| **Notes:**            | ● 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste  
                         ● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.  
                         ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |
| **References:**       | None                                                                                 |
| **DOE 5506**          | Small Fire - Container Handling (2b)                                                 |
| **Detail:**           |                                                                                      |
## Hazard Evaluation Table - Event RANTTOG-1-011

### Description:
Two (2) vehicles, each transporting multiple TRU Waste containers, impact at > 10 mph and ≤ 35 mph between RANT and Area G with subsequent fire resulting in the release of radiological material. The accident involves no additional waste.

### Locations:
- **Mesita del Buey (TA-54 Access Road between RANT and Area G)**

### MARs:
- 1,096 PEC (Statistical 96 metal containers: 48 containers per vehicle)

### Release Mechanisms:
- Fire
- Impact and spill
- Moderate energy impact

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Unmitigated Frequency: U

### Mitigated Frequency: BEU

### Methods of Detection:
- Observation

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tr>
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<td>Unmit.</td>
<td>DSA Mit.</td>
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<tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>H</td>
</tr>
</tbody>
</table>

### Preventive Features:
None

### Mitigative Features:

#### Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

#### Engineered
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

### Credited SSCs and ACs

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<th>Class</th>
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<td>Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td></td>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns</td>
</tr>
</tbody>
</table>
as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

| SS | Waste Packaging Control (IC) | Waste is packaged | • Rad: P, C, W; |
| PSAC Radiological Inventory Management - Defined Area MAR Control | Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas) | Reduces the radiological consequences as waste is agglomerated and burns as packaged |
| PSAC Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers | The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci. | Reduces the radiological consequences by limiting the MAR involved |
| PSAC Radiological Inventory Management - TRU Waste Drum Doublepack | Doublepack radiological waste drums ≥ 200 PEC | Reduce radiological consequences by limiting MAR involved |

Notes: ● It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating. ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506 Detail: ● Small Fire - Container Handling (2b)
### Hazard Evaluation Table - Event RANTTOG-1-012

**Description:**
Two (2) vehicles, each transporting a single TRU waste container, impact at > 10 mph and < 35 mph between RANT and Area G with subsequent fire resulting in the release of radiological material. The accident involves no additional waste.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARS:**
- 553 PEC (One [1] TRU waste container in transport)
- 56 PEC (One [1] TRU waste container in transport)

**Release Mechanisms:**
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
U

**Mitigated Frequency:**
BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
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<th>Chm</th>
<th>Phy</th>
</tr>
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<tr>
<td></td>
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<td>Unmit. DSA Mit.</td>
<td>Unmit. DSA Mit.</td>
</tr>
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<td>M</td>
</tr>
<tr>
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<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
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</tr>
</tbody>
</table>

### Preventive Features:

**Admin**
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

### Mitigative Features:

**Engineered**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
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<th>Class</th>
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</tr>
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<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and RANT.</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
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<td>Safety Function:</td>
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<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
<tr>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
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<td></td>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
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<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
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</tbody>
</table>

**Notes:**
- 1,058 PEC combustible waste bounds a single TRU waste container with 1800 PEC vitrified (cemented) waste.
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:** None

**DDE 5506**
- Small Fire - Container Handling (2b)
<table>
<thead>
<tr>
<th><strong>Hazard Evaluation Table - Event RANTTOG-2-001</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> A vented TRU waste container deflagrates during transport between RANT and Area G resulting in a release of radiological material.</td>
</tr>
<tr>
<td><strong>Locations:</strong> Mesita del Buey (TA-54 Access Road between RANT and Area G)</td>
</tr>
<tr>
<td><strong>MARS:</strong> 553 PEC (One [1] TRU waste container)</td>
</tr>
<tr>
<td><strong>Release Mechanisms:</strong> Internal deflagration, lid and debris ejection, with subsequent fire.</td>
</tr>
<tr>
<td><strong>Locations:</strong> Mesita del Buey (TA-54 Access Road between RANT and Area G)</td>
</tr>
<tr>
<td><strong>MARS:</strong> 553 PEC (One [1] TRU waste container)</td>
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<td><strong>Release Mechanisms:</strong> Internal deflagration, lid and debris ejection, with subsequent fire.</td>
</tr>
<tr>
<td><strong>Assumptions:</strong> None</td>
</tr>
<tr>
<td><strong>Causes:</strong> Drop, Ignition source, Operator error, Violent shaking.</td>
</tr>
<tr>
<td><strong>Unmitigated System Effects:</strong> None</td>
</tr>
<tr>
<td><strong>Methods of Detection:</strong> Observation</td>
</tr>
<tr>
<td><strong>Unmitigated Frequency:</strong> EU</td>
</tr>
<tr>
<td><strong>Mitigated Frequency:</strong> EU</td>
</tr>
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<table>
<thead>
<tr>
<th><strong>Consequence / Risk Rank</strong></th>
<th><strong>Rad</strong></th>
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<tbody>
<tr>
<td></td>
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<td>DSA Mit.</td>
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<td>P</td>
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<table>
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<tr>
<th><strong>Preventive Features:</strong></th>
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<tbody>
<tr>
<td><strong>Engineered</strong></td>
</tr>
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<tr>
<td><strong>Preventers</strong></td>
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<tr>
<td><strong>Control</strong></td>
</tr>
<tr>
<td><strong>Attribute</strong></td>
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<tr>
<td><strong>Affected Receptors</strong></td>
</tr>
<tr>
<td><strong>Safety Function:</strong></td>
</tr>
</tbody>
</table>

| **Mitigators** | PSAC |
| **Control** | Radiological Inventory Management - TRU Waste Drum Doublepack |
| **Attribute** | Doublepack radiological waste drums > 200 PEC |
| **Affected Receptors** | Rad: P, C, W; |
| **Safety Function:** | Reduce radiological consequences by limiting amount of MAR involved |

| **Notes:** |
| When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements |

| **References:** |
| None |

| **DOE 5506 Detail:** |
| Waste Container Deflagration - Container Handling (6b) |

---

## Hazard Evaluation Table - Event RANTTOG-3-001

### Description:
Pit 9 TRU waste container falls off vehicle during transport at \( > 10 \) and \( \leq 35 \) mph between RANT and Area G resulting in a release of radiological material.

### Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

### MARs:
- 278 PEC (One Pit 9 waste container in transport with 20% margin)

### Release Mechanisms:
- Loss of Confinement
- Moderate energy impact

### Assumptions:
None

### Causes:
- Degraded/Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
- Observation

### Unmitigated Frequency: A  
Mitigated Frequency: EU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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</table>

### Preventive Features:

#### Engineered
- None

#### Admin
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/Equipment (Periodic inspection and maintenance of LANL vehicles/equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/Equipment Safety Controls-Speed Limits (Posted speed limits \(< 15\) mph)

### Mitigative Features:

#### Engineered
- (SS) Hazardous Material and Waste Management - TRU Waste Container (I) (Metal TRU waste container are of sound integrity)

#### Admin
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums \( \geq 200 \) PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

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<tr>
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<tr>
<td>Mitigators</td>
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</tr>
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<td>Safety Function:</td>
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</table>

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12/17/2013
waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
<thead>
<tr>
<th>PSAC</th>
<th>Radiological Inventory Management - TRU Waste Drum Doublepack</th>
<th>Doublepack radiological waste drums &gt; 200 PEC</th>
<th>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Safety Function: Reduces radiological consequences due to exposure</td>
</tr>
</tbody>
</table>

Notes: ● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506 Detail: ● Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
### Hazard Evaluation Table - Event RANTTOG-3-002

**Description:**
Multiple TRU waste containers from Pit 9 fall off vehicle during transport > 10 and < 35 mph between RANT and Area G resulting in a release of radiological material.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARS:**
- 336 PEC (Pit 9 Statistical MAR of 48 drums in transport)

**Release Mechanisms:**
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Inclement weather
- Large animal impact
- Operator error
- Securing devices fail
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** A

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Mitigated Frequency</th>
<th>EU</th>
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<tbody>
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<td>Unmit. DSA Mit.</td>
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<td>C</td>
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</tr>
<tr>
<td>W</td>
<td>H I M III</td>
<td></td>
<td>All</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT (Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)

**Admin**
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
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</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of Transportation Vehicle Between TA-54 AREA G and TA-54 RANT</td>
<td>Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
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<tr>
<td>Safety Function:</td>
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<td></td>
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<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
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<td>Safety Function:</td>
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<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to</td>
</tr>
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</table>
waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for worker protection</td>
<td>Rad: W;</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
<td></td>
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</table>

Notes: When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506 Detail: Drop/Impact/Spill Due to Improperly Handled Container, etc. - Container Handling (10b)
## Hazard Evaluation Table - Event RANTTOG-4-001

### Description:
TRU Waste container emits high dose during transport between RANT and Area G results in a direct exposure to radiation.

### Locations:
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

### Release Mechanisms:
- N/A - Direct Exposure

### Assumptions:
None

### Causes:
- Container mishandling
- Equipment malfunction
- Improper container placement or handling
- Improper equipment use
- Loss of shielding (shifting, breaching, reconfigures waste, loss of cap, etc.)
- Mislabeled container
- Securing devices fail

### Unmitigated System Effects:
None

### Methods of Detection:
- Dosimetry
- Radcon instrumentation

### Unmitigated Frequency: A

### Mitigated Frequency: A

### Consequence / Risk Rank

<table>
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<tr>
<th>Receptor</th>
<th>Rad Consequence</th>
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<tr>
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</table>

### Preventive Features:
- Engineered: None
- Admin: None

### Mitigative Features:
- Engineered: None
- Admin: None

### Credited SSCs and ACs
- Preventers: None
- Mitigators: None
- Notes: None
- References: None

### DOE 5506 Detail:
- Direct Exposure to Radiation Events - Container Handling (13b)
- Direct Exposure to Radiation Events - Staging and Storage (13d)
### Hazard Evaluation Table - Event RANTRTOG-5-001

**Description:**
Vehicle transporting multiple high FGE TRU waste containers between Area G and RANT, is involved in an accident. Fuel spills/leaks in coincidence with ignition source, results in a pool fire. The fire burns the waste, which mixes with fire extinguishing water and collects in an unfavorable geometry resulting in a criticality.

**Locations:**
- Mesita del Buey (TA-54 Access Road between RANT and Area G)

**MARs:**
- Fissile Material

**Release Mechanisms:**
- N/A - Criticality

**Assumptions:**
None

**Causes:**
- Addition of moderator
- Fissile material collects in critical configuration
- Ignition source
- Reduction of waste volume
- Vehicle/equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Dosimetry
- Observation
- Radcon instrumentation

**Unmitigated Frequency:** NC

**Mitigated Frequency:** NC

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
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<tr>
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<td>H</td>
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</table>

**Preventive Features:**

- Engineered: None
- Admin: None

**Mitigative Features:**

- Engineered: None
- Admin: None

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SMP</td>
<td>Nuclear Criticality Program</td>
<td>Establishes administrative guidance for process and emergent nuclear criticality safety issues (special disposal conditions, safety evaluations, limits)</td>
</tr>
</tbody>
</table>

**Safety Function:** Reduces likelihood of inadvertent criticality to an acceptably low level which is not physically plausible

**Notes:**
- The physical process required for this event to occur is not physically plausible. The physical process would require a release of > 1 kg Pu, suspension of the Pu in the water stream, transference of the entire quantity of Pu by water, filtration of impurities, and concentration of sufficient Pu in an unfavorable configuration (> 30 g/liter).

**References:**
- None

**DOE 5506 Detail:**
- Fuel Pool Fire - Characterization (1a)
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Venting and/or Abating/Purging (1c)
- Fuel Pool Fire - Staging and Storage (1d)
- Fuel Pool Fire - Waste Repackaging (1f)
- Fuel Pool Fire - Type B Container Loading/Unloading (1g)
### Hazard Evaluation Table - Event TRU H3-1-001

**Description:**
A vehicle transporting a single TRU waste container at ≤ 10 mph impacts stored H3 containers. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the TRU and H3 waste containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARs:**
- 553 PEC (One [1] TRU waste container)
- ≤ 1,000,000 Ci of Tritium in storage

**Release Mechanisms:**
- Fuel pool fire release
- Low energy impact

**Assumptions:**
None

** Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU

**Mitigated Frequency:** BEU

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
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<td>W</td>
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<td>II</td>
<td>M</td>
<td>IV</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
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<tr>
<td></td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
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---


12/17/2013
## PSAC Radiological Inventory Management - TRU Waste Drum Doublepack

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<tr>
<th>PSAC</th>
<th>Radiological Inventory Management - TRU Waste Drum Doublepack</th>
<th>Doublepack radiological waste drums ≥ 200 PEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Function</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
- None

### Detail:
- DOE 5506
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)
## Hazard Evaluation Table - Event TRU H3-1-002

### Description:
A vehicle transporting multiple TRU waste containers at \( \leq 10 \) mph impacts stored H3 containers. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the TRU and H3 waste containers resulting in a release of radiological material.

### Locations:
- Area G

### MARs:
- 877 PEC (Statistical 48 (all) containers)
- \( \leq 1,000,000 \) Ci of Tritium in storage

### Release Mechanisms:
- Fuel pool fire release
- Low energy impact

### Assumptions:
None

### Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

### Unmitigated System Effects:
None

### Methods of Detection:
Observation

### Unmitigated Frequency:
EU

### Mitigated Frequency:
BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>M</td>
<td>IV</td>
</tr>
</tbody>
</table>

### Preventive Features:

#### Engineered
None

#### Admin
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back.).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits \( \leq 15 \) mph)

### Mitigative Features:

#### Engineered
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (IC) Metal TRU waste container are of sound integrity
- (SS) [IC] Waste Packaging Control Waste is packaged

#### Admin
- (PSAC) [IC] Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums \( \geq 200 \) PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Preventers: Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSAC</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong> Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Mitigators: Hazardous Material and Waste Management - TRU Waste Container (IC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong> Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
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<table>
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<tr>
<th>Class</th>
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<td></td>
<td>SS</td>
<td>Waste is packaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety Function:</strong> Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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</tbody>
</table>

**Chapter 3: Hazard and Accident Analysis**

**Appendix 3H**


**Basis for Interim Operation Rev. 3.0**

**November 2014**
<table>
<thead>
<tr>
<th>(IC)</th>
<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack Doublepack radiological waste drums &gt; 200 PEC</td>
</tr>
<tr>
<td></td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

Notes:  
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.  
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.  
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

References: None

DOE 5506  
Detail:  
- Fuel Pool Fire - Container Handling (1b)  
- Fuel Pool Fire - Other (1h)
Hazard Evaluation Table - Event TRU H3-1-003

**Description:**
A vehicle transporting a single TRU waste container at > 10 and ≤ 35 mph impacts stored H3 containers. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the TRU and H3 waste containers.

**Locations:**
- Area G

**MARS:**
- 553 PEC (One [1] TRU waste container)
- ≤ 1,000,000 Ci of Tritium in storage

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:**
- EU

**Mitigated Frequency:**
- BEU

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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</thead>
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<tr>
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<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
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<td>H</td>
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<td>M</td>
</tr>
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</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) (IC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
</tr>
</tbody>
</table>

**Safety Function:**
- Reduces likelihood of fuel interaction with MAR
- Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
- Reduces the radiological consequences as waste is agglomerated and burns as packaged.
<table>
<thead>
<tr>
<th>PSAC</th>
<th>Radiological Inventory Management - TRU Waste Drum Doublepack</th>
<th>Doublepack radiological waste drums ( \geq 200 ) PEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
<tr>
<td>Notes:</td>
<td>It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
</tr>
<tr>
<td>References:</td>
<td>None</td>
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<tr>
<td>DOE 5506</td>
<td>Fuel Pool Fire - Container Handling (1b)</td>
<td></td>
</tr>
<tr>
<td>Detail:</td>
<td>Fuel Pool Fire - Other (1h)</td>
<td></td>
</tr>
</tbody>
</table>
### Hazard Evaluation Table - Event TRU H3-1-004

**Description:**
A vehicle transporting multiple TRU waste containers at > 10 and ≤ 35 mph impacts H3 containers that are stored above ground, or are being lowered into a tritium disposal shaft. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the TRU and H3 waste containers resulting in a release of radiological material.

**Locations:**
- Area G

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Mitigation Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
<th>Mit. DSA</th>
<th>Mit. DSA</th>
<th>Mit. DSA</th>
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<td>C</td>
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<td>IV</td>
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<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- None

**Admin**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.)
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (IC) (Metal TRU waste container are of sound integrity)
- (SS) [IC] Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) [IC] Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
</tbody>
</table>

**Safety Function:**
Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.

| Mitigators | SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity |

**Safety Function:**
Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
<table>
<thead>
<tr>
<th>SS</th>
<th>Waste Packaging Control (IC)</th>
<th>Waste is packaged</th>
<th>Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
<td>Doublepack radiological waste drums &gt; 200 PEC</td>
<td>Safety Function: Reduce radiological consequences by limiting amount of MAR involved</td>
</tr>
</tbody>
</table>

**Notes:**

- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506**

**Detail:**

- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)
| Description: | A vehicle transporting multiple H3 waste containers at ≤ 10 mph impact a single TRU waste container. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the tritium and TRU waste resulting in a release of radiological material. |
| Locations: | Area G |
| MARs: | ≤ 1,000,000 Ci of Tritium in transport |
| Locations: | 553 PEC (One [1] TRU waste container) |
| Release Mechanisms: | Fuel pool fire release |
| Release Mechanisms: | Low energy impact |
| Assumptions: | None |
| Causes: | Degraded/ Inadequate road condition (e.g., erosion, pot holes) |
| Causes: | Equipment malfunction |
| Causes: | Inclement weather |
| Causes: | Operator error |
| Causes: | Vehicle accident |
| Causes: | Vehicle/ equipment mechanical failure (e.g., steering, brakes) |
| Unmitigated System Effects: | None |
| Methods of Detection: | Observation |
| Unmitigated Frequency: | EU |
| Mitigated Frequency: | BEU |

<table>
<thead>
<tr>
<th>Consequence / Risk Rank</th>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit.</th>
<th>Chm</th>
<th>DSA Mit.</th>
<th>Phy</th>
<th>DSA Mit.</th>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preventive Features:</th>
<th>Engineered None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
<td>(PSAC) Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)</td>
</tr>
<tr>
<td>Admin</td>
<td>(SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
</tr>
<tr>
<td>Admin</td>
<td>(SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
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<tr>
<td>Admin</td>
<td>(DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
</tr>
<tr>
<td>Admin</td>
<td>(DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits &lt; 15 mph)</td>
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</table>

<table>
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<tr>
<th>Mitigative Features:</th>
<th>Engineered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
<td>(SS) [IC] Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
<tr>
<td>Admin</td>
<td>(SS) [IC] Waste Packaging Control (Waste is packaged)</td>
</tr>
<tr>
<td>Admin</td>
<td>(PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums ≥ 200 PEC)</td>
</tr>
<tr>
<td>Admin</td>
<td>(DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credited SSCs and ACs</th>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of &gt; 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G</td>
<td>Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles</td>
<td>All</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Radiological Inventory Management - TRU Waste</td>
<td>Doublepack radiological waste drums ≥ 200 PEC</td>
<td>Rad: P, C, W;</td>
</tr>
</tbody>
</table>
## Drum Doublepack

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Reduce radiological consequences by limiting amount of MAR involved</th>
</tr>
</thead>
</table>

### Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

### References:
- None

### DOE 5506
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)

---

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
- None

**DOE 5506**
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)
Hazard Evaluation Table - Event TRU H3-1-006

Description:
A vehicle transporting multiple H3 waste containers at \( \leq 10 \) mph impacts two (2) stacks of TRU waste containers. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the tritium and stored TRU waste resulting in a release of radiological material.

Locations:  
- Area G

Release Mechanisms:  
- Fuel pool fire release
- Low energy impact

Assumptions:  
None

Causes:  
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:  
None

Methods of Detection:  
- Observation

Unmitigated Frequency:  
EU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
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<tbody>
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<td>Unmit.</td>
<td>DSA Mit.</td>
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<td>C</td>
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<td>II</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>M</td>
</tr>
</tbody>
</table>

Preventive Features:

Engineered  
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of \(< 15\) mph) with a gross weight of \(< 150,000\) lbs and a ground clearance of \(< 40\) inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits \(< 15\) mph)

Admin  
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Mitigative Features:

Engineered  
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

Admin  
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums \(\geq 200\) PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of (&lt; 15) mph) with a gross weight of (&lt; 150,000) lbs and a ground clearance of (&lt; 40) inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
</tr>
</tbody>
</table>

Safety Function: The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function

12/17/2013
typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

| PSAC Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G | Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles | All |
| Safety Function: Reduces likelihood of fuel interaction with MAR |

### Mitigators

| SS | Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
| Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers. |

| SS | Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |
| Safety Function: Reduces the radiological consequences as waste is agglomerated and burns as packaged |

| PSAC Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | Rad: P, C, W; |
| Safety Function: Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas. |

| Safety Function: Reduce radiological consequences by limiting amount of MAR involved |

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506**  
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)
Hazard Evaluation Table - Event TRU H3-1-007

Description:
A vehicle transporting multiple H3 waste containers at > 10 and < 35 mph impact a single TRU waste container. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the tritium and TRU waste resulting in a release of radiological material.

Locations:
- Area G

MARS:
- < 1,000,000 Ci of Tritium in transport
- 553 PEC (One [1] TRU waste container)

Release Mechanisms:
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

Assumptions:
None

Causes:
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

Unmitigated System Effects:

None

Methods of Detection:
- Observation

Unmitigated Frequency: EU

Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
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</table>

Preventive Features:

Engineered
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

Admin
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

Mitigative Features:

Engineered
- (SS) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) Waste Packaging Control (Waste is packaged)

Admin
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack(Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

Credited SSCs and ACs

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<td>Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of &lt; 15 mph) with a gross weight of &lt; 150,000 lbs and a ground clearance of &lt; 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
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Safety Function: The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function...
typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

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<td>Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
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<td>Waste Packaging Control (IC)</td>
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<td>Safety Function:</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged</td>
</tr>
<tr>
<td>PSAC</td>
<td>Fire Protection - Thermal Separation Distance - Defined Area</td>
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<tr>
<td>Safety Function:</td>
<td>Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.</td>
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<tr>
<td>PSAC</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack</td>
</tr>
<tr>
<td>Safety Function:</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved. Reduce the likelihood of progression of a fire between defined areas.</td>
</tr>
</tbody>
</table>

Notes:
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

References: None

DOE 5506
Fuel Pool Fire - Container Handling (1b)
Fuel Pool Fire - Other (1h)
### Hazard Evaluation Table - Event TRU H3-1-008

**Description:**
A vehicle transporting multiple H3 waste containers at > 10 and ≤ 35 mph impacts four (4) stacks of TRU waste containers. The accident involves no additional waste. Fuel is leaked and ignited resulting in a fuel pool fire involving the tritium and TRU waste resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- ≤ 1,000,000 Ci of Tritium in transport
- 877 PEC (Statistical 48 (all) containers)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Unmitigated Frequency:**
EU

**Methods of Detection:**
- Observation

**Consequence / Risk Rank**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unmit.</td>
<td>DSA Mit.</td>
<td>Unmit.</td>
</tr>
<tr>
<td>P</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
<tr>
<td>C</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (SS) Vehicle Barriers-High Risk Locations (Vehicle barrier systems installed at high risk locations (concrete barriers) must be capable of stopping a vehicle (moving at a velocity of < 15 mph) with a gross weight of < 150,000 lbs and a ground clearance of < 40 inches. • The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.)
- (SMP) Vehicle/ Equipment Safety Controls - Vehicle Barriers - Non-high Risk (Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored)

**Admin**
- (PSAC) Escort of > 100 gallons Flammable Liquid Inventory Vehicles within TA-54, AREA G (Vehicles/ equipment with greater than the total of 100 gallon of flammable/ combustible liquid on board (i.e., fuel tanks, hydraulics, fuel cans) must be escorted along designated routes of travel except for emergency response vehicles)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Mitigative Features:**

**Engineered**
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Admin**
- (PSAC) Fire Protection - Thermal Separation Distance - Defined Area (Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers.)
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>SS</td>
<td>Vehicle Barriers-High Risk Locations</td>
<td>All</td>
</tr>
</tbody>
</table>

**Chapter 3: Hazard and Accident Analysis**
Appendix 3H
| Mitigators | SS Hazardous Material and Waste Management - TRU Waste Container (IC) | Metal TRU waste container are of sound integrity | Rad: P, C, W; |
| Mitigators | SS Waste Packaging Control (IC) | Waste is packaged | Rad: P, C, W; |
| Mitigators | PSAC Fire Protection - Thermal Separation Distance - Defined Area | Reduce the frequency of the propagation of fire between defined areas by limiting the heat flux to radiological waste containers. | Rad: P, C, W; |

**Safety Function:**
- The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact. The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the material-at-risk (MAR) in transport, and no additional radiological waste is involved.

**Notes:**
- It is assumed that no additional waste is sufficiently close to be subjected to the radiant heating of the fuel pool.
- The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements.

**References:**
None

**DOE 5506 Detail:**
- Fuel Pool Fire - Container Handling (1b)
- Fuel Pool Fire - Other (1h)
### Hazard Evaluation Table - Event TRU LLW-1-001

**Description:**
Vehicle transporting multiple TRU waste containers crashes into LLW disposal pit at > 10 mph and < 35 mph and ruptures fuel tank resulting in a pool fire with the release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 100 PEC exposed MAR and < 3,000 Ci exposed Tritium-contaminated waste
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fuel pool fire release
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** EU
**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>DSA Mit</th>
<th>Chm</th>
<th>DSA Mit</th>
<th>Phy</th>
<th>DSA Mit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>M</td>
<td>III</td>
<td>M</td>
<td>IV</td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>M</td>
<td>III</td>
<td>M</td>
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<tr>
<td>W</td>
<td>H</td>
<td>II</td>
<td>H</td>
<td>III</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventive Features:**

**Engineered**
- (PSAC) Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and >800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).)
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc.))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

**Admin**
- (PSAC) Radiological Inventory Management - Overburden/ Soil Barrier Control (Establishes > 3 inches of ground cover or equivalent thermal barrier between below-ground and above-ground MAR inventory)
- (SS) (IC) Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)
- (SS) (IC) Waste Packaging Control (Waste is packaged)

**Mitigative Features:**

**Engineered**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (PSAC) Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)
- (PSAC) Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums > 200 PEC)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

**Admin**
- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS</td>
<td>Hazardous Material and Waste Management</td>
<td>Metal TRU waste container are of sound integrity</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>Waste Management - TRU Waste Container (IC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>SS Waste Packaging Control (IC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Waste is packaged Rad: P, C, W;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>PSAC Radiological Inventory Management - Defined Area MAR Control</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>PSAC Radiological Inventory Management - Transportation Vehicle limits-compliant metal containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety Function:</th>
<th>PSAC Radiological Inventory Management - TRU Waste Drum Doublepack</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Doublepack radiological waste drums &gt; 200 PEC Rad: P, C, W;</td>
</tr>
</tbody>
</table>

**Notes:** The fuel pool is assumed to consist of one hundred (100) gallons of fuel at 0.15 inch depth.

**References:** None

**DOE 5506 Detail:** Fuel Pool Fire - Container Handling (1b)
### Hazard Evaluation Table - Event TRU LLW-1-002

**Description:**
Vehicle transporting multiple TRU waste containers crashes into LLW disposal pit and breaches containers resulting in a fire with the release of radiological material.

**Locations:**
- Area G

**MARs:**
- ≤ 100 PEC exposed MAR and ≤ 3,000 Ci exposed Tritium-contaminated waste
- ≤ 1,100 PEC (MAR limit for single transport vehicle)

**Release Mechanisms:**
- Fire
- Impact and spill
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Consequence / Risk Rank</th>
<th>Preventive Features</th>
<th>Mitigative Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventive Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PSAC)</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers (Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back)).</td>
</tr>
<tr>
<td>(SMP)</td>
<td>Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))</td>
</tr>
<tr>
<td>(SMP)</td>
<td>Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)</td>
</tr>
<tr>
<td>(DID)</td>
<td>Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))</td>
</tr>
<tr>
<td>(DID)</td>
<td>Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits &lt; 15 mph)</td>
</tr>
</tbody>
</table>

**Mitigative Features:**

<table>
<thead>
<tr>
<th>Admin</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SS) IC</td>
<td>Hazardous Material and Waste Management - TRU Waste Container (Metal TRU waste container are of sound integrity)</td>
</tr>
<tr>
<td>(SS) IC</td>
<td>Waste Packaging Control (Waste is packaged)</td>
</tr>
<tr>
<td>(PSAC)</td>
<td>Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))</td>
</tr>
<tr>
<td>(PSAC)</td>
<td>Radiological Inventory Management - Overburden/ Soil Barrier Control (Establishes &gt; 3 inches of ground cover or equivalent thermal barrier between below-ground and above-ground MAR inventory)</td>
</tr>
<tr>
<td>(PSAC)</td>
<td>Radiological Inventory Management - Transportation Vehicle limits -compliant metal containers (The total TRU MAR inventory on a transportation vehicle with only compliant metal containers does not exceed 1,100 PE-Ci.)</td>
</tr>
<tr>
<td>(PSAC)</td>
<td>Radiological Inventory Management - TRU Waste Drum Doublepack (Doublepack radiological waste drums &gt; 200 PEC)</td>
</tr>
<tr>
<td>(DID)</td>
<td>Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)</td>
</tr>
</tbody>
</table>

**Credited SSCs and ACs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within TA-54, Area G – Compliant Containers</td>
<td>Transportation vehicles with compliant metal containers and &gt;800 PE-Ci will be escorted by a rolling roadblock (i.e. escort vehicle in front and back).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety Function:</td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>SMP</td>
<td></td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
</tr>
<tr>
<td>SMP</td>
<td></td>
<td>Safety Function:</td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Hazardous Material and Waste Management - TRU Waste Container (IC)</td>
<td>Metal TRU waste container are of sound integrity</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Mitigators</td>
<td>SS Waste Packaging Control (IC)</td>
<td>Waste is packaged</td>
<td>Rad: P, C, W;</td>
</tr>
<tr>
<td>Mitigators</td>
<td>PSAC Radiological Inventory Management - Overburden/Soil Barrier Control</td>
<td>Establishes &gt; 3 inches of ground cover or equivalent thermal barrier between below-ground and above-ground MAR inventory</td>
<td>Rad: W;</td>
</tr>
</tbody>
</table>

**Notes:**
- Combustible /flammable materials external to container
- When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements

**References:** None

**DOE 5506 Detail:**
- Small Fire - Container Handling (2b)
- Small Fire - Retrieval and Excavation (2e)
## Hazard Evaluation Table - Event TRU LLW-3-001

**Description:**
Vehicle transporting multiple non-metal TRU waste containers at > 10 mph and < 35 mph drives off into LLW disposal pit breaching containers resulting in a release of radiological material.

**Locations:**
- Area G

**MARS:**
- < 100 PEC exposed MAR and < 3,000 Ci exposed Tritium-contaminated waste
- 475 PEC (Statistical 2 non-metal containers in transport)

**Release Mechanisms:**
- Impact and spill
- Loss of Confinement
- Moderate energy impact

**Assumptions:**
None

**Causes:**
- Degraded/ Inadequate road condition (e.g., erosion, pot holes)
- Equipment malfunction
- Inclement weather
- Large animal impact
- Operator error
- Vehicle accident
- Vehicle/ equipment mechanical failure (e.g., steering, brakes)

**Unmitigated System Effects:**
None

**Methods of Detection:**
- Observation

**Unmitigated Frequency:** U
**Mitigated Frequency:** BEU

### Consequence / Risk Rank

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Rad</th>
<th>Chm</th>
<th>Phy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>M</td>
<td>II</td>
<td>IV</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>II</td>
<td>M</td>
</tr>
<tr>
<td>W</td>
<td>H</td>
<td>I</td>
<td>M</td>
</tr>
</tbody>
</table>

#### Preventive Features:

**Engineered:** None

- (PSAC) Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers (Transportation vehicles with non-compliant metal and non-metal containers and > 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back))
- (SMP) Maintenance Program - Vehicle/ Equipment (Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift))
- (SMP) Training and Qualification Program - Qualifications (Personnel maintain applicable LANL qualifications for vehicle and equipment operation)
- (DID) Hazardous Material and Waste Management - Inclement Weather Control (Suspend outdoor activities associated with handling/ transportation of radiological waste during inclement weather (sustained high winds, lightning, etc))
- (DID) Vehicle/ Equipment Safety Controls-Speed Limits (Posted speed limits < 15 mph)

#### Mitigative Features:

**Engineered:** None

- (PSAC) Radiological Inventory Management - Defined Area MAR Control (Limit MAR in Defined Areas: Process Areas, Bldg 412, LAA, Transport Vehicles, and Storage Areas. (TRU Storage Areas not collocated with SSSR Areas))
- (SMP) Radiation Protection Program (Evaluates radiological conditions and processes for worker protection)
- (DID) Hazardous Material and Waste Management - Secure Transport (TRU waste containers are secured during transport)

### Credited SSCs and ACs

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>Attribute</th>
<th>Affected Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventers</td>
<td>PSAC</td>
<td>Escort of High MAR TRU Waste Transport Within Ta-54, Area G– Non-compliant Containers</td>
<td>Transportation vehicles with non-compliant metal and non-metal containers and &gt; 450 PE-Ci will be escorted by a rolling roadblock (i.e., escort vehicle in front and back)</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the frequency of vehicle accidents and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>SMP</td>
<td>Maintenance Program - Vehicle/ Equipment</td>
<td>Periodic inspection and maintenance of LANL vehicles/ equipment (forklift, manlift)</td>
<td>All</td>
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<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduce likelihood of equipment malfunction</td>
</tr>
<tr>
<td>SMP</td>
<td>Training and Qualification Program - Qualifications</td>
<td>Personnel maintain applicable LANL qualifications for vehicle and equipment operation</td>
<td>All</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces likelihood for vehicle and equipment accidents</td>
</tr>
<tr>
<td>Safety Function:</td>
<td></td>
<td></td>
<td>Reduces the radiological consequences by limiting the MAR involved</td>
</tr>
<tr>
<td>SMP</td>
<td>Radiation Protection Program</td>
<td>Evaluates radiological conditions and processes for</td>
<td>Rad: W;</td>
</tr>
<tr>
<td></td>
<td>worker protection</td>
<td></td>
<td></td>
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<td>------------------</td>
<td>--------------------------------------------------------</td>
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<tr>
<td>Safety Function:</td>
<td>Reduces radiological consequences due to exposure</td>
<td></td>
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<tr>
<td>Notes:</td>
<td>● Non-compliant container consequences bound the compliant container consequences.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>● When Maintenance Program and Training and Qualification Program are used together, one full bin of reduction may be given based on the robustness of the programs and the individual elements</td>
<td></td>
<td></td>
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<tr>
<td>References:</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOE 5506 Detail:</td>
<td>● Vehicle/Equipment Impacts Waste/Waste Containers - Container Handling (9b)</td>
<td></td>
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</tr>
</tbody>
</table>
APPENDIX 3I
30-FT SAFE STANDOFF DISTANCE FOR DRUM VENTING
Dose Rates for the Area Inside the Safe Standoff Distance

The safe standoff distance is credited with protecting workers outside the standoff distance from the radiological hazards and the pressure effects of a container deflagration\(^1\). The standoff distance is based on a quantitative estimation of the dose rate (in rem/min) that a worker may experience at 30 ft from a postulated deflagration. The dose rate is evaluated in the context of a worker’s ability to evacuate if a deflagration occurs.

The methodology to determine the safe standoff distance as a function of a worker’s ability to evacuate is not without precedent within the DOE complex. The hazard analysis at the Savannah River Site (SRS), Aiken, SC [Ref. 1] determined that at dose rates > 100 rem/min, the evacuation of workers near the deflagration is ineffective at limiting worker doses.

From the SRS Consolidated Hazard Analysis document [Ref. 1], pg 64:

To determine the appropriate standoff area, documentation of drum deflagrations experiments (Gordon, R. J., Explosion Characteristics of H2 – Air Mixtures Relative to Transuranium (TRU) Waste Containers, E. I. DuPont de Nemours, Savannah River Plant, Aiken, SC, February 18, 1986) were reviewed coupled with informed qualitative dose estimates. Based on these considerations, it was judged that a distance of approximately 30 feet was sufficient to protect workers from the immediate radiological and physical consequences of a lid ejecting drum deflagration. Thirty feet provides workers protection from the impingement of debris that could be ejected horizontally in a drum (most prevalent container type) explosion. Additionally, this distance allows workers outside the standoff area time to react to the accident and evacuate before receiving a significant airborne radiological dose. Factors that could alter this distance include: access to egress routes, the presence of barriers such as the DVS chamber, the RUBB structure, etc. that could reasonably be expected to limit the spread of debris and radioactive contamination, etc. These additional factors may warrant an increase or decrease in the safe standoff distance. If decreasing the safe standoff distance, however, justification must be developed that addresses both physical and radiological worker consequences.

A quantitative assessment of the dose rate is calculated using the SRS methodology, and is derived from:

\[
\text{Dose Rate (rem/min) = (Instantaneous ST)/Volume } \times \text{ BR } \times \text{ DCF (Equation 1)}
\]

The parameters of the dose rate are discussed further.

**Instantaneous ST**

Table 4.4.2-1 of DOE-STD-5506 [Ref. 2] lists the damage ratios (DR) of the source term (ST) components of a deflagration. The DR values are a composite result of several empirical deflagration studies involving simulated waste found in TRU waste containers. The ST components of the deflagration are summarized in Table 3I-1 [Ref. 2]:

\(^1\)Engineering calculation Blast Overpressure Calculation from a DOT 7A Type A 55-gallon and 85-gallon Transuranic (TRU) Drum Explosion, CALC-11-TA-54-AREAG-010, Rev. 0, June 2011, indicates that the 30-ft separation is sufficient to protect the facility worker from calculated peak overpressures as a result of a deflagration.
Table 3I-1 – Drum Deflagration Damage Ratios

<table>
<thead>
<tr>
<th>ST Component</th>
<th>Waste Form Percentage</th>
<th>Damage Ratio for Release Phenomenon</th>
<th>Damage Ratio for Fraction Burned Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ejected flexing in air</td>
<td>n/a</td>
<td>0.4</td>
<td>n/a</td>
</tr>
<tr>
<td>Ejected combustible waste burning outside</td>
<td>100%</td>
<td>0.4</td>
<td>0.05</td>
</tr>
<tr>
<td>Combustible waste burning inside drum</td>
<td>100%</td>
<td>0.6</td>
<td>n/a</td>
</tr>
</tbody>
</table>

The instantaneous ST to the facility worker is comprised of the initial ejected waste content that experiences flexing in air, and the ejected combustible waste that is burning outside of the drum. The ST from the confined burning part of the deflagration is associated with a slow, smoldering fire, and is not considered in the instantaneous ST to the facility worker. As an example, presuming a deflagration involving a drum with material–at-risk (MAR) of 140 $^{239}$Pu equivalent curies (PE-Ci), the instantaneous ST is derived:

$$ ST = MAR \times DR \times ARF \times RF \quad (Equation\ 2) $$

Where:

- **MAR** = Material-at-risk (PE-Ci)
- **ARF × RF for the initial ejected material** = 1E-4
- **ARF × RF for confined burning of combustible material** = 1E-2

$$ Instantaneous\ ST = (140\ PE-Ci \times 0.4 \times 1E-4) + (140\ PE-Ci \times 0.4 \times 0.05 \times 1E-2) $$

$$ = 3.4E-2\ PE-Ci \quad (Equation\ 3) $$

**Volume**

The volume is the hemisphere with a radius of 30 ft.

The dose rate estimates are probably over-conservative because they are an average dose rate within the volume of the hemisphere. At the 30-ft radius, an actual dose rate will be much lower, and, at the source, the actual dose rate will be higher. Calculations of actual values of dose rates are complicated and convoluted. However, the dose rate estimates in this document are also considered reasonably bounding.

The volume of a hemisphere ($2/3 \times \pi \times r^3$) with a radius ($r$) of 30 ft is

$$ 56,549\ ft^3 = 1,601\ m^3 \quad (Equation\ 4) $$
Breathing Rate (BR) and Inhalation Dose Conversion Factor (DCF)

- BR = Breathing Rate = \(3.3\times10^{-4} \text{ m}^3/\text{sec} = 2\times10^{-2} \text{ m}^3/\text{min}\) (consistent with DOE-STD-5506 [Ref. 2])
- DCF = Inhalation Dose Conversion Factor = \(3.2\times10^{-5} \text{ Sievert/Becquerel} \) or \(1.2\times10^8 \text{ rem/Ci}\) – applicable to the facility and collocated worker for nitrated \(^{239}\text{Pu}\) from ICRP 68 [Ref. 3] for Moderate solubility, 5 µm unfiltered releases)

Dose Rate Calculation

Using Equations 1, 3, and 4 to determine the dose rate from a deflagration involving 140 PE-Ci in combustible waste:

\[
\text{Dose Rate} = \left[\frac{3.4\times10^{-2} \text{ PE-Ci}}{1,601 \text{ m}^3}\right] \times 2\times10^{-2} \text{ m}^3/\text{min} \times 1.2\times10^8 \text{ rem/PE-Ci} = 50 \text{ rem/min}
\]

At this dose rate (< 100 rem/min), it is presumed that the worker may readily evacuate, so the dose to the worker is due to the instantaneous release of radiological material from a deflagration involving 140 PE-Ci. In general, a low collocated worker dose (< 25 rem) will result in a dose rate < 100 rem/min to the worker when using the deflagration ST model (Table 3I-1).

Application of Dose Rate Estimates

Worker dose rate estimates for varying MAR values are shown in Table 3I-2. The data indicates that between 140 and 480 PE-Ci, additional controls are required for the protection of the worker in addition to the 30-ft separation distance, because the dose rate could exceed 100 rem/min in this MAR range. Additional worker protection controls for venting, such as a contamination-controlled environment (e.g., enclosure, ventilation flow, and/or filtration) as specified by Radiation Protection Program requirements, are discussed in Section 3.3.

The source term and consequence analysis for the collocated worker and public receptors is discussed further in DBA 4C, Section 3.4 of the Area G BIO.

<table>
<thead>
<tr>
<th>MAR</th>
<th>Instantaneous ST=(MARx0.4x1E-4)+(MARx0.02x1E-2)</th>
<th>(Worker) Dose Rate = rem/min within 30 ft hemisphere</th>
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</thead>
<tbody>
<tr>
<td>45</td>
<td>0.0108</td>
<td>16</td>
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<td>140</td>
<td>0.0336</td>
<td>50</td>
</tr>
<tr>
<td>480</td>
<td>0.1152</td>
<td>173</td>
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<tr>
<td>882</td>
<td>0.21168</td>
<td>317</td>
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</table>

Table 3I-2 –Potential Worker Dose Rate vs. MAR (presumes a 100% combustible waste matrix)
References:


CHAPTER 4

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**4.5.8** Drum Venting of Unvented TRU Waste Drums

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<td>Code of Federal Regulations</td>
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<td>CMP</td>
<td>corrugated metal pipe</td>
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<td>CoC</td>
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<tr>
<td>DF</td>
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<tr>
<td>DOE</td>
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<tr>
<td>DR</td>
<td>damage ratio</td>
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<td>FRP</td>
<td>fiberglass-reinforced plywood</td>
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<td>LAA</td>
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<td>LANL</td>
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<tr>
<td>NPH</td>
<td>Natural Phenomena Hazard</td>
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<tr>
<td>NRC</td>
<td>Nuclear Regulatory Commission</td>
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<tr>
<td>OSHA</td>
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<tr>
<td>PE-Ci</td>
<td>plutonium equivalent curie</td>
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<td>POC</td>
<td>Pipe Overpack Container</td>
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</tr>
<tr>
<td>RANT</td>
<td>Radioassay and Nondestructive Testing Facility</td>
<td></td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
<td></td>
</tr>
<tr>
<td>RF</td>
<td>Respirable Fraction</td>
<td></td>
</tr>
</tbody>
</table>
SAC  Specific Administrative Control
SMP  Safety Management Program
SNL  Sandia National Laboratory
SSC  structure, system, and component
SSSR  Sort, Segregate, Size Reduction, and Repackaging
SR   Surveillance Requirement
SWB  Standard Waste Box
TA   Technical Area
TRU  Transuranic
TRUPACT  Transuranic Package Transporter
TSD  LANL Transportation Safety Document
TSR  Technical Safety Requirement
USQ  Unreviewed Safety Question
WAC  Waste Acceptance Criteria
WIPP  Waste Isolation Pilot Plant
Chapter 4 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 INTRODUCTION

This chapter provides details on those structures, systems, and components (SSCs) that are designated as safety-class and safety-significant for Technical Area (TA)-54, Area G, as well as Specific Administrative Controls (SACs) that have safety importance equivalent to engineered controls that would be classified as safety-class or safety-significant if the engineered controls were available and selected.

The purpose of the selected safety-class and safety-significant SSCs and SACs is to provide protection to the public, collocated workers, and workers by serving as preventers and/or mitigators of postulated accidents. The selection of potential safety-class and safety-significant SSCs and SACs was made during the Consolidated Hazards Analysis process; see Appendix 3-H, Consolidated Hazard Analysis, of this Basis for Interim Operation (BIO). The accidents and associated controls are presented in Chapter 3 (Appendix 3A, Unique and Representative Events for TA-54, Area G Accident Analysis, Tables 3A-1 and 3A-2) of this BIO. The safety-class and safety-significant SSCs identified in the accident analyses to reduce risk to the public, collocated workers, and workers are discussed in Chapter 3 and identified in Table 4-1, Summary of Credited SSCs. The safety-class/safety-significant SACs identified in the accident analyses to reduce risk to the public, collocated workers, and workers are discussed in Chapter 3 and identified in Table 4-4.

The scope of this chapter includes the following:

- Description of the safety-class and safety-significant SSCs and SACs for TA-54, Area G operations, including the required safety functions.
- Identification of the functional requirements necessary for the safety-class and safety-significant SSCs and SACs to perform their safety functions, and the general conditions caused by postulated accidents under which these SSCs and SACs must operate.
- Identification of the performance criteria necessary to provide reasonable assurance that the functional requirements will be met.
- Identification of assumptions for SSCs and SACs that require Technical Safety Requirement (TSR) coverage.

In accordance with DOE-STD-1186 [DOE 2004], SACs are generally addressed through the TSRs in two forms:

1. SACs can be written in the format of a Limiting Condition for Operation (LCO)/ Surveillance Requirement.

2. SACs can also be written as specific Directive Action Administrative Controls (ACs) in the Administrative Controls section of the TSRs.
Table 4-1. Summary of Credited SSCs

<table>
<thead>
<tr>
<th>Control1</th>
<th>Section References</th>
<th>Safety Functions</th>
<th>Functional Requirements</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Barriers at High-Risk Locations (SC-SSC)</td>
<td>Accident Analysis (AA): DBA-1A, 1B, 1C, 2A, 7A Chapter 4 (C.4): 4.3.1 Chapter 5 (C.5): 5.6.1 TSRs: 6.1.1</td>
<td>The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The safety function is mitigative when the vehicle barrier at a high-risk location reduces radiological consequences by limiting the amount of material-at-risk (MAR) involved.</td>
<td>Capable of preventing vehicular impacts between Area G vehicles and the transuranic (TRU) waste containers at high-risk locations. Ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>At high-risk locations at TA-54, Area G, the vehicle barrier system (e.g., concrete barriers or alternate design) must be capable of stopping a vehicle (moving at a velocity &lt; 15 mph) with a gross weight &lt; 150,000 lb and a ground clearance of &lt; 40 in. Placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location. When vehicle barriers at a high risk location require relocation, repair, or maintenance, access to the road approaching the high risk location will be restricted so that no vehicle can make a perpendicular approach toward the defined area that is being protected. While the road closure is in effect, the defined area is not at high risk of vehicle impact. Applicability: The vehicle barriers are required to meet the performance criteria when the defined area at the high risk location being protected is in Operation or Warm Standby mode.</td>
</tr>
</tbody>
</table>

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1 SC = safety-class, SS = safety-significant, DF = design feature
Table 4-1. Summary of Credited SSCs

<table>
<thead>
<tr>
<th>Control1</th>
<th>Section References</th>
<th>Safety Functions</th>
<th>Functional Requirements</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRU Waste Containers (Pipe Overpack Containers [POCs] and Type B Containers) (SC-SSCs)</td>
<td>AA: N/A C.4: 4.3.2, 4.3.3, 4.4.1 C.5: TSRs: 6.1.2, 6.1.3</td>
<td>The POC, government-supplied equipment, is a SC-DF to protect the assumptions of the analysis for damage ratio (DR) =0.1. The sealed Type B container, (government or commercially supplied equipment) is a SC-DF to protect the assumptions of the analysis for DR=0.0.</td>
<td>POCs shall resist mechanical and thermal stresses generated from postulated accidents. Type B containers shall resist mechanical and thermal stresses that might occur as the result of postulated operational accidents, external, and Natural Phenomena Hazard (NPH) accident scenarios</td>
<td>POCs are procured to meet Waste Isolation Pilot Plant (WIPP) criteria described in Laboratory Packaging and Transportation requirements. Applicability: The POCs are required to meet the performance criteria when they contain high activity waste material. Type B containers meet 49 CFR 173.416 [CFR 2010] requirements for the specified container. Applicability: Type B containers are required to meet the performance criteria when they are sealed, with radiological material inside.</td>
</tr>
</tbody>
</table>
### Table 4-1. Summary of Credited SSCs

<table>
<thead>
<tr>
<th>Control1</th>
<th>Section References</th>
<th>Safety Functions</th>
<th>Functional Requirements</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRU Waste Containers (SS-SSC) Initial Condition</td>
<td>A: DBA-1A, 1B, 1D, 2A, 2B, 3, 9, 10, 10a, 11, 12 C. 4: 4.4.1 C.5: 5.6.4, 5.5.2.2.13 TSRs: 5.6.11, 6.2.1</td>
<td>Reduces the radiological consequences as waste is agglomerated and burns as packaged waste. <strong>/</strong> Reduces the consequences of mechanical and thermal effects to waste within containers of sound integrity. ** Reduces the consequences of thermal effects to contained waste within non-combustible waste containers. **</td>
<td>Contain waste so that, under a fire accident condition, the waste burns as confined waste. <strong>/</strong> Withstand mechanical stresses that might occur as the result of operational accidents and external event accidents. ** Provide protection to TRU waste within the metal TRU waste container from direct impingement of thermal stresses. **</td>
<td>TRU waste containers package waste. <strong>/</strong> TRU waste containers are of sound integrity. ** TRU waste containers are of non-combustible construction. ** Applicability: The TRU waste containers are required to meet the performance criteria when they contain TRU waste MAR.</td>
</tr>
</tbody>
</table>

*Applicable to non-compliant (metal and non-metal) TRU waste containers **Applicable to compliant TRU waste containers
4.2 REQUIREMENTS

Based on the types of safety SSCs analyzed in this chapter, the following parts of the Code of Federal Regulations (CFR) and U.S. Department of Energy (DOE) Guides and Standards are applicable:


4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

The SSC listed below is designated as safety-class. Table 4-1 provides a summary of the safety-class SSCs, their key parameters, and the design basis accidents for which they are credited in Chapter 3.

4.3.1 Vehicle Barriers at High-Risk Locations

4.3.1.1 Safety Function

Vehicle barriers are designated as safety-class SSCs based on their ability to prevent impacts between moving vehicles and TRU waste containers in defined areas at high-risk locations.

The safety function of the vehicle barrier at high-risk locations is preventive or mitigative, depending on the accident scenario for which the barriers are credited:

- The safety function is preventive when the vehicle barrier at a high-risk location reduces the likelihood for vehicle impact of stored waste containers. The preventive safety function typically involves a non-radiological-waste-bearing vehicle from impacting radiological waste containers, thereby preventing a release of radiological material due to the vehicle impact.
- The safety function is mitigative when the vehicle barrier at a high-risk location reduces the radiological consequences by limiting the amount of MAR involved. The mitigative safety function typically involves a radiological-waste-bearing vehicle that is prevented from impacting additional radiological waste containers. The radiological release is limited to the MAR in transport, and no additional radiological waste is involved.

Vehicle barrier systems at high-risk locations perform these safety functions for impact with no fire, impact with fire, and impact with pool fire accidents. See Table 4-1 for the unique and representative accident analyses from Chapter 3, Section 3.4 that credit this control and its safety functions.
4.3.1.2 System Description

Vehicle impacts to radiological waste containers and impacts with subsequent fires were determined to result in high radiological consequences to the public. Vehicle barrier systems at high-risk locations reduce the public risk and therefore are designated as safety-class.

The TRU waste containers may be located in various defined areas. Roadways within TA-54, Area G provide primary routes of travel for vehicles accessing and operating within Area G (see Chapter 1, Figure 1-3). In certain cases, the line-of-travel direction is toward a defined area and then turns just before reaching the area to route traffic beside and around the area. The hazard analysis postulated that a vehicle traveling toward a defined area could fail to make or complete its turn due to human error or equipment malfunction, resulting in an impact to waste containers by the vehicle. Therefore, barriers are installed at these high-risk locations to prevent vehicles from inadvertent impacts of waste containers in defined areas.

A high-risk location is any area identified in Area G where a TRU waste storage area, TRU retrieval area, SSSR area, or TRU process area is perpendicular to a designated vehicle roadway and could be impacted if a vehicle continued traveling in a straight path. An area where the designated vehicle roadway would only result in a glancing impact (i.e., not a straight path) is not considered a high-risk location. An area is not considered a high-risk location if a vehicle must make a turn in order to provide a pathway to TRU waste. This control also does not apply to vehicles that must travel behind the vehicle barriers in order to access defined areas, because accessing areas behind vehicle barriers would necessitate low speeds and attentive driving.

Properly positioned and connected vehicle barriers provide protection against motor vehicles inadvertently impacting TRU waste containers in defined areas at high-risk locations at Area G. Vehicle barriers are standard traffic control obstacles that absorb or redirect the momentum of errant vehicles to prevent impact with TRU waste containers. The movable concrete barriers are interconnected and positioned at Area G to prevent accidental vehicle impacts to TRU waste containers in defined areas at the high-risk location. Barrier design, integrity, and proper placement are ensured by this TSR DF. Annual in-service inspections (ISIs) ensure the integrity of the barrier system, including the interconnecting wire rope and hardware.

Vehicle barrier systems at high-risk locations do not rely on any other SSCs to perform their required function. The failure of any SSC will not result in the failure of a vehicle barrier. The placement of the vehicle barriers is important to prevent vehicles from intruding upon a thermal separation distance. Note that vehicles with greater than 100 gal of flammable liquid aboard (such as the water truck), and vehicles transporting high amounts of MAR are under escort. The escort helps to ensure speed limits are not exceeded. The requirement for vehicle barriers at high-risk locations is discussed further in System Evaluation, Section 4.3.1.4.

4.3.1.3 Functional Requirements

To fulfill the preventive safety function of reducing the likelihood for vehicle impact to stored waste containers, or the mitigative safety function of reducing consequences by limiting the amount of MAR involved in a vehicle impact scenario, the functional requirement of the vehicle barrier at high-risk locations is as follows:

- Capable of preventing vehicular impacts between Area G vehicles and TRU waste containers at high risk locations.
• Placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

### 4.3.1.4 System Evaluation

The performance criteria imposed on the vehicle barriers at high-risk locations so that they can meet functional requirements and thereby satisfy their safety functions is as follows:

- At high-risk locations at TA-54, Area G, the vehicle barrier system (e.g., concrete barriers or alternate design) must be capable of stopping a vehicle (moving at a velocity \( \leq 15 \text{ mph} \)) with a gross weight \( \leq 150,000 \text{ lb} \) and a ground clearance of \( \leq 40 \text{ in} \).

- The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

A vehicle barrier system at a high-risk location is designed to stop vehicles with a momentum of up to \(3.3\times10^6 \text{ ft-lb/s} \). The design is based on stopping the maximum postulated gross weight vehicle (i.e., a water truck weighing 150,000 lb) traveling at the TA-54, Area G posted speed limit (15 mph). The vehicle comes to a stop at a location that protects the thermal separation distance from TRU waste containers in defined areas at high-risk locations. The location will assume that the vehicle contains no more than 100 gal of flammable liquid because vehicles containing more than that are under escort. The vehicle barrier system at high-risk locations is designed to stop a 150,000-lb vehicle traveling with a momentum of up to \(3.3\times10^6 \text{ ft-lb/s} \) (i.e., 15 -mph) [LANL 2014]. The design basis water truck has a fuel capacity of greater than 100 gal of flammable liquid and is required to be escorted within Area G. The designated routes and escort requirement helps to limit the speed and the path of travel of the escorted water truck.

Each barrier has a nominal height of 48 in., based on the lowest point of the water truck bumper, which was determined to be less than or equal to a height of 37 in. (ground surface to bottom bumper surface). Each barrier has a minimum weight of 17,000 lb, and the interconnection of at least six barriers provides a vehicle barrier system weight of at least 102,000 lb.

The vehicle barriers are steel-reinforced concrete and can be physically interconnected. As the configuration of Area G varies to accommodate the closure of Area G to meet New Mexico Consent Order [NMED 2008] requirements, TRU waste defined areas at high-risk locations may shift. The vehicle barriers are constructed in a precast shape to permit them to be located, re-located, or removed as required. When vehicle barriers at a high risk location require relocation, repair, or maintenance, access to the road approaching the high risk location will be restricted so that no vehicle can make a perpendicular approach toward the defined area that is being protected. While the road closure is in effect, the defined area is not at high risk of vehicle impact.

The capability of vehicle barriers is designed into the barriers and their installation at high-risk locations. Except for high-energy impacts by vehicles or equipment, or long-term degradation, it is anticipated that their capability would not be degraded during the lifetime of the facility.

### 4.3.1.5 Controls (TSR)

Vehicle barriers are passive DFs. The barriers are designed, constructed, positioned, and installed to meet the performance criteria so that safety functions are met.
A periodic ISI (see Table 4-2) is required to ensure the vehicle barriers’ continued functionality throughout the lifetime of the facility. The inspection evaluates each installed barrier against the vehicle barrier design criteria and evaluates its continued capability to perform its function. Periodic ISIs are required to ensure that barriers are present at high-risk locations and that they are properly placed.

### Table 4-2. In-Service Inspection for Vehicle Barriers at High-Risk Locations

<table>
<thead>
<tr>
<th>In-Service Inspections</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>The physical integrity of the vehicle barrier system shall be inspected to identify any abnormalities (e.g., component deterioration, loose connectors, corrosion, or cracks) that may prevent the system from performing its safety function.</td>
<td>Annually</td>
</tr>
<tr>
<td>The physical placement of the vehicle barriers shall be inspected to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.</td>
<td>Annually and Before changes to designated routes are implemented and before establishing new defined areas</td>
</tr>
<tr>
<td>Designated routes shall be reviewed to ensure that vehicle barriers are present at high-risk locations.</td>
<td>Annually and Before changes to designated routes are implemented and before establishing new defined areas</td>
</tr>
</tbody>
</table>

The Configuration Management Program ensures that the barriers meet the design criteria, that they are located and installed in accordance with the design criteria, and that any planned modifications are evaluated.

#### 4.3.2 Pipe Overpack Containers

##### 4.3.2.1 Safety Function

The POC, government-supplied equipment, is a safety-class DF to protect the assumptions of the analysis for DR=0.1, mitigating releases of radioactive material when the container is subjected to mechanical or thermal stresses from postulated accidents.

##### 4.3.2.2 System Description

Pipe overpack containers are procured according to specifications of their design capability. The capability of the pipe components to maintain structural integrity during hypothetical accident conditions is due to the design and material construction of the pipe overpack. Testing has demonstrated the ability of the pipe overpack to provide two significant control functions: (1) containment of fine particulate waste material during normal conditions of transport and hypothetical accident conditions, and (2) shielding.
Procurement specifications ensure that the POC can meet its control functions according to the WIPP Waste Acceptance Criteria (WAC) [DOE 2013]. Design specifications for the various types of POCs can be found in the WIPP WAC. The POC is used at Area G according to WIPP WAC specifications to ensure that it performs its control function for DR=0.1.

4.3.2.3 Functional Requirements

To protect the presumptions of the Area G BIO accident analysis for the assignment of DR=0.1 for POCs, the government-supplied equipment is procured and utilized according to WIPP WAC specifications [DOE 2011b]. Through procurement specifications,

- POCs shall resist mechanical and thermal stresses generated from postulated accidents.

4.3.2.4 System Evaluation

The performance criterion imposed on the POCs so that they can meet functional requirements and thereby satisfy their safety functions is as follows:

- POCs are procured to meet WIPP criteria as described in Laboratory Packaging and Transportation requirements.

The POCs are robust engineered containers. The capability of the pipe components to maintain structural integrity during the evaluated accident scenarios is due to the design and material construction of the POCs. DOE-STD-5506 [DOE 2007] cites several studies of POCs under various accident conditions.

For spill scenarios, POCs with TRU waste material are vulnerable only to drops and falls from a distance of > 30 ft (9 m); structural collapse of substantial construction facilities where falling structural concrete slabs impact POCs, such as seismic collapse; and puncture by forklift tines. The POC was determined by finite element modeling to be vulnerable to forklift tine puncture due to the chisel design assumption and the very small impact area. For the concrete slab and forklift tine puncture, a DR=0.1 is assigned, and this DR value is assigned for POC usage at Area G.

Stacked POCs could be toppled due to a forklift collision. The POCs would be expected to withstand the impact associated with the toppling of stacks of POCs, as the distance to fall is much less than 30 ft. Because of the fiberboard material fill in the POC, the robust design of the Schedule 20 or Schedule 40 inner pipe, and the POC drop test performance, no release is expected from a cylinder missile impact or from tornado/wind-generated missiles.

For thermal insults, DOE-STD-5506 [DOE 2007] notes that the POCs are designed in a manner that precludes their failure during an expected storage area fire, and that POCs involved in storage and room fires need not be further evaluated in an accident analysis. For POCs subjected to fuel pool fires, the cited studies indicate that losses due to thermal stresses are negligible. For conservatism, a DR=0.1 is also assigned for these accidents. In the Sandia National Laboratory (SNL) study of POCs subjected to an engulfing pool fire test that is cited in DOE-STD-5506, four POCs were placed on an open support stand with one-meter spacing between them in a square array. The bottom of the units was one meter above the surface of a 10 m² pool of jet fuel floating on top of a layer of water at the pool fire test facility at SNL. The fuel was replenished so that the fire duration was 30 min. This type of fire test generally results in flame temperatures between 800 °C and 1,100 °C. The containers successfully survived the test.
4.3.2.5 Controls (TSR)

The POCs are passive design features and are included in the design features portion of the TSR document. Based on the durability demonstrated in the tests of the POC, as passive design features, the POCs are not expected to change or to experience operability degradation over time. Documentation that accompanies a POC is verified before MAR is added to ensure that the POC is a WIPP-approved design [DOE 2011b].

The performance criterion for the Pipe Overpack Containers is,

- Pipe Overpack meets WIPP waste acceptance criteria for criticality control, shielding, and containment of waste material.

The ISI for the POCs is the verification that the POC is procured to meet WIPP criteria before loading MAR.

4.3.3 Type B Containers

4.3.3.1 Safety Function

The sealed Type B container is a safety class DF to protect the assumptions of the analysis for DR=0.0.

4.3.3.2 System Description

Type B containers are robust engineered containers and are either government-supplied (e.g., TRUPACT II or HalfPACT) or commercially supplied (e.g., Model 10-160B) transportation containers designed to withstand accident conditions without releasing radioactive material. The capability of the Type B containers to maintain structural integrity during the evaluated accident scenarios is due to the design and material construction of the Type B container. Type B containers are fabricated and tested to meet design and performance requirements from their respective Safety Analysis Report for packaging. Once the Type B container has been loaded, sealed, and tested, the MAR in the Type B container can be credited with a Damage Ratio of 0.0.

4.3.3.3 Functional Requirements, System Evaluation, Performance Criteria

To protect the assumptions of the Area G BIO for the assignment of DR=0 for Type B containers, the equipment is used according to the CoC issued by the NRC for the Type B container. The CoC ensures that the container can perform its safety function

- Type B containers shall resist mechanical and thermal stresses that might occur as the result of postulated operational, external, and NPH accident scenarios.

4.3.3.4 System Evaluation

The Type B containers are either government or commercially supplied equipment. Accordingly, the system evaluation is performed by other such entities. Type B containers are inspected and certified that they meet the performance criteria as described in the respective Safety Analysis Report for packaging and CoC.

Type B containers, when properly sealed and tested, provide primary confinement of MAR. Because of the primary containment provided, the damage ratio for these waste containers is zero. Safety basis documentation is issued for Type B containers in the form of a CoC by the NRC, based upon the
respective Safety Analysis Report for packaging developed in accordance with 49 CFR 173 [CFR 2010] and 10 CFR 71 [CFR 2011b]. For this SSC, acceptance is achieved through a receipt inspection that verifies the currency of the CoC and the use of approved procedures to load, close, and test containers in preparation for shipment.

4.3.3.5 TSR Controls

Type B containers are passive design features and are included in the design features portion of the TSR document.

The performance criterion for the Type B container is:


The ISI requires verification that Type B containers have a current inspection sticker (provided by WIPP) or documentation of compliance provided by the manufacturer before loading MAR into the containers.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

The SSCs listed below are designated as safety-significant.

4.4.1 TRU Waste Containers

4.4.1.1 Safety Function

Two general types of TRU waste containers are present at Area G: non-metal and metal containers. Chapter 2 distinguishes the Area G containers as compliant (metal) or non-compliant (metal and non-metal). The information in this section further clarifies the protection provided by compliant metal containers. The hazard and accident analysis credits the waste containers for the following safety functions:

1. Reduces the radiological consequences as waste is agglomerated and burns as packaged waste.
2. Reduces the consequence of thermal effects to contained waste within non-combustible waste containers.
3. Reduces the consequence of mechanical and thermal effects to waste within containers of sound integrity.

This control is applicable to all accident scenarios, except for accidents involving Sort, Segregate, Size Reduction, and Repackaging (SSSR) activities.

4.4.1.2 System Description

4.4.1.2.1 Compliant (Metal) TRU Waste Containers

Most metal TRU waste containers in TA-54, Area G were procured to specifications that ensure sound integrity, ability to confine contents, and resistance to mechanical insults by an all-metal construction. A small percentage of the TRU waste containers used within TA-54, Area G were not procured to a particular specification, but were determined to meet the inspection criteria for a container of sound integrity, as prescribed in DOE-STD-5506-2007 [DOE 2007]. Metal TRU waste containers that are
currently credited for risk reduction in TA-54, Area G are 55-, 85- and 110-gallon drums; standard waste boxes (SWBs); ten-drum overpacks; corrugated metal boxes; and Bolas Grande spheres. Chapter 2 provides additional specifics of these containers.

Containers of sound integrity are able to absorb impact energy (e.g., drops or vehicle impacts) without releasing material, or at least limiting the amount of material that is released during the event. In addition, containers of sound integrity limit the amount of material that could be released due to container degradation. The TRU waste containers can be adversely affected by impacts from vehicles or equipment operating in their vicinity, or by drops from vehicles, equipment, or cranes. Most containers are stored within a structure, the collapse of which could affect container integrity. The collapse of lightweight domed structures, or a portion thereof, has been evaluated to have a minor effect on structurally sound TRU waste containers.

TRU waste containers of sound integrity are passive and do not rely on another SSC to perform their safety function. The unmitigated analysis source term parameters (e.g., DR < 1) presume containers of sound integrity for accidents involving compliant metal containers. Therefore, to protect the assumption of the analysis, if any of the drums listed above are found to show a loss of integrity, a TSR administrative control requires that the degraded container be overpacked. Other controls, such as vehicle barriers or thermal separation distances, protect the containers from accident conditions.

DOE-STD-5506-2007 inspection criteria [DOE 2007, Chapter 5, Section 5.5.2.2.14; and TSRs, Section 5.6.12.3] do not require a container vent to satisfy sound integrity requirements. Containers received from waste generators, or loaded within Area G, are verified to be of sound integrity and of non-combustible construction.

4.4.1.3 Functional Requirements

4.4.1.3.1 Compliant (Metal) TRU Waste Containers

To fulfill the safety function of reducing radiological consequences because waste is agglomerated and burns as packaged (confined) waste, the functional requirement of the compliant (metal) TRU waste container is the following:

- Contain waste, unless ejected, so that under a fire accident condition, the waste burns as confined waste.

To fulfill the safety function, the functional requirement of the compliant (metal) TRU waste container is the following:

- Withstand mechanical stresses that might occur as the result of operational accidents and external event accidents.

To fulfill the safety function of reducing consequences due to thermal effects to contained waste within non-combustible waste containers, the functional requirement of the compliant (metal) TRU waste container is the following:

- Provide protection to TRU waste within the metal TRU waste container from direct impingement of thermal stresses.

The containment of packaged waste by compliant (metal) TRU waste containers is a performance criterion that ensures that waste is agglomerated and burns as packaged and confined waste, as assumed in the hazard and accident analysis. The fact that the TRU waste is packaged supports application of the
 airborne release fractions (ARFs), respirable fractions (RFs), and DRs assumed in the accident analyses of fire events.

That compliant (metal) TRU waste containers are of sound integrity is a performance criterion to ensure that waste containers withstand mechanical stresses that might occur as the result of operational accidents and external event accidents. Fulfillment of this performance criterion ensures that the unmitigated consequences of mechanical and thermal stresses to confined waste due to fire, explosion, and spill events are reduced. All compliant metal TRU waste containers are visually inspected upon receipt and during handling. Any drum showing signs of degradation is overpacked into a larger metal container or repackaged into a compliant container.

That compliant metal TRU waste containers are of non-combustible construction fulfills a performance criterion that ensures that waste containers provide protection to TRU waste within the metal TRU waste container from direct impingement of thermal stresses. All new metal TRU waste containers are procured to meet the performance criteria. Any closed waste container constructed of a non-combustible material (e.g., steel or concrete) is credited with limiting the propagation of fire between non-combustible containers in a TRU Waste Storage Area. This attribute limits the consequences of a fire by limiting the amount of MAR involved during fire scenarios.

The facility implements procedures that require operators to visually inspect compliant (metal) TRU waste containers for integrity when handling or transporting the waste containers. These procedures require the identification of deficiencies and the implementation of appropriate corrective actions, such as overpacking the container. The visual inspection ensures that credited compliant (metal) TRU waste containers meet performance criteria for waste packaging, sound integrity, and all-metal construction. Specifically, a compliant (metal) TRU waste container is demonstrated to be of sound integrity based on the Hazardous Material and Waste Management Program, in accordance with DOE-STD-5506-2007 [DOE 2007] inspection criteria. The inspection criteria implicitly also ensure that waste packaging and non-combustible construction performance criteria are met.

4.4.1.4 Controls (TSR)

This control has been written in a DF format to ensure that compliant (metal) TRU waste containers meet performance criteria at Area G so that safety functions are met.

An in-service inspection applicable to compliant metal TRU waste containers is required as described in this BIO, Section 5.6.4. In addition, a TSR Administrative Control (AC), implemented through the Hazardous Material and Waste Management Program, requires the Facility to implement procedures for operators to visually inspect TRU waste containers before or during handling or transport according to prescriptive inspection criteria to ensure that performance criteria, and hence safety functions, are met.

4.5 SPECIFIC ADMINISTRATIVE CONTROLS

A summary list of the SACs for Area G is shown in Table 4-3. The Reference column provides the accident analysis (AA) scenarios that credit the controls. Chapter 3, Section 3.3, provides a summary of how these controls are credited in the HA. Further detail on each SAC is discussed in its specific subsection, which follows the table.
<table>
<thead>
<tr>
<th>Specific Administrative Control</th>
<th>Section References</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Inventory Management (above-ground MAR limits and doublepack requirements)</td>
<td>AA: DBA-1A, 1B, 1D, 2A, 2B, 3, 4A, 4D, 4E, 4F, 7B, 8, 9, 10, 10a, 11, 12</td>
<td>The safety function is to reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
<td></td>
<td>Chapter 4 (C.4): 4.5.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chapter 5 (C.5): 5.5.1.1, 5.5.1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.1.1 to 3.1.7</td>
<td></td>
</tr>
<tr>
<td>Thermal Separation Distances</td>
<td>AA: DBA-1A, 1B, 2A, 3, 4E, 10, 12</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.2</td>
<td>Reduce the likelihood of involvement of radiological waste.</td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.2.1</td>
<td></td>
</tr>
<tr>
<td>Control of Liquid Run-On</td>
<td>AA: DBA-1D</td>
<td>The safety function of this control is to prevent the flow of liquid fuel into TRU retrieval areas.</td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.2.3</td>
<td></td>
</tr>
<tr>
<td>Combustible/ Flammable Liquids in Defined Areas and associated Thermal Separation Distance</td>
<td>AA: DBA-1A, 1B, 2A, 2A, 4A, 4D, 4E, 4F, 7B, 8, 9, 10, 10a, 11, 12</td>
<td>The safety function of the combustible/ flammable liquids in defined areas containing only TRU metal</td>
</tr>
<tr>
<td>(TRU Metal Containers)</td>
<td>C.4: 4.5.5</td>
<td>containers control is to reduce probability of fire by identifying fire initiators and incipient fires and</td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.6</td>
<td>eliciting an appropriate response and reduce radiological consequences by limiting the amount of MAR</td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.3.1</td>
<td>involved.</td>
</tr>
<tr>
<td>Combustible/ Flammable Liquids in Defined Areas and associated Thermal Separation Distance</td>
<td>AA: DBA-1A, 1B, 2A, 2A, 4A, 4D, 4E, 4F, 7B, 8, 9, 10, 10a, 11, 12</td>
<td>The safety function of the combustible/ flammable liquids in defined areas containing only TRU non-metal</td>
</tr>
<tr>
<td>(TRU Non-Metal Containers)</td>
<td>C.4: 4.5.5</td>
<td>containers control is to reduce probability of fire by identifying fire initiators and incipient fires and</td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.6</td>
<td>eliciting an appropriate response and reduce radiological consequences by limiting the amount of MAR</td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.3.1</td>
<td>involved.</td>
</tr>
<tr>
<td>Control of Transient Combustibles – Fuel Package Limit</td>
<td>AA: DBA-2B, 10, 12</td>
<td>Reduces the likelihood of a fuel package being involved in a fire. Reduces the likelihood of fire</td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.4</td>
<td>progression in a defined area.</td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.2.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.6</td>
<td>Reduces the likelihood and radiological consequences from a sympathetic deflagration.</td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.1.7</td>
<td>Reduces likelihood of inadvertent unvented drum toppling leading to a deflagration.</td>
</tr>
<tr>
<td></td>
<td>TSRs: LCO 3.4.1</td>
<td></td>
</tr>
<tr>
<td>Specific Administrative Control</td>
<td>Section References</td>
<td>Safety Function</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Unvented TRU Waste Drum Handling and Transport</td>
<td>AA: DBA-4A, C.4: 4.5.7, C.5: 5.5.1.8, TSRs: LCO 3.4.2</td>
<td>Reduce the physical consequences of a deflagration by protecting workers and limiting debris dispersion if a deflagration occurs. Reduce radiological consequences by ensuring contained burning if a deflagration occurs.</td>
</tr>
<tr>
<td>Drum Venting of Unvented TRU Waste Drums</td>
<td>AA: DBA-4A, 4C: 4.5.8, C.5: 5.5.2.1.14, 5.5.2.1.15, 5.5.2.1.16, TSRs: SAC 5.7.14, 5.7.15, 5.7.16</td>
<td>Reduce physical consequences to workers due to injury resulting from deflagration, and when venting is required. Reduce the likelihood for ignition of flammables/combustibles or deflagration.</td>
</tr>
<tr>
<td>Escort of High-MAR TRU Waste Transport within TA-54, Area G</td>
<td>AA: DBA-1A, 2A, 4D: 4.5.10, C.5: 5.5.2.1.4, TSRs: SAC 5.7.4</td>
<td>The safety function is to reduce the likelihood of a vehicle accident involving radiological waste and impact to stored radiological waste containers.</td>
</tr>
<tr>
<td>Escort of Transportation Vehicle between TA-54, Area G and RANT</td>
<td>AA: DBA-1A, 2A: 4.5.11, C.5: 5.5.2.1.5, TSRs: SAC 5.7.5</td>
<td>Reduce the frequency of vehicle accidents resulting in fuel interaction with MAR on transports between Area G and the Radioassay and Nondestructive Testing (RANT) Facility.</td>
</tr>
<tr>
<td>Escort of &gt; 100 gal flammable liquid inventory vehicles within TA-54, Area G</td>
<td>AA: DBA-1B, 1C: 4.5.12, C.5: 5.5.2.1.6, TSRs: SAC 5.7.6</td>
<td>Reduce the likelihood of fuel interaction with MAR during vehicle transports with &gt; 100 gal of flammable liquid on board.</td>
</tr>
<tr>
<td>Vehicle/Equipment Safety Control—Refueling Location</td>
<td>AA: DBA-1B, 1C: 4.5.13, C.5: 5.5.1.9, TSRs: LCO 3.5.1</td>
<td>Reduce the frequency of a refueling accident involving a fuel pool fire from impacting TRU waste.</td>
</tr>
<tr>
<td>Doublepacking TRU Waste Drums with MAR ≥ 200 Plutonium- Equivalent Curies (PE-Ci) During Trenches A-D Retrieval Activities.</td>
<td>AA: DBA-2B, 4E, 4F: 4.5.15, C.5: 5.5.2.1.3, TSRs: SAC 5.7.3</td>
<td>Reduce radiological consequences by limiting the amount of MAR involved.</td>
</tr>
<tr>
<td>Elevated Waste Movements and Critical Lifts - Spotter for TRU Waste Container Lifts &gt; 4 ft</td>
<td>AA: DBA-4A, 4F, 5B: 4.5.16, C.5: 5.5.2.1.8, TSRs: SAC 5.7.8</td>
<td>Reduce frequency for container puncture, drops, toppling, and impacts.</td>
</tr>
<tr>
<td>Elevated Waste Movements</td>
<td>AA: DBA-5B, 8</td>
<td>Reduces frequency of load drops resulting</td>
</tr>
</tbody>
</table>
## Table 4-3. Summary of Specific Administrative Controls

<table>
<thead>
<tr>
<th>Specific Administrative Control</th>
<th>Section References</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>and Critical Lifts - Critical Lifts &gt; 12 ft or MAR &gt; 150 PE-Ci</td>
<td>C.4: 4.5.17, C.5: 5.5.2.1.8, TSRs: SAC 5.7.8</td>
<td>in release of radiological material</td>
</tr>
<tr>
<td>Mobile Loading Payload Lifts</td>
<td>AA: DBA-8, C.4: 4.5.18, C.5: 5.5.2.1.9, TSRs: SAC 5.7.9</td>
<td>The safety function of this control is to prevent a assembled payload being lifted using mobile loading equipment (e.g., crane or forklift) from dropping on top of another payload or a defined area containing TRU waste and to prevent high-MAR payload drop, to minimize consequences by limiting the MAR involved in the accident.</td>
</tr>
<tr>
<td>Stationary Fire Watch During Hot Work Control</td>
<td>AA: DBA-1B, 3, C.4: 4.5.19, C.5: 5.5.2.1.1, TSRs: SAC 5.7.1</td>
<td>The safety function is to reduce the frequency of ignition of flammables/combustibles</td>
</tr>
<tr>
<td>Vehicle Refueling Prohibition</td>
<td>AA: DBA-1A, C.4: 4.5.14, C.5: 5.5.2.1.2, TSRs: SAC 5.7.2</td>
<td>The safety function of this control is to reduce the likelihood of a fire from a refueling accident involving MAR on a transportation vehicle.</td>
</tr>
<tr>
<td>Projected Above-Ground Inventory</td>
<td>AA: N/A, C.4: 4.5.20, C.5: 5.5.2.1.10, TSRs: SAC 5.7.10</td>
<td>Protects validity of MAR inventory statistical analysis used as basis of Area G BIO accident analysis.</td>
</tr>
<tr>
<td>Pole-Mounted Transformer Distance from TRU Waste Storage Areas</td>
<td>AA: DBA No. 12, C.4: 4.5.9, C.5: 5.5.2.1.11, TSRs: SAC 5.7.11</td>
<td>Preserves initial conditions that post-seismic fire will not involve storage areas. Reduces likelihood of post-seismic fire in TRU waste areas caused by pole-mounted transformer falling onto waste containers during a seismic event.</td>
</tr>
<tr>
<td>Prohibitions on Opening Sealed Inner TRU Waste Packages Discovered within a TRU Waste Container During SSSR Activities</td>
<td>AA: N/A, C.4: 4.5.21, C.5: 5.5.2.1.12, TSRs: SAC 5.7.12</td>
<td>Protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.</td>
</tr>
<tr>
<td>Retrieval Area Unvented TRU Waste Drum Isolation Requirement and Stacking Prohibition</td>
<td>AA: DBA-4A, 5A, C.4: 4.5.22, C.5: 5.5.2.1.7, TSRs: SAC 5.7.7</td>
<td>Reduces frequency for deflagration. Reduces the likelihood and radiological consequences from a sympathetic deflagration. Reduces likelihood of inadvertent unvented drum toppling, leading to a deflagration</td>
</tr>
</tbody>
</table>
### Table 4-3. Summary of Specific Administrative Controls

<table>
<thead>
<tr>
<th>Specific Administrative Control</th>
<th>Section References</th>
<th>Safety Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene Cylinder Control</td>
<td>AA: DBA-4A, 13</td>
<td>Reduces the likelihood of an acetylene cylinder explosion involving MAR.</td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.2.1.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: SAC 5.7.13</td>
<td></td>
</tr>
<tr>
<td>Stationary Fire Watch During SSSR Activities</td>
<td>AA: N/A</td>
<td>Reduces the consequences of a fire.</td>
</tr>
<tr>
<td></td>
<td>C.4: 4.5.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.2.1.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: SAC 5.7.17</td>
<td></td>
</tr>
<tr>
<td>Controls for Opening Sealed Containers with Bolted Lids/Flanges</td>
<td>AA: N/A</td>
<td>Reduces the likelihood and consequence of a deflagration.</td>
</tr>
<tr>
<td>During SSSR Activities</td>
<td>C.4: 4.5.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.5: 5.5.2.1.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSRs: SAC 5.7.18</td>
<td></td>
</tr>
</tbody>
</table>

### 4.5.1 Radiological Inventory Management

#### 4.5.1.1 Safety Function

The safety function is to reduce radiological consequences by limiting the amount of MAR involved. This control addresses fire, deflagration, and loss of confinement.

#### 4.5.1.2 Specific Administrative Control Description

This SAC limits the quantity of radiological material located in defined areas and on transportation vehicles. Limiting the quantity of radiological material available for postulated process upsets is a means of controlling the consequences of that upset. The limitation of the MAR, in combination with the SAC imposing a thermal separation distance (Section 4.5.2), controls the amount of MAR that would be involved in a single upset condition. Based upon the various activities and processes within TA-54, Area G, defined areas were identified. Each inventory limit applies to an area and is discussed below.

Defined areas may be flexible in size and shape to account for process or storage configuration changes. Their boundary may be defined by a fixed structure (e.g., walls of a dome or perimeter of a paved pad), or identified and marked using other physical means (e.g., painted line marking the perimeter of an applicable area, rope boundary, etc.). In addition, use of equipment to continuously monitor the quantity of radiological material within each defined area is not practical. Therefore, an administrative means to define areas and limit the quantity of radiological material within the area is required. An aerial photo of TA-54, Area G, as currently configured is shown in Chapter 1, Figure 1-3. Defined areas may be established or removed as required, and will be tracked by facility operations.

### Sort, Segregate, Size Reduction, and Repackaging (SSSR) Area

The SSSR areas involve the opening of a container, spreading out its contents, examining the contents, separating those contents as required, and then repackaging the contents into one or more containers. Due to the condition of the materials being examined (i.e., not agglomerated, spread out), the
vulnerability to fire is increased; therefore, the amount of available material allowed in this defined area is limited to $\leq 18$ PE-Ci equivalent combustible waste in process, and an additional $\leq 18$ PE-Ci equivalent combustible waste that is staged in closed containers awaiting processing or removal.

**Low-Activity Area**

Low-activity areas (LAA) were identified for storage, characterization, compaction, consolidation, and disposal of low-level waste, mixed low-level waste, and tritium-contaminated waste. LAAs may include radioactive waste placed within below grade pits or shafts, or contained in roll-off bins, transportainers, drums or other containers that are stored above grade. Combustible and dispersible materials within a low-activity area are contained within some form of wrapping (e.g., plastic wrap, cardboard box, or wooden crate) that would result in the material burning in an agglomerated condition, thereby reducing the ARFs and RFs. Material that is covered by $\geq 3$ in. of dirt [see Chapter 3, section 3.3.2.3.2.2 K], or an equivalent thermal barrier, is not counted against the low-activity area inventory limits, as this depth of dirt is sufficient to prevent the buried waste from burning. The amount of available tritium-contaminated material allowed to be exposed in all LAAs is limited to $\leq 3,000$ tritium curies, resulting in a low risk to all receptors with no other credited controls beyond SMPs. The total above ground MAR at all Area G LAAs is limited to $\leq 100$ PE-Ci. To be counted as buried and removed from the above-ground inventory, waste within an LAA is covered with $\geq 3$ inches of overburden fill material (dirt or equivalent barrier).

**Building 54-412**

Building 54-412 was identified for the storage of TRU waste up to a limit of 56 equivalent combustible PE-Ci, in one or more defined areas within the building. Within Building 54-412, SSSR areas may be established for the processing of TRU waste containers. These SSSR areas are required to be maintained in accordance with their specific defined area controls, and any MAR within these areas would be credited against the total MAR inventory limit of 56 equivalent combustible PE-Ci for all defined areas within Building 54-412. This is due to their placement within a common structure. The amount of available material allowed in Building 54-412 is limited to less than or equal to 56 equivalent combustible PE-Ci. The MAR limits, with other credited controls, results in low risk to all receptors.

**Transportation Vehicles**

**Transporting Low-Activity Waste:**

Transportation vehicle MAR limits were identified for the transport of low-level waste, mixed low-level waste, and tritium-contaminated waste. Combustible and dispersible materials on a low-activity transportation vehicle are contained within some form of wrapping (e.g., plastic wrap, cardboard box, or wooden crate) that would result in the material burning in an agglomerated condition, thereby reducing the ARFs and RFs. The amount of available material allowed on a low-activity transportation vehicle is limited to $\leq 35$ PE-Ci and $\leq 3,000$ tritium curies, resulting in low risk to all receptors with no other credited controls beyond SMPs.

**Transporting TRU Waste:**

Transportation vehicle MAR limits were identified for transporting TRU waste containers. The amount of available material allowed on a TRU transportation vehicle is limited, as listed in Table 4-4:
Table 4-4. Transportation Vehicle MAR Limits

<table>
<thead>
<tr>
<th>Container Types in Transport</th>
<th>MAR Limit (PE-Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliant metal containers</td>
<td>1,100</td>
</tr>
<tr>
<td>One or more non-compliant metal or non-metal containers</td>
<td>615</td>
</tr>
</tbody>
</table>

The compliant metal container MAR limit of 1,100 PE-Ci that is associated with TRU transportation vehicles is based on past operational practices. In order to meet the New Mexico Environmental Department (NMED) requirements [NMED 2008] to close TA-54, Area G as a TRU waste facility by 2015, this MAR limit for TRU waste transportation is essential.

The selection of either MAR limit alone still results in high consequences for certain unique and representative vehicle accidents; however, setting the MAR limit to a value ≤ 1,100 PE-Ci for compliant metal containers, or ≤ 615 PE-Ci for non-compliant metal or non-metal containers, would require more vehicle transports within TA-54, Area G and between TA-54, Area G and the RANT facility. Therefore, an additional suite of preventive controls was selected to reduce the frequency of a vehicle accident.

Transporting Tritium Waste:

Transportation vehicle MAR limits were identified for the transport of tritium containers. Tritium is stored on a matrix within a container, which limits its release. Based on operational experience and the need for alignment with tritium areas, balanced against minimizing the consequences from a fire, the transportation limit for tritium waste was set at 1,000,000 tritium curies, which reduces the risk to the public to Low.

Process Area

Process areas were identified for performing closed TRU waste container activities. Activities in these defined areas consist of mobile loading operations, non-destructive examination, assay, High Energy Real-Time Radiography (HE-RTR), venting, handling, and temperature equilibration of containers. The amount of available material allowed in the HE-RTR process area is limited to ≤ 1,100 PE-Ci. This limit is specified to protect an assumption of the accident analysis related to seismic collapse of the HE-RTR structure. The amount of MAR allowed in other individual process areas (e.g., mobile loading, drum venting) is limited to ≤ 1,100 PE-Ci in each process area. The total amount of MAR allowed in the Pad 10 process area is limited to ≤ 4,000 PE-Ci. The total MAR limit for the Pad 10 process area accommodates the inventory staged for, or undergoing one or more NDA/NDE characterization processes (e.g., RTR, HENC, Super HENC, and Temperature Equilibrium Units). The individual process area MAR limit and the Pad 10 total MAR limit protect assumptions in the safety analysis for fire events that affect the entire Area G site including wildland and seismically induced fires. These MAR limits, together with other credited controls, results in a sufficient level of dose reduction for the evaluated fire scenarios. A process area may contain intermingled low-level or mixed waste containers within the area, in addition to TRU waste. The MAR limit applies to all radioactive waste within a defined area, except facility-generated job waste that has not yet been characterized as low-level waste.
Retrieval Area

Retrieval areas were identified for the retrieval of TRU waste containers from Pit 9 and Trenches A through D. These are defined areas where TRU waste containers were initially buried. Activities in these areas consist of removing dirt and covering to provide access to the containers, attachment of devices and restraints to permit the removal of each container from the area, and then the lifting/removal of the container from the pit or trench. The amount of exposed (i.e., covered with less than 3 in. of dirt [see Chapter 3, section 3.3.2.3.2.2 H], or thermal equivalent) material allowed in retrieval areas is limited to \( \leq 1,500 \text{ PE-Ci} \) because the physical geometry, configuration, and individual container MAR inventories are a pre-existing condition. That is, two containers in Trenches A through D cask are conservatively estimated to contain 750 PE-Ci each \( (2 \times 750 = 1,500) \). The 1,500 PE-Ci limit bounds the anticipated exposed inventory during Pit 9 and Trenches A through D retrieval activities.

The MAR limit alone still results in high consequences for unique and representative retrieval accidents; however, setting the MAR limit to a value \( \leq 1,500 \text{ PE-Ci} \) would not allow retrieval activities to occur. Therefore, additional preventive and mitigative controls were selected to reduce the risk for a retrieval accident.

The retrieval area MAR control does not apply to retrieval of CMPs. The CMPs provide assurance that radiological materials contained within a solid concrete matrix are not readily releasable. If the CMPs degrade, the Radiation Protection Program or Resource Conservation and Recovery Act (RCRA) permit requires that the degraded CMPs be wrapped in plastic or other material to confine radiological contamination. Because of the cemented waste form and the associated low damage ratio, airborne, and respirable fractions, source terms are negligible from CMPs subjected to hazard events involving fire, deflagration, loss of confinement/containment, external, or NPH events. Retaining radiological waste in a concrete aggregate within a CMP ensures that the consequences of any given event are negligible; thus CMPs are not required to be protected in the TSRs.

TRU Non-Compliant Metal and Non-Metal Container Storage Area

Non-compliant metal and non-metal TRU container storage areas were identified for the storage of TRU waste containers; however, any TRU container may be stored in these areas. These areas may be enclosed within a domed structure or a building, or may be exposed to the elements on storage pads. The storage area MAR limits were identified for the storage of non-compliant metal or non-metal TRU waste containers. The amount of available material allowed in a non-compliant metal or non-metal container storage area is limited to \( \leq 2,000 \text{ PE-Ci} \). This MAR limit for TRU waste storage is essential to meet the NMED requirements [NMED 2008] to close TA-54, Area G as a TRU waste facility by 2015. Compliant metal TRU containers can be stored in the non-compliant metal or non-metal TRU container storage area. In this case, the non-compliant metal or non-metal TRU container MAR limits apply. A storage area or process area may contain intermingled low-level or mixed waste containers within the area, in addition to TRU waste. The MAR limit applies to all radioactive waste within a defined area, except facility-generated job waste that has not yet been characterized as low-level waste.

Tritium Area

Tritium areas were identified for the storage of non-TRU tritium containers that do not qualify for disposal in the low-activity area. Tritium is stored in a matrix within metal containers, which limits its release. Tritium containers are stored in these defined areas before further processing and/or disposal. Tritium areas are required to be protected by the thermal separation distance (Section 4.5.2) for metal containers. Based on operational experience, balanced against minimizing consequences from a fire, the tritium area limit was set at 1,000,000 tritium curies, which results in low risk to all receptors.
TRU Compliant Metal Container Storage Area

TRU metal container storage areas were identified for the storage of TRU waste containers. These areas may be enclosed within a domed structure or a building, or may be exposed to the elements on storage pads. The storage area MAR limits were identified for the storage of compliant metal TRU waste containers. The amount of available material allowed in a TRU compliant metal container storage area is limited to \( \leq 22,000 \) PE-Ci. To meet the NMED requirements [NMED 2008] to close TA-54, Area G as a TRU waste facility by 2015, this MAR limit for TRU waste storage is essential. A storage area or process area may contain intermingled low-level or mixed waste containers within the area, in addition to TRU waste. The MAR limit applies to all radioactive waste within a defined area, except facility-generated job waste that has not yet been characterized as low-level waste.

The selection of this MAR limit alone still results in high consequences for unique and representative storage accidents; however, setting the MAR limit to a value \( \leq 22,000 \) PE-Ci would require the movement of significant quantities of material to separate the MAR to meet a reduced limit. This is contrary to closure objectives, and would also require additional transport of containers without resulting in an overall decrease in TA-54, Area G MAR. The selected MAR limit protects an initial assumption. Rather than selecting a lower TRU compliant metal container storage area MAR limit, additional preventive and mitigative controls were selected to reduce the risk from TRU compliant metal container storage area accidents.

Area G Site Above-Ground MAR Limits

TA-54, Area G has been a burial and storage site for radiological waste for Los Alamos National Laboratory (LANL) since 1957. The above-ground TRU MAR inventory limit of 57,000 PE-Ci and the above-ground tritium MAR inventory limit of 4,000,000 tritium Ci were established based on the current above-ground inventory, additions of MAR from expected retrieval activities, and new waste receipts. To meet the NMED requirements [NMED 2008] to close TA-54, Area G as a TRU waste facility by 2015, these MAR limits for TA-54, Area G are essential. The selection of the MAR limit alone still results in high consequences for unique and representative external and NPH accidents. Considering the limited life of this facility, there are no feasible cost-effective SSCs or administrative controls available for reducing the facility risk associated with these above-ground inventory limits. This approach ultimately reduces the LANL risk by facilitating the expeditious removal of MAR from TA-54, Area G.

Waste is Located in Defined Areas

The Area G above-ground MAR limit requires that all above-ground MAR be located inside a defined area appropriate to the waste and container type. This control is specified to protect accident analysis assumptions regarding Area G site locations where radioactive material releases are evaluated to occur. The accident analysis evaluates the release of radioactive material occurring at designated locations used for the storage and processing of radioactive waste. By requiring that all above-ground MAR be located inside an appropriate defined area, this accident analysis assumption is protected.

TRU Waste Drum

Above-ground TRU waste drums with \( \geq 200 \) PE-Ci will be doublepacked to limit the amount of radiological material subject to release in an accident. Doublepacking provides an additional barrier for protection against fires, internal deflagrations, external impacts, and other mechanisms that would result in a release of MAR, and reduces the potential consequences to the public, collocated workers, and facility workers.
Except for the drums that make up the double-pack, there are no credited SSCs whose failure must be considered because it could result in the inability of the Radiological Waste Inventory Controls to perform their safety function.

### 4.5.1.3 Functional Requirements

Defined areas must be identified and documented. Defined areas may also be physically identified (e.g., a painted line marking the perimeter of an applicable area, a rope boundary) or designated by a fixed structure (e.g., walls of a dome or perimeter of a paved pad).

The equivalent combustible PE-Ci (Chapter 3, Section 3.3.2.3.2) must be determined based on the combustible and dispersible composition of the radiological waste within the SSSR area and Building 54-412.

The radiological inventory of each defined area shall be tracked and limited, as specified in Chapter 3 of this BIO.

### 4.5.1.4 Specific Administrative Control Evaluation

Individual container inventory is either provided by the waste generator or determined by assay within TA-54, Area G. The TRU waste inventory is tracked in accordance with Radiological Waste Inventory Management and the applicable implementing procedures. Radiological Inventory Management relies on the specific criteria for systems, components, protocols, software, and procedures that are used to perform measurements to ensure that the quality of inventory data is commensurate with the associated safety functions.

The Area G DSA approved in 2003 [LANL 2003] required that drums with \( \text{MAR} \geq 300 \text{ PE-Ci} \) were to be overpacked. These overpacked, vented containers were considered compliant at the time, and should also be considered to have been protected from exposure to ambient environmental conditions and to have retained their sound integrity. Therefore, these drums previously overpacked under the 2003 Area G DSA will still fulfill the definition of a doublepack in the current safety basis, without the necessity for facility inspection of the inner container.

The task of verifying the cumulative inventory of a defined area is performed before container movement operations, in accordance with procedures. Time is available to recover from an error, as the task is performed before introducing containers into a defined area.

Procedures provide guidance for determining the inventory of containers to be relocated and the inventory of the defined areas that are to be entered. The Radiological Inventory Management controls provide the data to support the required calculations for determining the PE-Ci.

Workers are trained on procedures for the movement of waste containers. Procedures identify where inventory can be obtained, provide guidance for performing the inventory limit evaluation, and provide guidance on the appropriate actions. This activity is considered low difficulty.

An adverse event is not caused by exceeding an inventory limit. An additional upset is required to involve the excess inventory in an adverse event. Therefore, if it is determined that an inventory limit has been exceeded, the facility has the opportunity to remove the excess inventory from the defined area and restore the MAR to within the applicable limit.
Waste container activities may occur in a domed structure, a building, or external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.1.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that defined area inventory limits, as listed in Chapter 3, are met.

Surveillance Requirements (SRs) are necessary to verify that: 1) the radiological inventory of a defined area does not exceed the inventory limits analyzed in Chapter 3 and, 2) above-ground MAR is located inside a defined area consistent with accident analysis assumptions.

4.5.2 Thermal Separation Distances

4.5.2.1 Safety Function

Depending on the fire accident scenario, the safety function of this control to protect against fire events is to:

- Reduce radiological consequences by limiting the amount of MAR involved.
- Reduce the likelihood of fire progression between defined areas.

4.5.2.2 Specific Administrative Control Description

This SAC requires the establishment of a thermal separation distance around applicable defined areas that contain radiological material. A thermal separation distance surrounding each applicable defined area shall be established as follows:

1. TRU Storage Areas, Process Areas and Retrieval Areas containing only Metal Containers and all Tritium Areas shall have the following Thermal Separation Distances:

<table>
<thead>
<tr>
<th>Thermal Separation Distance with no Liquid Impediment</th>
<th>or</th>
<th>Thermal Separation Distance with an established Liquid Impediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 ft</td>
<td></td>
<td>7 ft</td>
</tr>
</tbody>
</table>

2. TRU Storage Areas, Process Areas and Retrieval Areas containing one or more non-metal containers shall have the following Thermal Separation Distances:

<table>
<thead>
<tr>
<th>Thermal Separation Distance with no Liquid Impediment</th>
<th>or</th>
<th>Thermal Separation Distance with an established Liquid Impediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>43 ft</td>
<td></td>
<td>24 ft</td>
</tr>
</tbody>
</table>

3. An SSSR Area shall have the following Thermal Separation Distances:
These separation distances are not applicable to:

1. Defined areas containing only Bolas Grande/ metal spheres or CMPs.
2. Items in transit to and from defined areas.
3. The distance between exposed MAR and the impediment for liquid fueled retrieval equipment located at Pit 9 and Trenches A-D.
4. Low Activity Areas.

The establishment of thermal separation distances is designated as an SAC because there are no SSCs available to accomplish the credited safety function. Maintenance of a minimum thermal separation distance around an applicable defined area reduces the likelihood that a fire in one area will impact waste containers in an adjacent area.

Combustible materials can be ignited when exposed to sufficient heat flux for a sufficient period of time, causing the temperature of the combustible material to rise to its ignition temperature. The composition and configuration of the adjacent waste container will determine the heat flux necessary to result in its combustion. Reference LANL 2011a notes that “an incidental heat flux of 45 kW/m²... represents the lowest heat flux that could cause drum lid failure.” Non-metal containers such as FRPs require a heat flux of ≥ 10 kW/m² to cause ignition of the containers and their contents. The safety analysis determined that, considering the activities and container types, the specified minimum thermal separation distances were sufficient to limit the heat flux in adjacent defined areas to preclude fire spread to these areas.

Non-metal containers, such as FRPs, require a heat flux of ≥ 10 kW/m² to cause ignition of the containers and their contents. Reference LANL 2011a analyzed a condition in which the largest crate or FRP box at Area G was burned. The calculation considered the separation distance of 1.86 m from the burning FRP to compliant metal waste containers, so that the radiant heat flux to the metal waste containers would be < 45 kW/m². The minimum thermal separation distance is set at 7 ft. Normal combustibles are considered to be ignited by a radiant heat flux of 10 kW/m². From reference LANL 2011a, exposed normal combustibles, such as SSSR activities in a process area, require a separation distance of 7.23 m (23.7 ft) from the leading edge of a fire.

The 7-ft and 24-ft distances provide sufficient distances between the leading edge of a fire and the metal or non-metal waste containers, respectively. However, in the event of a liquid-fuel pool fire, a means to ensure that the leading edge of the pool fire does not intrude into that separation distance is necessary. This can be done by providing a liquid impediment (e.g., berm, curb, slope, or ditch) that would contain or divert the pool so that the leading edge remains separated from the waste containers by the specified distances.

<table>
<thead>
<tr>
<th>With non-metal containers</th>
<th>or</th>
<th>With non-metal containers with an established Stationary Fire Watch</th>
<th>or</th>
<th>With only Metal Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 ft</td>
<td></td>
<td>10 ft</td>
<td></td>
<td>10 ft</td>
</tr>
</tbody>
</table>
distance, or by including the calculated radius of the burning fuel pool in the minimum thermal separation distance so that the flame centerline remains sufficiently separated from the waste containers.

To determine the safe distance from the flame centerline of a pool fire, reference LANL 2011a also analyzed the radiant heat flux from fuel spills ranging up to 5000 gal. Because additional controls are imposed to reduce the likelihood of availability of fuel quantities greater than 100 gal, the calculation to determine the thermal distance separation, with liquid impediment, was based on a 100-gal fuel spill. The calculation assumes that the fuel pool occurs on a smooth, flat surface that allows the pool to spread out so that it has the largest pool area possible. The reality of Area G is that most of the roads are gravel and the storage areas are asphalt. This assumption is conservative in that it allows for the largest pool area. Implementation will ensure that the topography (e.g., grades or slopes) does not invalidate the assumptions of the accident analysis.

The 100-gal fuel pool fire yielded a separation distance of 6.5 m (21.2 ft) from the fuel pool flame centerline to limit the radiant heat flux to < 45 kW/m². The minimum thermal separation distance for applicable defined areas with only metal containers is set at 22 ft if no liquid impediment is available to limit the progression of the leading edge of a pool fire.

The waste containers in the non-metal storage arrays are assumed to ignite if exposed to a radiant heat flux of > 10 kW/m², conservatively presuming that the FRP or other non-metal container storage arrays are considered normal combustibles.

The minimum thermal separation distance for applicable defined areas with non-metal containers is set at 43 ft if no liquid impediment is used to limit the progression of the leading edge of a pool fire.

This control, along with the SAC requirements that (a) combustible/flammable liquids brought into a defined area are limited and attended, (b) hot work in non-metal storage areas is accompanied by a stationary fire watch and (c) transient combustibles are controlled, are judged to be sufficient to prevent propagation of fires between applicable defined areas of non-metal TRU waste containers.

Material in an SSSR area presents a lower profile (e.g., face or view) to an adjacent fire due to the nature of the process. The lower profile would require a higher heat flux to initiate combustion than a defined area containing non-metal containers. Reference LANL 2011a also analyzed a condition in which up to 150 lb of stacked waste boxes (i.e., 6 single-height waste boxes at 25 lb each and 2-ft height), were burned. As indicated, normal combustibles are considered to be ignited by a radiant heat flux of 10 kW/m². The analyzed fire created a 10 kW/m² radiant heat flux at a distance of 2.9 m (9.5 ft). This condition is considered to bound separation distances between SSSR activities involving compliant containers with a lower profile and adjacent SSSR activities involving compliant containers. The 10-ft separation distance ensures that no additional waste will become involved in a fire.

Certain waste containers, such as Bolas Grande spheres and CMPs (Section 2.6.1), are not adversely affected by fire. That is, a fire affecting these containers will not result in the release of radiological material because they contain no dispersible combustible material. Therefore, a separation distance is not required for these container types.

The effectiveness of this control depends on implementation of combustible/flammable liquid limits. A fuel spill occurring within one defined area could provide a means to propagate to an adjacent defined area. However, the SAC limiting combustible/flammable liquids (Section 4.5.5) restricts the maximum fuel pool size within a defined area to 100 gal. The maximum MAR involved in a 100-gal pool fire was determined using a storage area. With separation distances between applicable defined areas, the MAR
involved in a pool fire spanning two affected areas would be less than the maximum analyzed pool fire event.

This control performs a safety function by reducing the likelihood that the heat flux from a fire will ignite adjacent radiological material. TA-54, Area G is an existing facility whose mission is being transferred to other facilities with the subsequent closure of TA-54, Area G as a TRU waste facility. The design, installation, and maintenance of permanent physical thermal barriers would impose significant costs upon the facility. Therefore, a SAC is necessary to minimize the risk for heat flux-induced ignition of adjacent radiological material.

No additional SSCs are relied upon to implement the actions of this control.

4.5.2.3 Functional Requirements

The following functional requirements are necessary for performance of this SAC:

- The potential flame front (e.g., berms and trenches for pool spills, limited combustible perimeter for solid combustibles) is established.
- Defined areas are identified and documented. They may also be physically identified by a fixed structure (e.g., walls of a dome or perimeter of a pad), or marked using other means (e.g., painted line marking the perimeter of an applicable area, rope boundary, etc.).
- The type of container storage area (i.e., metal versus non-metal) is determined.
- A thermal separation distance of greater than or equal to that prescribed in Section 4.5.2.2 is established.
- A liquid impediment, if used to reduce the minimum thermal separation distance for an applicable defined area, will be capable of containing or diverting up to 100 gal of liquid spilled at a rate of 25 gallons per minute (gpm) (rounded up from 24.24-gpm average leak rate from a punctured 100-gal fuel tank, as calculated in LANL 2011b). Given the posted speed limit and other controls, a vehicle accident sufficiently energetic to cause a catastrophic failure of a fuel tank is not postulated. A controlled drawing or evaluation will identify the credited liquid impediments, and where and how they are implemented.

4.5.2.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

- Thermal separation distances shall be as specified in Section 4.5.2.2.

The required distance to prevent sufficient heat flux from an adjacent fire from impacting waste in applicable defined areas containing metal and non-metal TRU waste containers has been calculated for specific areas based on the type of containment. This distance has been incorporated into the SAC.

Before the establishment of a defined area, an assessment is required to determine the type of containers that will be contained therein and the activities to be conducted within the area. The defined area boundary will be established based on container type and marked by an approved means. Procedures will require an operator to verify that a separation distance has been established around applicable defined areas.
Facility procedures will identify standard guidance for the establishment and maintenance of applicable defined areas and the required minimum separation distances.

The maintenance of boundaries and minimum separation distances is considered to be a low level of difficulty. Configuration management of applicable defined areas supports compliance with this SAC.

The establishment and maintenance of separation distances is an ongoing activity and is not a time-critical activity. The discovery of a failure to maintain adequate separation distance will require the immediate movement of containers or adjustment of the applicable defined area boundary within a reasonable time period to re-establish compliance. The failure to maintain a distance does not result in an adverse event but raises the likelihood that, if an accident were to occur, additional radiological material would be involved.

The establishment and maintenance of separation distances are activities that may occur in a domed structure, a building, or external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period. Performance of this SAC does not depend on SSCs.

4.5.2.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that separation distances are established and maintained as identified in Table 4-5.

SRs are necessary to periodically verify that separation distances about each defined area are maintained, based on the container type permitted within the applicable defined areas, and to verify the initial and continuing capability of established liquid impediments to contain or divert 100 gal of liquid.

4.5.3 Control of Liquid Run-On

4.5.3.1 Safety Function

The safety function of the liquid impediments established between liquid-fueled retrieval equipment and the edge of Pit 9/Trenches A through D is to stop the flow of liquid fuel into TRU retrieval areas.

4.5.3.2 Specific Administrative Control Description

The accident analysis involving a fuel pool fire credits a thermal separation distance from the edge of a fuel pool fire to a defined area assuming a spill on a flat, smooth surface. Alternatively, a berm or impediment may contain a fuel spill and prevent a potential fuel fire from impacting waste. This control is established to control liquid fuel run-on into Pit 9 and Trenches A through D.

4.5.3.3 Functional Requirements

The following functional requirement is necessary for performance of this SAC:
Based upon the volume of the maximum fuel capacity of the retrieval equipment, the liquid impediment has sufficient width, depth, and/or incline to stop liquid flow into, or to direct liquid flow away from, Pit 9/Trenches A through D.
### 4.5.3.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

- Liquid impediments surrounding retrieval equipment shall direct liquid flow away from Pit 9/Trenches A through D.

The presence of the liquid impendiment protects the retrieval area from the fuel within the excavation equipment and allows the exemption from the thermal separation distances control and the combustible/flammable liquids control for the area between the impendiment and the exposed MAR. There is no requirement for a thermal separation distance between the impendiment and the subterranean retrieval area because the radiant heat flux diminishes with horizontal distance and with height above the burning fuel, and is negligible at elevations lower than that of the burning fuel pool. Therefore, the MAR would be exposed to minimal heat flux.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period. Performance of this SAC does not depend on SSCs.

### 4.5.3.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that liquid impediments can support their safety function.

SRs are necessary to verify the initial and continuing capability of established liquid impediments to contain or divert the full capacity of liquid fuel that could be spilled from the retrieval equipment.

### 4.5.4 Control of Transient Combustibles – Fuel Package Limit

#### 4.5.4.1 Safety Function

The safety function of this SAC is to reduce the likelihood of a fuel package being involved in a fire and reduce the consequences of a fire by limiting fire progression within a defined area and the amount of MAR involved.

#### 4.5.4.2 Specific Administrative Control Description

The combustible fuel package load size of 100 lb limits the radiant energy thermal output of the fire, at a distance of > 9 ft, to levels below 10 kW/m², which is sufficient to prevent ignition of the exposed combustible package.

Combustible materials stored in a metal container require a radiant heat flux \( \geq 45 \text{ kW/m}^2 \) to ignite within the container. The combustible fuel package load size of 100 lb limits the radiant energy thermal output of the fire, at a distance of > 3 ft, to levels below 45 kW/m², which is sufficient to prevent ignition of the combustible package within a metal container [LANL 2011a].

The control applies to combustible material fuel packages (i.e., ordinary combustible material > 20 lbs) other than radioactive waste containers and their contents that are introduced into applicable defined areas, and their associated thermal separation distance. Combustible materials that constitute part of a waste package, or are introduced to remediate waste packages in situ, once affixed to the TRU waste
package, are considered to be part of the waste package and are not subject to this control. Combustible/flammable liquids (which are addressed separately, in Section 4.5.5), and ordinary combustible material in transit are not subject to this control. Stored non-metal waste containers such as FRPs, radiological barrier devices, and boundary markers (e.g., rope, plastic stanchions, signs) are also not counted as transient combustible fuel packages.

This control is not applicable to Low Activity Areas. For postulated fire scenarios, the safety analysis does not credit the control of transient combustible fuel packages to mitigate potential radiological releases involving up to 100 PE-Ci of MAR stored in Low Activity Areas. Hence, the safety analysis allows Low Activity Areas to be excluded from the Applicability of this LCO.

The control for Thermal Separation Distances in Section 4.5.2 excludes certain Defined Areas from the Thermal Separation Distance requirement. When a Defined Area is excluded from the Thermal Separation Distance requirement, the control of transient combustible fuel packages within the Thermal Separation Distance is not applicable. However, the control of transient combustible fuel packages must still be met within all applicable Defined Areas.

This control performs a safety function by reducing the likelihood that the heat flux from a fire will ignite adjacent radiological material. Area G is an existing facility whose mission is being transferred to other facilities with the subsequent closure of Area G as a TRU waste facility. The design, installation, and maintenance of permanent physical thermal barriers would impose significant costs upon the facility. Therefore, a SAC is necessary to minimize the risk for heat flux-induced ignition of adjacent radiological material, and thus to minimize the propagation of a fire.

No additional SSCs are relied upon to implement the actions of this control. Facility procedures dictate the requirements of this control.

4.5.4.3 Functional Requirements

The following functional requirement is necessary for performance of this SAC:

- Fuel packages used within an applicable defined area and the associated thermal separation distance area are managed.

This control is dependent on the operator’s ability to discern 100-lb packages within an applicable defined area. Facility written procedures and lists of examples of fuel packages of 100 lb or more should be implemented. Because the fuel packages are transient in nature, it is will not be practical to identify permanent boundary locations. Operators should plan their work, and identify materials and equipment to perform tasks, so that operators are aware of the control responsibilities in introducing fuel packages, such as fuel packages with weight greater than 100 lb, within applicable defined areas.

4.5.4.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

1. A fuel package shall be attended.

   or

2a. Each fuel package shall be \( \leq 100 \) lb of transient combustible material.

   and

2b. Fuel packages shall be \( \geq 9 \) ft away from non-metal waste containers and other fuel packages.
2c. Fuel packages shall be $\geq 3$ ft away from metal containers.

The required distance to prevent sufficient heat flux from a 100-lb fuel package to cause ignition of combustible waste has been calculated for specific areas based on the type of containment. This distance has been incorporated into the SAC performance criteria. The requirement for a trained individual to attend transient combustible material fuel packages that do not meet the weight or distance controls helps to prevent fires by protecting the combustible material from fire hazards, and helps to mitigate the potential consequences by responding appropriately if a fire occurs.

Facility procedures will identify standard guidance for operator usage of fuel packages > 100 lb, and the control requirements for introducing the fuel packages into an applicable defined area. A medium level of difficulty is assigned to the performance of the SAC, because operators will require knowledge of fuel packages that are subject to this SAC.

The implementation of the transient combustible SAC will occur in applicable defined areas as specified in Section 4.5.4.2. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period. Performance of this SAC does not depend on SSCs.

4.5.4.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that performance criteria are met.

The following SRs are required:

- Weekly, verify that, within defined areas and their associated thermal separation distances, fuel packages are each $\leq 100$ lb of transient combustible material, or are attended.
- Weekly, verify that, within defined areas and their associated thermal separation distances, fuel packages are $\geq 9$ ft away from non-metal waste containers and other fuel packages, or are attended.
- Weekly, verify that, within defined areas and their associated thermal separation distances, fuel packages are $\geq 3$ ft away from metal waste containers and other fuel packages, or are attended.
- Shiftly, verify that any fuel packages that do not meet LCO Statements 2a, 2b, or 2c are attended.

4.5.5 Combustible/Flammable Liquid Controls in Defined Areas and Associated Thermal Separation Distance

4.5.5.1 Safety Function

The safety function of the combustible/flammable liquids in defined areas and associated thermal separation distance control is to reduce probability of fire by identifying fire initiators and incipient fires and eliciting an appropriate response and reduce radiological consequences by limiting the amount of MAR involved.
This control is credited for pool fire accidents. By limiting the amount of flammable/combustible liquids, the amount of MAR potentially involved in an accident is limited.

### 4.5.5.2 Specific Administrative Control Description

This SAC limits the total amount of flammable/combustible liquids within a defined area and applicable thermal separation distance. The applicability of the thermal separation distance requirement for a given defined area is described in Section 4.5.2. For a defined area containing only metal containers, the SAC limits the amount of combustible/flammable liquid to 100 gal. It also requires that combustible/flammable liquids in quantities > 7 gal be attended. The SAC requires that all combustible/flammable liquid volumes in each defined area that contains non-metal containers be attended. It also limits the total amount of combustible/flammable liquids in defined areas with non-metal containers to 100 gal.

The establishment of combustible/flammable liquid limits is designated as a SAC because there are no feasible, cost-effective SSCs available considering the limited life of this facility, and because combustible/flammable liquids are infrequently required for a limited duration of use.

This SAC is performing a safety function in that it limits the liquid fuel inventory that may be involved in a defined-area pool fire. During normal operations, a limit of 7 gal of combustible/flammable liquid unattended is adequate to mitigate the risk of a fuel pool fire within a defined area that contains only metal containers. Fuel pool fires ≤ 7 gal were determined to have minimal risk due to their short burn duration and limited involvement of MAR in metal containers (See Chapter 3, Section 3.3.2.3.2.2.A.2). The requirement for a trained attendant reduces the likelihood of initiating a fire involving flammable/combustible liquids.

Multiple vehicles, equipment, and liquid fuel containers are occasionally required to enter a metal container defined area. Due to the limited operations that require liquid-fueled vehicles or equipment to be in a defined area, additional measures are needed to minimize the likelihood and size of a fuel spill and to respond to the event should it occur. Therefore, attendance of all liquid fuel quantities in excess of 7 gal is required at all times. Attendance of the combustible/flammable liquids is required at all times while the combustible/flammable liquids are within a defined area that contains non-metal containers. The attendee is trained on what to observe, how to respond to spills, to be aware of spill response material locations, and to identify fire initiators and incipient fires and elicit an appropriate response. This is an administrative function that does not rely on any SSCs for its performance.

There are no feasible cost-effective SSCs available considering the limited life of this facility, and that liquid-fueled vehicles and equipment (e.g., diesel forklifts, manlifts) are infrequently required for limited-duration use. Electric forklifts are inefficient and do not function well over the rough terrain of the Area G environs. Even if the domes are on a paved surface, the forklifts still would have to travel between domes on mostly unpaved roads. Electric forklift tires and suspension do not travel well on unpaved roads, thus presenting another waste container hazard (unnecessary shaking/jarring of containers). The total combustible/flammable liquid quantity (e.g., fuel, hydraulics, or lubricant) of a single forklift is estimated to be 100 gal. Therefore, a SAC is required to perform this function.

This SAC interfaces with the SAC requiring escort of greater than 100-gal liquid flammable liquid inventory vehicles within TA-54, Area G (see Section 4.5.12). The requirement to escort high-fuel-capacity vehicles ensures that vehicles that have a total combustible/flammable liquid inventory onboard of > 100 gal (e.g., refueling tanker, tractor with saddlebag fuel tanks) travel along a defined route at a limited speed when transiting past defined areas. This reduces the likelihood that a vehicle containing liquid fuel quantities of greater than 100 gal enters a defined area.
The SAC also interfaces with the SAC that requires a minimum thermal separation distance from the containers within applicable defined areas to other defined areas or potential sources of fuel for a fire to minimize the likelihood of spread of a fire from one area to another.

The following are excluded from the requirements of this SAC:

- Propane, because it is not considered a liquid fuel in the accident analysis
- TRU waste container contents
- Low-level waste (LLW) and mixed low-level waste (MLLW) container contents
- The liquids contained in equipment used for nondestructive assay/nondestructive examination (NDA/NDE) activity
- Combustible/flammable liquids with a flammability rating of 0 and 1
- The distance between exposed MAR and the impediment for liquid fueled retrieval equipment located at Pit 9 and Trenches A-D.

- Low Activity Areas

4.5.5.3 Functional Requirements

The following functional requirements are necessary to fulfill the safety functions of this control:

- For any defined area, account for the total combustible/flammable liquid volume within the area and the amount of combustible/flammable liquid volume to be added to the area, and verify that the total volume would be \( \leq 100 \text{ gal} \).
- For a defined area containing only metal containers, account for total combustible/flammable liquid volume within the area and the amount of unattended combustible/flammable liquid volume to be added to the defined area, and verify that the total unattended volume would be \( \leq 7 \text{ gal} \).
- For a defined area containing non-metal containers, all combustible/flammable liquid volumes within the area are identified and attended.
- Assign individuals trained in spill and fire response, to attend combustible/flammable liquid volumes, when required.
4.5.5.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

The following combustible/flammable liquid controls shall be met in individual defined areas and applicable thermal separation distances:

1a. For defined areas containing only metal containers, volumes > 7 gal shall be attended. 
1b. For defined areas containing any non-metal containers, all volumes shall be attended. 

and

2. The total volume shall be \( \leq 100 \text{ gal} \).

The following are excluded from the requirements of this LCO:

- Propane, because it is not considered a liquid fuel in the accident analysis
- TRU waste container contents
- Low-level waste and MLLW container contents
- The liquids contained in equipment used for NDA/NDE activity
- Combustible/flammable liquids with a flammability rating of 0 and 1
- The area within liquid impediments surrounding liquid fueled retrieval equipment located at Pit 9 and Trenches A-D.
- Low Activity Areas

Infrequently, liquid-fueled vehicles and equipment (e.g., diesel forklifts, manlifts) are required to perform certain maintenance activities (e.g., dome maintenance). Therefore, it is necessary that liquid-fueled vehicles be permitted into defined areas, which increases the likelihood of fuel pool fires during these infrequent and limited-duration activities. The total combustible/flammable liquid quantity (fuel, hydraulics, lubricants) of a single forklift is estimated to be \( < 100 \text{ gal} \). To protect the initial assumption of a 100-gal maximum fuel pool fire, the total liquid combustible/flammable volume within the defined area is limited by procedure to \( \leq 100 \text{ gal} \).

When the total liquid fuel volume in a defined area containing only metal containers exceeds 7 gal, additional risk is present and, therefore, combustible/flammable liquids in excess of 7 gal are required to be attended. Attendance of the liquid fuel containers, vehicles, and equipment ensures that someone is available to observe any fire hazards or adverse event (e.g., fuel spill or leak) involving the contained liquid fuel and respond to mitigate the fuel spill, and prevent a fire. Mitigation of the fuel spill would involve the removal of the container, vehicle, and/or equipment from the defined area and prompt mitigation of the fuel spill. The attendee is trained on spill response and is aware of the locations of spill response materials.

Before bringing combustible/flammable liquids into a defined area with only metal containers, facility operators are required to determine the total volume of combustible/flammable liquids that would be in the defined area should the additional combustible/flammable liquids be introduced. If the addition of the combustible/flammable liquids to the defined area would result in exceeding a total unattended volume of 7 gal, then facility operators would not permit the additional combustible/flammable liquids to be left.
unattended within the defined area. This activity requires the identification and summation of all unattended combustible/flammable liquid volumes within the area, addition of the volume to be introduced, and verification that the total unattended volume would not exceed 7 gal.

The use of combustible/flammable liquids is typically not a time-critical activity and, therefore, time is available to assess and ensure compliance with this SAC before permitting combustible/flammable liquids to enter the defined area.

Facility procedures identify guidance for assessing the total volume of combustible/flammable liquids, attended and unattended, within a defined area, and for communicating to the facility operator when combustible/flammable liquids cannot be introduced into a defined area.

Assessing the total volume of combustible/flammable liquids and unattended combustible/flammable liquids is considered a low-difficulty task. Also, the attendance of combustible/flammable liquids volumes located within a defined area is a low-difficulty task. The use of combustible/flammable liquids is typically not a time-critical activity and, therefore, time is available to assess and ensure compliance with this SAC before permitting combustible/flammable liquids to enter the defined area. The discovery of a failure to maintain combustible/flammable liquid volumes within limits will require the removal of vehicles, equipment, and/or containers within a reasonable time period to re-establish compliance.

The discovery of a failure to attend required combustible/flammable liquid volumes will require the vehicles, equipment, and/or containers to be attended or removed from the defined area. The failure to maintain combustible/flammable liquid volumes does not result in an adverse event, but may raise the quantity of radiological material that would be involved if an accident and a pool fire were to occur.

The establishment and maintenance of combustible/flammable liquid volumes are activities that may occur in a domed structure, a building, or external to any structure. Because these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

This control is not applicable to Low Activity Areas. For postulated fire scenarios, the safety analysis does not credit the combustible/flammable liquids control to mitigate potential radiological releases involving up to 100 PE-Ci of above ground MAR in Low Activity Areas. Hence, the safety analysis allows Low Activity Areas to be excluded from the requirements of this SAC.

4.5.5.5 Controls (TSR)

This SAC has been written in the LCO format to ensure compliance with the combustible/flammable liquid volume limits of defined areas and applicable thermal separation distances.

Before combustible/flammable liquid enters the applicable area, the following SRs are required:

- Verify that the total volume of combustible/flammable liquids in each defined area and applicable thermal separation distance ≤ 100 gal prior to introducing combustible/flammable liquid into the applicable area.
• Verify that combustible/flammable liquid volumes > 7 gal intended for introduction into a defined area containing only metal containers and applicable thermal separation distance are attended prior to combustible/flammable liquid entering the applicable area.

• Verify that all combustible/flammable liquids in each defined area and applicable thermal separation distance containing TRU non-metal containers are attended.

4.5.6 TRU Waste Container Management - Above-Ground Unvented TRU Waste Drums

4.5.6.1 Safety Function

The safety functions of the above-ground unvented TRU waste drum control are the following:

• Reduces the likelihood of deflagration due to mechanical insult.

• Reduces the likelihood and radiological consequences from a sympathetic deflagration.

• Reduces the likelihood of inadvertent unvented drum toppling, leading to a deflagration.

4.5.6.2 Specific Administrative Control Description

This SAC requires that unvented waste drums be isolated and not stacked. Closed (unvented) metal TRU waste drums permit the buildup of combustible gases. Physical interactions with such containers can result in the ignition of the combustible gas, resulting in a deflagration with the potential for lid ejection. Typically one or more passive vents are installed in each drum to allow for atmospheric breathing.

It has been postulated that stacked unvented drums could result in sympathetic deflagrations; that is, a deflagration in the lower container causes the upper container to deflagrate. Not permitting unvented drums to be stacked prevents sympathetic deflagrations from occurring and prevents an unvented drum from toppling from an upper tier. An unvented drum can deflagrate if mechanically insulted or toppled from a stack. The isolation of unvented drums within a limited-activity area reduces the likelihood for an unvented drum to be inadvertently impacted by nearby work activities (e.g., forklift operations). Prohibiting the stacking of unvented drums prevents sympathetic deflagrations and reduces the likelihood for an unvented drum to be toppled, which could initiate an individual deflagration. Unvented TRU waste drums in underground storage are in a stacked array, so this SAC does not apply to these unvented drums.

Isolating and not stacking unvented TRU waste drums provides for safe storage of the containers until they are passively vented or overpacked/doublepacked. Overpacked drums provide an additional volume for the unvented drum to relieve its pressure without resulting in unvented drum lid loss and ejection of contents, even if an internal deflagration were to occur [DOE 2007]. This SAC is necessary to provide administrative compensatory measures while the containers are in an unvented condition. To ensure that the isolated unvented TRU waste drums are not impacted by normal operations, a 15-ft exclusion area for non-essential personnel and activities minimizes the probability that any drum-moving or -handling operations could inadvertently impact the stored unvented drums, causing their deflagration.

The 15-ft exclusion area distance is measured from the outermost edge of the drums in the isolation area. The 15-ft exclusion area around the perimeter of the isolation area is derived from consideration of an accident involving a drop/tip over of a third-tier pallet of drums and forklift into the exclusion area. If it is presumed that the ends of the forklift tines are at the outside rim of the exclusion area, the forklift tines are at the height required to remove a third-tier pallet, and the third-tier pallet and forklift fall over, the pallet will fall a maximum of approximately 11 ft within the exclusion zone. In this improbable, bounding drop/tip over accident, a 4-ft distance is still maintained between the dropped pallet and the edge of the
isolation area. A 15-ft exclusion area is a separation distance that can be readily implemented at Area G for the storage of unvented waste containers.

Upon removal of a drum from its discovered stacked condition, unvented drums are isolated and not stacked, and are handled in accordance with Section 4.5.7.

The TRU unvented waste drum control is designated as an SAC, as there are no feasible cost-effective SSCs available to accomplish the credited safety functions.

Some TRU waste containers, by design and/or construction (Section 2.6.2), are passively vented (i.e., do not permit buildup of volatile/flammable gases) and do not require the installation of physical vents to meet this SAC. These containers are not leak-tight and, therefore, any gas generated within the container would diffuse over time. Among these containers are SeaLand containers (cargo containers), transportainers, metal-encased wood boxes, FRPs, plastic-wrapped waste, and CMPs.

Some TRU waste containers (e.g., metal boxes, Bolas Grande spheres), by their robust design and/or construction (Section 2.6.2), are designed to withstand an explosion and do not require the installation of physical vents to meet this SAC. These containers are capable of preventing the release of radiological material, and, therefore, the buildup of contained volatile/flammable gases is not of concern. Per DOE-STD-5506-2007, which cites results of Idaho Drum Deflagration Tests, containers of sound integrity that are overpacked, SWBs, direct loaded RH canisters with welded lids, and RH canister with nested metal drums can be credited to prevent lid loss and ejection of material during a deflagration. The DOE-STD-5506-2007 cites the following: “For SWB, RH canister with nested metal drums, and the overpacked drum, a significant release from the potential venting through the outer container seal is not expected.” Container status is determined by observation of TRU waste drums for installed vents and vent condition. Observation determines that unvented TRU waste drums are isolated and not stacked. No additional data is required (e.g., tables or drawings) to support this SAC. No SSCs are required for implementation of this SAC. The SAC 4.5.7, Unvented TRU Waste Container Handling and Transport, provides controls for the handling and transport of unvented TRU waste drums.

4.5.6.3 Functional Requirements

The following functional requirements are necessary for performance of this SAC:

- The vented status of above-ground TRU waste drums is determined.
- Above-ground unvented TRU waste drums are isolated by one of the following methods:
  - Isolate by establishing a 15-ft isolation zone around the container’s location.
  - Move drum to a separate location and establish a 15-ft isolation zone around the drum’s location (i.e., drum is individually isolated).
  - Move drum to an isolated container storage area with a 15-ft isolation zone around the area (i.e., drum is isolated as part of group of unvented containers).
- Above-ground unvented TRU waste drums are not stacked.

4.5.6.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

Above-ground unvented TRU waste drums shall meet the following:
1. Placed in an isolation area
   and
2. Not stacked.

Implementation of this SAC requires that unvented above-ground TRU waste drums are isolated and not stacked.

Observation of above-ground TRU waste drums is a continual activity in accordance with the Radiological Waste and Material Management program due to the normal operations of TA-54, Area G.

The movement of a discovered unvented TRU waste drum into an isolated and unstacked condition is similar to normal container operations, except for the implementation of the controls for the handling of unvented drums. This activity is considered a low level of difficulty.

Upon observation that an above-ground TRU waste drum is not vented, an operator will take action to ensure that the suspect container is isolated and not stacked. The facility may take further action to have the container vented or to place it in an overpack/double-pack.

The isolation of an above-ground unvented TRU waste drum is not a time-critical activity. While the activity should be completed in a timely manner, the unvented drum would require an additional upset to cause it to deflagrate.

The TRU waste drum activities may occur in a domed structure or a building, or external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should have minimal effect on environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.6.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that above-ground TRU waste drums are managed.

LCO: Unvented TRU waste drums that are above ground and not overpacked shall be:
   1. Located in an access-restricted isolation area
      and
   2. Not stacked

On a frequency of weekly when unvented TRU waste drums are present in the isolation area, and after an unvented drum is placed in the isolation area, an SR is required to
   • Verify unvented TRU waste drums in the isolation area are not stacked and that the isolation area includes a 15-ft exclusion area.

A SR for verification of vented TRU drums is not required because the Hazardous Material and Waste Management Program requires that facility procedures direct operators to inspect drums (compliant, metal TRU waste containers) for vents when the containers are transported or handled.
An element of the Hazardous Material and Waste Management Program, derived in this section on the implementation of the SAC to isolate unvented TRU waste drums, is as follows:

- Access restrictions to the isolation area where unvented TRU waste drums are stored are as follows:
  - Normal operations within the isolation area are restricted to only those necessary to disposition unvented TRU waste drums, such as applying or removing a lid-restraining device, using a forklift to move or remove the unvented TRU waste drum, head gas sampling, or performing surveillances and inspections for regulatory compliance;
  - To prevent inadvertent access to the area, barriers or posting will be placed around the isolation area;
  - A 15-ft exclusion area exists between areas of normal operations and the edge of the outermost unvented TRU waste drum in the isolation area.

A separate SAC for unvented drums in a retrieval area is written as a Directive Action administrative control, as described in Section 4.5.22 of this BIO.

4.5.7 Unvented TRU Waste Drum Handling and Transport

4.5.7.1 Safety Function

The safety function of the unvented TRU waste drum handling (other than minor movement) and transport control is to:

- Reduce the physical consequences of a deflagration by limiting debris dispersion if a deflagration occurs.
- Reduce radiological consequences by ensuring contained burning if a deflagration occurs.

During the handling (other than minor movement) and transport of unvented TRU waste drums, there is a potential to cause significant shaking of an unvented drum, thereby increasing the likelihood of a deflagration. This control ensures that the workers performing the movement are protected from physical injury from flying debris and that the release of radiological material is limited.

4.5.7.2 Specific Administrative Control Description

This SAC requires that once an unvented TRU waste drum is prepared for transport, then the unvented drum must be transported with a lid restraint and either a shielding barrier or standoff distance. The term blast shield is the same as the DOE-STD-5506 term impact shielding [DOE 2007].

Handling occurs within a defined area or between two defined areas that are collocated within the same building, dome, or pad, and does not include lifting with a forklift. Handling is performed with a lid restraint attached to the unvented drum.

The transport of an unvented drum is considered the movement of an unvented drum between defined areas that are not located within a single building, dome, or pad; the receipt of an unvented drum into a defined area; or the shipment of an unvented drum from a defined area.

In preparation for handling or transport, certain minor movements are necessary to accomplish the required controls or to prepare an unvented drum for venting. Minor movements include movement of a
drum to the extent necessary for attachment or removal of a lid restraining device or other blast-mitigation device.

There are multiple acceptable methods for reducing the consequences of an unvented drum deflagration. The circumstances of a handling/transport activity will determine which method is best for the given situation. While a specific SSC (e.g., standoff distance, shielding barrier) is required, the decision of which method to use is administrative. Therefore, this control is implemented as an SAC. Lid restraints provide a means to restrain an unvented drum lid in the event of a deflagration, and these are required during handling and transportation. The restraint is not required to keep the lid in place during all anticipated deflagrations, but is relied upon to reduce the kinetic energy of the lid due to the deflagration and to justify confined burning. A lid restraint is placed on the upper portion of an unvented drum and is secured in place by tension applied to the strap surrounding the unvented drum. Lid restraints are installed in accordance with procedures and are periodically inspected for degradation.

In addition to a lid restraint, transport of an unvented drum requires a standoff distance or shielding/barrier. A safe standoff distance provides a means to prevent worker injury from the blast and from release of radiological material. Shielding barriers provide a means to protect personnel from the pressure surge and to limit radiological exposure. The confinement of radiological material limits its dispersal, and thereby reduces the quantity of radiological material available for worker uptake. The Radiation Protection Program specifies worker controls for work near unvented drums.

The facility procedures that implement this control must ensure that all receptors involved in the handling or transport of the unvented TRU waste drum are protected by lid restraints and, for transport, one of the additional SAC requirements (standoff distance or shielding/barrier). When the unvented TRU waste drum is not being handled or transported, the lid-restraining device may be removed. The removal of the lid-restraining device is allowed because its removal from the unvented TRU waste drum does not result in much perturbation to or movement of the unvented TRU waste drum. Unvented drums at rest are unlikely to deflagrate. The TRU waste unvented drum inspection activities, and minor movements (e.g., to attach or remove a lid restraining device or other blast-mitigation device) are not anticipated to cause unvented drum deflagration. This is based on DOE-STD-5506-2007 [DOE 2007], which cites the results of Idaho drum deflagration tests and the conclusion that significant perturbation is required to initiate a deflagration of an unvented drum. Applying this rationale, such minor movements are exempt from this control.

This control provides a mechanism to manage the movement of unvented TRU waste drums, such as legacy drums that may be found within the drum storage areas, or that are found to contain a hydrogen concentration greater than 8% by volume through WIPP WAC headspace gas analysis testing. Drums without a vent, or with an obviously degraded vent, are considered unvented drums because they are sufficiently sealed to allow for the accumulation of flammable gas. Other types of TRU waste containers at TA-54, Area G may not have a vent. However, either these unvented containers do not have the capability to provide enough of a seal to contain any hydrogen build-up, or they are so robust that they would be able to withstand the effects of a deflagration. All of these other TRU waste containers without a vent are capable of containing the radiological contamination. These containers include SWBs, SeaLand containers (cargo containers), transportainers, metal boxes, metal-encased wood boxes, corrugated metal boxes, metal spheres, Bolas Grandes spheres, FRPs, plastic-wrapped waste, and CMPs. Per DOE-STD-5506-2007, which cites results of Idaho Drum Deflagration Tests, containers of sound integrity that are overpacked, SWBs, direct loaded RH canisters with welded lids, and RH canister with nested metal drums can be credited to prevent lid loss and ejection of material during a deflagration. The DOE-STD-5506-2007 cites the following: “For SWB, RH canister with nested metal drums, and the overpacked drum, a significant release from the potential venting through the outer container seal is not expected.”
The placement of an unvented drum into a vented overpack/doublepack allows the drum to be treated as a vented outer drum. For consideration of vented drums, it is the outermost drum that is of concern.

The lid-restraining device and blast shield SSCs do not necessarily require specific protection in the TSRs as DFs because their safety importance to the completion of actions required in this SAC necessitates their usage and maintenance through the Training and Qualification, Quality Assurance, Conduct of Operations, Configuration Management, and Maintenance Safety Management Programs.

4.5.7.3 Functional Requirements

The following functional requirements are necessary for performance of this SAC:

- The vented status of above-ground TRU waste drums is determined.
- Unvented TRU waste drums are fitted with a lid restraint for handling or transport, and for transport, one of the following additional controls are implemented:
  - Shielding/engineered barrier is positioned between the drum and any personnel located within ≤ 30 ft of the unvented TRU waste drum.
  - Maintain safe standoff distance of ≥ 30 ft.
- This LCO is not applicable during minor movements of unvented TRU waste drums.

4.5.7.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

Unvented TRU waste drums being transported shall:

1. Have a lid restraining device installed.
   and
2a. Have shielding/engineered barrier between the unvented TRU waste drum and the worker.
   or
2b. Maintain safe standoff distance ≥ 30 ft between the unvented TRU waste drum and the worker.

During handling (other than minor movement), a lid restraining device is required, but the additional controls specified in 2a and 2b are not required.

Thirty feet has been analyzed as the minimum distance required to protect workers from significant consequences due to the pressure surge or dispersion of radiological material (Appendix 3I).

Lid restraints are credited with reducing the kinetic energy of an ejected drum lid and/or preventing ejection of material resulting from a drum deflagration. The proper installation and use of these devices, in accordance with procedures, is credited for reducing the likelihood of significant injury to workers performing unvented drum handling and movement. Commercially purchased lid restraining devices in good condition are judged to meet this requirement.

Impact-resistant shielding/barrier is also credited with protecting the worker from the pressure surge and dispersion of radiological material, and must meet industrial safety requirements. Forklifts with enclosed cabs meet this requirement due to the large area presented by metal components (e.g., forklift mast) located between the drum and the forklift operator, as well as the cab construction.
Due to their widespread industrial use, the forklift enclosures or other types of shielding/barriers are procured, installed, and maintained in accordance with standard industrial practices applied to such devices. This LCO does not require specific performance or quality criteria for those devices.

Workers are trained to inspect drums before movement. Procedures provide criteria for the determination of unvented drums, guidance for preparing unvented drums for handling and transport, and guidance for handling and transporting unvented drums.

Workers are trained to inspect equipment such as lid restraints, lifting devices, and blast shields for degradation and/or improper installation. Procedures provide inspection criteria.

The establishment of a safe standoff distance of $\geq 30$ ft around the unvented drum is directed by procedure. The maintenance of this standoff distance throughout the movement is prescribed by procedure.

The failure to meet this control does not, in and of itself, cause an accident, and time is available to recover from an error before operations.

The TRU waste drum activities may occur in a domed structure or a building, or external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should have minimal effect on environmental conditions.

The handling and transport of drums is a daily task. The handling and transport of an unvented drum requires additional controls, which are not difficult to implement. The inspection of equipment to be used, installation in accordance with procedure, and the establishment of a safe standoff distance (if required) are routine practices for TA-54, Area G operations. The handling and transport of the drum is standard practice, except for the maintenance of the standoff distance during the handling transport. Therefore, the task is not considered difficult.

The handling and transport of drums is not a time-critical activity. A drum at rest is less likely to deflagrate than one in motion. If it is discovered that an unvented drum is being handling and transport without this control in place, the handling and transport can be suspended, the selected control imposed, and the action completed. The failure to implement this control does not result in a deflagration event. Therefore, upon discovery that a control is not in place, there is time to remedy the situation before completing the handling and transport.

Compliance with this SAC is not dependent on human performance and resource availability in a time-critical situation. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.7.5 Controls (TSR)

This SAC has been written in the LCO format to ensure that performance criteria are met.

Before initiating an unvented TRU waste drum handling or transport activity, SRs are required to verify that the unvented TRU waste drum being handled (other than minor movement) or transported:

1. Have a lid-restraining device installed.

Before initiating an unvented TRU waste drum transport activity, SRs are required to verify that the unvented TRU waste drum being transported has one of the following:
2a. Have shielding/engineered barrier between the unvented TRU waste drum and the worker.

or

2b. Maintain a safe standoff distance ≥ 30 ft between the unvented TRU waste drum and the worker.

There is no SR to verify that drums are vented. The nature of drum handling/movement activities already requires surveillance of the drums, especially for the presence of vents. This is also included in the Hazardous Material and Waste Management controls for TRU waste drum inspection. The facility implements procedures that require operators to visually inspect TRU waste drums for integrity and/or vents when handling drums. These procedures require the identification of deficiencies and the implementation of appropriate corrective actions. As a result, there is no additional value in performing an extra surveillance to ensure the presence of vents on the TRU drums within the TA-54, Area G storage locations. The control described in Section 4.5.6 does require weekly verification that unvented drums in an isolation area are not stacked and the isolation area includes a 15-ft separation distance.

4.5.8 Drum Venting of Unvented TRU Waste Drums

4.5.8.1 Safety Function

This control is a SAC because it addresses the suite of controls required when performing venting of unvented TRU waste drums.

The suite of drum venting controls involves a combination of equipment usage and operator decision/action to use these controls when venting drums under normal conditions. Therefore, this control is established as a suite of three directive action SACs.

The safety functions of this set of drum venting controls are to:

- Reduce the potential consequences to facility workers in the event of a drum deflagration.
- Reduce the likelihood for deflagration when venting is required.
- Reduce radiological consequences to all receptors resulting from deflagration during drum venting.

This control is credited to mitigate or prevent the consequences of a deflagration during drum venting process.

4.5.8.2 Specific Administrative Control Description

The suite of drum venting SACs requires the following: use of drum venting tools or processes that reduce the likelihood for mechanically-induced sparking; use of a blast-mitigation device (e.g., doublepack, lid restraint); and implementation of a standoff distance of at least 30 ft [see Appendix 3I] during venting.

The venting of unvented drums reduces the likelihood of drum deflagration, and this SAC limits the consequences should a deflagration occur during the installation of a vent. Due to the nature of TA-54, Area G activities, a single feasible cost-effective SSC is not available to control venting for all anticipated venting activities. Therefore, this control is implemented as a suite of directive action SACs.

Unvented TRU waste drums have the potential to accumulate hydrogen, flammable volatile organic compounds, or waste decomposition products such as methane. The venting process penetrates the
confinement barrier of the drum, which can result in spark generation leading to a deflagration of the confined combustible gases. This deflagration can result in a radiological uptake and the dispersal of objects and material that can physically injure nearby workers.

The equipment/tools and/or processes that minimize mechanically-induced sparking reduce the likelihood of a sparking-induced deflagration event. Equipment/tools used to minimize mechanically-induced sparking may be constructed of non-sparking material, and/or the process may be conducted in such a manner that the potential for sparks is minimized (e.g., low-speed cold drilling).

Drum venting requires the use of a lid restraint, double-pack, or other blast-mitigation device on the unvented drum. The blast-mitigation device protects against lid loss and provides a means to limit the release of radiological material and to limit physical hazards to workers. The accident analysis credits the blast mitigation devices as safety-significant when venting a drum with ≤ 480 PE-Ci equivalent combustible waste. The blast mitigation devices are used to lower the ARF*RF from that of unconfined burning to one of confined burning. When venting a drum with > 480 PE-Ci equivalent combustible waste, the analysis credits a doublepack with a safety-class reduction in the damage ratio as well as an ARF*RF reduction.

A minimum separation distance of 30 ft between personnel and the unvented drum reduces the likelihood of personnel injury and limits the uptake of radiological material that could be released in the event of a deflagration during venting.

A radiological confinement-controlled environment is established in accordance with Radiation Protection Program requirements.

Failure of the equipment/tools to minimize mechanically-induced sparking would result in inability to complete the action required by the SAC. Also, failure of the lid-restraining device or other blast-mitigation device would result in inability to complete the action required by the SAC. The equipment and tools used to minimize mechanically-induced sparking, the blast-mitigation device, and the lid-restraining device do not necessarily require specific protection in the TSRs because their safety-significant importance to the completion of actions required in this SAC is based on their usage and maintenance through the Training and Qualification, Quality Assurance, Conduct of Operations, Configuration Management, and Maintenance Safety Management Programs. Due to their widespread industrial use, the non-sparking tools and blast-mitigation devices are procured, installed, and maintained in accordance with standard industrial practices applied to such devices; their management through the SAC provides acceptable mitigation of the hazard without requiring specific performance or quality criteria for those devices.

The use of a contamination-controlled environment does not require specific designation as an SSC because its usage is governed by Radiation Protection Program requirements.

4.5.8.3 Functional Requirements

The functional requirements required to fulfill the safety functions during drum venting is as follows:

- The equipment or process used to penetrate the lid of an unvented drum must be of the type that does not produce mechanically-induced sparks. A vented 55-gallon, 85-gallon, or 110-gallon TRU waste drum that contains an unvented inner drum is considered an unvented drum for the purposes of this SAC. Lid restraints, doublepack, or other blast-mitigation device shall be designed to minimize lid ejection due to a deflagration.
• A standoff distance of at least 30 ft from the drum being vented is implemented during drum venting.

• The Radiation Protection Program provides requirements for use of radiological contamination control.

Because the drum venting SACs also depend on operator decision and action, the implementation of the SACs is dependent on the robustness of SMPs such as Training and Qualification, Conduct of Operations, and Radiation Protection. The Training and Qualification Program is important because it ensures that Area G personnel are trained and qualified to accomplish their safety-related responsibilities. The Conduct of Operations SMP is important to the implementation of the SACs because it requires the identification of risk and the implementation of controls to perform work safely and securely. The Radiation Protection SMP is important because it provides the requirements for radiological contamination control and provides additional requirements for the protection primarily of the worker, as well as other receptors. The suite of SMPs ensures the implementation of the drum venting controls through procedures, operator knowledge of the hazards associated with drum venting, and training on the prohibitions for performing drum venting.

4.5.8.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

Venting of unvented TRU waste drums requires the following:

1. The process used to penetrate the lid of an unvented TRU waste drum, during its venting, must be of the type that does not produce mechanically-induced sparks.

2. Use of a blast-mitigation device (e.g., lid restraint, doublepack) when venting unvented TRU waste drum. For TRU waste drums with MAR > 480 PE-Ci equivalent combustible waste, a doublepack shall be used to provide blast mitigation.

3. Personnel are located outside the safe standoff distance (i.e., > 30 ft) during drum venting.

When penetrating the lid of an unvented drum, during its venting, the equipment/process used must be of the type to minimize generation of a mechanical spark (e.g., non-sparking tools; use cold drilling, controlled speed drilling, or drum punch). By their use, the likelihood of a spark occurring is minimized. Preventing the occurrence of sparks will minimize the likelihood that a flammable gas mixture can ignite within the unvented drum, and lead to a deflagration. For the Nuclear Filter Technology Drum Venting System, the drill speed must be below 640 rpm. The use of rotational drill speeds below 640 rpm has been determined to meet the safety function [LANL 2012].

Section 4.4.3.1 of DOE-STD-5506 describes confined and unconfined burning. Confined burning includes MAR burning inside a drum that has lost the seal and/or the lid. DOE-STD-5506 refers to DOE-HDBK-3010-94 which states that even waste placed together in a pile without bag containment forms a loosely agglomerate package of sorts. DOE-STD-5506 concludes: “Therefore, combustion of TRU wastes that is contained in drums or boxes, meets the definition of packaged waste, even when these containers have suffered lid degradation or loss.” In fact, the derivation of the ARF and RF for confined burning, in section 5.2.1.1 of DOE-HDK-3010, Vol. 1, is based on results from waste contained in a cardboard box. The descriptions within DOE-STD-5506 and the DOE-HDBK-3010 confirm that measures that prevent the waste from being ejected will provide confined burning. A 55-gallon drum without the lid in place is determined by DOE-STD-5506 to provide confined burning. A lid restraint which would cause the lid to be retained would exceed the confinement provided by a 55-gallon drum that has experienced lid loss.
According to DOE-STD-5506, waste burning within a doublepack will behave as if it were burning within an intact drum experiencing seal loss, providing additional confinement of the waste material would still be contained within the drum containment cabinet and would burn as confined.

Devices credited to prevent ejection of waste include lid restraint, doublepack and the DVS enclosure. The lid restraint must be installed according to manufacturers’ instruction.

The use of a doublepack is discussed in DOE-STD-5506 as ensuring lid retention and therefore confined burning and, further, retaining the waste in a configuration that simulates seal failure on an intact drum. The DVS enclosure would be expected to provide confinement similar to that provided by a doublepack. The DVS enclosure consists of the DVS containment cabinet with the door closed and the drum raised into position for venting (against the gasket seal housing). The waste is retained in a configuration at least as secure as a second drum would provide. Even if the waste were to eject from the drum, the ejected material would still be contained within the chamber and would burn as confined.

Blast-mitigation devices (e.g., lid restraints, doublepacks, and other devices) are either purchased or designed and manufactured to meet the functional requirements, and are periodically inspected for degradation. Blast-mitigation devices shall be maintained by preventive maintenance and replaced when appropriate. It is acceptable to use more than one blast-mitigation device (e.g., a lid-restraint on the drum that is then vented within the drum venting system chamber), as long as the device whose use is credited with consequence reduction meets the associated performance and quality requirements. The use of an additional blast-mitigation device may provide further defense-in-depth, but is not credited in the accident analysis, and is not required to meet the same requirements as the credited device.

Procedures direct the establishment of a safe standoff distance of $\geq 30$ ft from the unvented drum before the drum is vented. Maintenance of the standoff distance throughout the venting process is prescribed by procedure. The 30-ft (radius) standoff distance serves two worker protection functions in the event of a deflagration during drum venting: 1) it helps to limit the potential inhaled radiation dose rate for facility workers, and 2) it protects workers from serious injury from the blast wave (as derived in CALC-11-TA-54-AREAG-010).

Personnel necessarily must be within 30 ft of the drum prior to venting (e.g., set-up of drum in venting apparatus), but must maintain the $\geq 30$ ft standoff distance during the venting. This standoff distance, in conjunction with a radiological contamination control environment (element of the Radiation Protection Program), provides a means to minimize the worker from being impacted by flying debris and limits the amount of radiological material available for uptake.

Since the deflagration hazard only exists during the actual venting (puncture), this control is only applicable during venting (e.g., activities such as setting up the drum do not have the potential to puncture the drum and therefore the subsequent deflagration hazard does not exist, and the control is not applicable). The failure to meet either of these SACs does not, in and of itself, result in worker injury. Spark generation during a venting activity could result in a deflagration should the drum have a combustible atmosphere. However, blast mitigation would minimize worker consequences. Time is available to recover from an error of omitting the blast-mitigation device before beginning the venting activity.

Operators are trained on the venting process, procedures, and equipment. Drum venting procedures define the process and appropriate controls for the venting process to be used and the steps to implement the selected controls. Before venting a drum, Operations, Engineering, and Radiation Protection will select the appropriate process to be used for the planned activity and the applicable controls for the condition.
Operations will secure the area within the standoff distance in accordance with procedures before the drum is vented.

Workers are trained on the method for the venting of drums and the equipment to be used. Procedures provide specific guidance for selecting the equipment, inspecting it, setting up the drum, establishing a standoff distance, and performance of the vent activity.

Although this activity is complex, the activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

The venting of drums is not a time-critical activity. Drum deflagration is most likely to occur at the moment of venting. If it is discovered that an unvented drum is about to be vented without specified controls in place, the venting preparation can be suspended, the controls imposed, and the action can then be completed. Failure to implement the controls does not necessarily result in a deflagration event. This activity is not time-constrained and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.8.5 Controls (TSR)

The venting controls have been written in the directive action SAC format to control the venting of an unvented TRU waste drum.

4.5.9 Pole-Mounted Transformer Distance from TRU Waste Storage Areas

4.5.9.1 Safety Function

The safety function of this SAC is to prevent pole-mounted transformers from falling onto or in close proximity of TRU waste storage areas to prevent a post-seismic transformer fuel pool fire from impacting waste, thereby mitigating consequences from a post-seismic fire.

4.5.9.2 Specific Administrative Control Description

Pole-mounted transformers must be located so that, if toppled during a seismic event, a post-seismic fuel pool fire does not impact TRU waste. The safe distance is the summation of the height of the pole-mounted transformer, the radius of the potential resulting fuel pool possible from the spilled transformer flammable/combustible oil (with a flammability rating greater than 1), and the associated thermal separation distance necessary to prevent the TRU containers from becoming affected by the transformer fuel pool fire. Alternatively, the pole-mounted transformer can fall at a berm, ditch, curb, or equivalent liquid impediment that is at a safe thermal separation distance away from a TRU waste storage area.

The accident analysis for a seismic event and post-seismic fire assumes that a flammable/combustible liquid-filled pole-mounted transformer will not topple onto a TRU waste storage area, with high consequences. This control protects the assumption of the analysis.

4.5.9.3 Functional Requirements

The following functional requirements are necessary to fulfill the safety function of this control:

- Pole-mounted transformers are identified.
• Define the distances between pole-mounted transformers and TRU waste storage areas or

• Ensure that pole-mounted transformers are separated from TRU waste container storage areas so that any spilled flammable/combustible fuel will not impinge upon the minimum thermal separation distance specified in Section 4.5.2.2.

• Alternatively, ensure that the transformer is located at a distance such that it cannot fall beyond a liquid impediment that is sized to prevent the volume of liquid contained within the transformer from impinging upon the minimum separation distance of a TRU waste storage area.

The control will be implemented by procedures that contain the appropriate algorithm for determining the required separation distance.

4.5.9.4 Specific Administrative Control Evaluation

The performance criterion required to meet the credited safety function is as follows:

• Liquid-fueled pole mounted transformers shall be located a safe distance away from the TRU waste container storage areas, as determined by the height of the pole-mounted transformers. If the pole-mounted transformer contains flammable/combustible liquid (i.e., with a flammability rating greater than 1), the safe distance is the height of the transformer, the radius of the fuel pool based on the volume of the fuel within the transformer, and a thermal separation distance to protect the TRU waste container storage areas. The safe distance can also be the distance required to ensure that the pole-mounted transformer does not fall beyond a liquid impediment.

The accident analysis for a seismic event and post-seismic fire presumes that a pole-mounted transformer falls onto a TRU non-metal container storage area. If a transformer falls into a TRU waste container storage area, and a fuel pool fire is initiated, the ensuing fire may be sufficient to propagate within the TRU waste container storage area, resulting in high consequences. Therefore, such a condition is precluded by imposition of this control.

Facility procedures identify guidance for determining safe distances of pole-mounted transformers from TRU waste container storage areas, and describe the actions necessary to take if the safe distance requirement (i.e., greater than the minimum thermal separation distance) between the pole-mounted transformer’s tumble, spillage, and fuel pool fire and the TRU container storage areas is not satisfied.

Establishing a safe distance between pole-mounted transformers (that may pose a threat of falling, spilling flammable/combustible liquid, and causing a fuel pool fire) and TRU non-metal container storage areas is not considered a difficult task.

This control does not apply to pad-mounted or floor-mounted transformers, as these do not present the same seismic toppling concern as elevated, pole mounted transformers. The control also does not apply to transformers containing only Class IIIB combustible liquid. Such liquids have a National Fire Protection Association (NFPA) 704 Flammability Rating of 0 or 1, or (if a Flammability Rating is not available for a particular liquid), have a flashpoint of 200 °F or higher. These liquids require considerable preheating under all ambient temperature conditions, before ignition and combustion can occur. Transformer liquids of this type will not start a fire, do not present the same fire hazard as flammable/combustible liquids with a lower flash point temperature, and are not subject to this control.

The discovery of a failure to establish a safe distance between pole-mounted transformers and TRU storage areas will not result in an accident condition, but the consequences that could result from a fuel pool fire caused by the transformer’s tumbling into a TRU storage area would be unacceptably high.
Engineering evaluations are necessary to ensure that safe distances between pole-mounted transformers and TRU waste container storage areas are established and maintained, and to ensure that any liquid impediments are appropriately designed to prevent run-on of the transformer fluid.

4.5.9.5 Controls (TSR)

This control is designated in the TSR as Directive Action AC.

4.5.10 Escort of High-MAR TRU Waste Transport within TA-54, Area G

4.5.10.1 Safety Function

The safety function of this control is to reduce the likelihood of a vehicle accident involving radiological waste and impact to stored radiological waste containers.

During the transportation of radiological waste that has the potential for high consequences to the public, i.e., transports of TRU metal waste containers with MAR > 800 PE-Ci or transports of TRU non-metal waste containers with MAR > 450 PE-Ci, there is a potential for vehicle accidents that can result in a release of radiological material.

4.5.10.2 Specific Administrative Control Description

To perform the mission at TA-54, Area G, it is necessary to move TRU waste between different defined areas. For example, retrieved MAR may be moved to a storage location or a venting location. Being able to transport higher-MAR quantities minimizes the number of transports that must occur, but transporting higher-MAR quantities could result in greater consequences if a vehicle accident resulted in a radiological release.

To reduce the risk associated with high MAR on a TRU waste transportation vehicle, an additional control is implemented to escort the TRU waste transportation vehicle with a rolling roadblock. A TRU waste transportation vehicle with high MAR includes a vehicle with metal containers with > 800 PE-Ci, and a vehicle with non-metal containers with > 450 PE-Ci. A rolling roadblock consists of an escort vehicle in front of and another behind the TRU waste transportation vehicle. The escort minimizes the potential for another vehicle impacting the TRU waste transportation vehicle with the high MAR, and also ensures compliance with the 15-mph posted speed limit at which the TRU transportation vehicle travels to minimize the potential for the TRU transportation vehicle to cause an accident.

There are no boundaries or interface points with any SSCs relevant to the safety functions.

This SAC is performing a safety function in that it greatly reduces the likelihood of a vehicle accident involving radiological waste that has the potential for high consequences to the public. There are no feasible, cost-effective SSCs available, considering the limited life of this facility and the configuration of TA-54, Area G. Therefore, an SAC is required to perform this function. This is an administrative function that does not rely on any SSCs for its performance.

Designated routes of travel will be established by procedure, and are required to be known by escort drivers. Transport vehicles that are operating under the LANL Transportation Safety Document (TSD) [LANL 2011c] are not subject to this control. Consistent with the interface between a nuclear facility at LANL and the LANL TSD, the TSD governs and applies during transport along public roads and until the vehicle comes to a complete stop at the required location for unloading, and receipt acceptance of a waste container at Area G occurs.
4.5.10.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- TRU waste inventory of containers to be transported and container type is determined.
- Transport vehicles (excluding forklifts) are escorted by rolling roadblock when transporting TRU waste containers with MAR quantities that, if involved in an accident, will result in unacceptable releases of radiological material.

The implementation of this SAC is through the Vehicle/Equipment Safety Controls SMP and is dependent on the robustness of other SMPs, such as Training and Qualification, Conduct of Operations, and Configuration Management. The Training and Qualification Program is important because it ensures that Area G Site personnel are trained and qualified to accomplish their safety-related responsibilities. The Conduct of Operations SMP is important to the implementation of this SAC because it requires the identification of risk and the implementation of controls to perform work safely and securely. The Configuration Management Program is critical to ensure that designated routes of travel are established and evaluated when route changes become necessary as the footprint of Area G changes. The suite of SMPs ensures the implementation of this control through procedures and operator knowledge of hazards associated with escort of transport vehicles.

4.5.10.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

- Any transportation vehicles with only metal containers and > 800 PE-Ci shall be escorted by a rolling roadblock (i.e., escort vehicle in front and back).
  and
- Transportation vehicles with one or more non-metal containers containing > 450 PE-Ci shall be escorted by a rolling roadblock (i.e., escort vehicle in front and back).

The implementation of this SAC will be ensured by facility procedures requiring determination of the inventory being transported on a vehicle. Before transport, the PE-Ci inventory on the truck is determined. If this value has the potential to result in high consequences (> 800 PE-Ci in metal containers, > 450 PE-Ci in one or more non-metal containers), then facility procedures dictate that the transport vehicle is escorted by a rolling roadblock.

Escort vehicle operators are trained on the designated routes of travel. In addition, escort vehicle operators are trained on the proper procedure for escorting transport vehicles. Due to the strict inventory-tracking practices and knowledge of drum contents, transport vehicle loads are well-characterized, and, if the inventory of waste on a transport is > 800 PE-Ci for metal containers and > 450 PE-Ci for one or more non-metal containers, procedures require a rolling roadblock escort.

Procedures provide specific guidance on requirements for rolling roadblock escorts and determination of designated route of travel. Designated routes of travel will be established and documented, and are required to be known by drivers. Due to the nature of TA-54, Area G operations and the need for various combinations of origination and destination points, designated routes may be modified and the changes evaluated through the Unreviewed Safety Question (USQ) program.

The activity is well-defined and characterized in procedures so that operator actions are considered to be a low level of difficulty.
The TRU waste transport vehicles and escort vehicles are inspected and maintained regularly in accordance with the vehicle maintenance program SMP.

The transportation of containers with a rolling roadblock escort is not a time-critical activity. If it is discovered that a transport of waste material sufficient to cause high consequences to the public is taking place without a rolling roadblock escort, the transport activity can be suspended, the escort put in place, and the action can then be completed. The failure to implement the control does not necessarily result in a vehicle accident but raises the likelihood that, if an accident were to occur, additional radiological material would be involved.

Transport and rolling roadblock escort of TRU waste containers will typically occur external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.10.5 Controls (TSR)

This SAC has been written as a Directive Action AC to ensure that TRU waste transports within TA-54, Area G are performed to fulfill the safety function.

4.5.11 Escort of Transportation Vehicle between TA-54, Area G and RANT

4.5.11.1 Safety Function

The safety function of this control is to reduce the frequency of vehicle accidents resulting in fuel interaction with MAR during transport of MAR between Area G and the RANT Facility entrance gate.

During transports from TA-54, Area G to the RANT Facility, there is a potential for transport vehicles to be involved in vehicle accidents. These accidents could result in a release due to impact or a fuel pool fire.

4.5.11.2 Specific Administrative Control Description

To perform the mission at TA-54, Area G, it is necessary to move TRU waste MAR between Area G and RANT. To reduce the risk associated with a TRU waste transfer between Area G and RANT, a control is implemented to escort the transportation vehicle with a rolling roadblock. A rolling roadblock consists of an escort vehicle in front of and another behind the transportation vehicle. The escort minimizes the potential for another vehicle to impact the transportation vehicle, and also ensures that the transportation vehicle travels at the posted speed limit to minimize the potential for the transportation vehicle causing an accident.

There are multiple acceptable methods for reducing the likelihood of an accident involving a transport vehicle outside of TA-54, Area G. While a specific SSC (e.g., an automated transport vehicle) is possible, due to time constraints and outside initiators, there are no feasible cost-effective SSCs available to accomplish the credited safety function. Therefore, the escort of TRU waste transport vehicles outside Area G is designated as a SAC.
There are no boundaries or interface points with any SSCs relevant to the safety functions. The action required by the SAC is the escort of TRU transportation vehicles between TA-54, Area G, and the RANT entrance gate. This is an administrative function that does not rely on any SSCs for its performance.

There are no physical parameters associated with the performance of this SAC.

Transport vehicles that are operating under the LANL Transportation Safety Document [LANL 2011c] are not subject to this control. Consistent with the interface between a nuclear facility at LANL and the LANL TSD, the TSD governs and applies during transport along public roads until the vehicle comes to a complete stop at the required location for unloading, and receipt acceptance of a waste container at the Area G occurs.

4.5.11.3 Functional Requirements

The functional requirement to meet this SAC is as follows:

- Escort is assigned to a transport vehicle when the transport vehicle is travelling between Area G and the RANT entrance gate with MAR onboard.

The implementation of this SAC is through the Vehicle/Equipment Safety Controls SMP and is dependent on the robustness of other SMPs, such as Training and Qualification, Conduct of Operations, and Configuration Management. The Training and Qualification Program is important because it ensures that Area G Site personnel are trained and qualified to accomplish their safety-related responsibilities. The Conduct of Operations SMP is important to the implementation of this SAC because it requires the identification of risk and the implementation of controls to perform work safely and securely. The Configuration Management Program is critical to ensure that the designated route of travel between Area G and RANT, and requirements for transports on this designated route of travel, are established and reevaluated if changes become necessary. The suite of SMPs ensures the implementation of this control through procedures and operator knowledge of the hazards associated with escort of TRU waste transport vehicles between the RANT entrance gate and Area G.

4.5.11.4 Specific Administrative Control Evaluation

The performance criterion required to meet the functional requirements and credited safety functions is as follows:

- Transportation vehicles with MAR onboard shall be escorted by a rolling roadblock (i.e., escort vehicle in front and back) between TA-54, Area G and the RANT entrance gate.

The implementation of this SAC will be ensured by facility procedures requiring all transports of MAR between TA-54, Area G and the RANT entrance gate to have a rolling roadblock escort.

Escort vehicle operators are trained on the designated routes of travel. In addition, escort vehicle operators are trained on the proper procedure for escorting transport vehicles. Procedures provide specific guidance on requirements for rolling roadblock escorts.

TRU waste transportation is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

The vehicles are inspected and maintained regularly in accordance with the vehicle maintenance program SMP.
The transportation of containers with a rolling roadblock escort is not a time-critical activity. It should not be affected by environmental conditions. If it is discovered that a transport of waste material between TA-54, Area G and the RANT entrance gate is taking place without a rolling roadblock escort, the transport activity can be suspended, the escort put in place, and the action can then be completed. The failure to implement the control does not necessarily result in a vehicle accident but raises the likelihood that, if an accident were to occur, additional radiological material would be involved.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.11.5 Controls (TSR)

This SAC has been written as a Directive Action AC to ensure that TRU waste transports between TA-54, Area G and RANT are performed to ensure the fulfillment of the safety function of this control.

This SAC applies to the transportation vehicles with MAR onboard during transport between TA-54, Area G and the RANT entrance gate. When movement of the TRU waste transportation vehicle is not occurring (e.g., during loading and unloading), the rolling roadblock escort is not required. This control is not required within the RANT facility boundary (i.e., beyond the RANT entrance gate). The escort is not required in the RANT yard because the transportation vehicle is traveling at a low speed to turn into or out of the RANT yard.

4.5.12 Escort of > 100-Gal Flammable Liquid Inventory Vehicles Within TA-54, Area G

4.5.12.1 Safety Function

The safety function is to reduce the likelihood of fuel interaction with MAR during vehicle transports with > 100 gal of flammable/liquid on board.

During the transport of > 100-gal of flammable liquid, it is possible for an accident to occur than can result in a fuel spill that interacts with TRU waste containers, and can result in a fuel pool fire with lid loss and ejection of waste.

4.5.12.2 Specific Administrative Control Description

The TRU waste containers at TA-54, Area G are susceptible to fuel pool fires causing a lid loss and ejection of waste with unconfined burning. The Combustible/Flammable Liquids SAC has been written to restrict the amount of fuel within a defined area. To prevent fuel in greater than analyzed volumes from entering the defined areas, the requirement to escort vehicles with > 100 gal of flammable liquid along designated routes is designated as a SAC.

Controls on vehicles/equipment with greater than a total contained 100-gal fuel inventory (including the vehicle’s fixed fuel tank capacity and any transported containers of flammable liquid) minimize the likelihood that an accidental fuel spill and fire would occur in the vicinity of MAR and result in a release of radiological material. Drivers with vehicles or equipment with the capacity to contain > 100 gal may not be familiar with the TA-54, Area G site. The large-fuel-capacity vehicles and equipment that are required to pass near defined areas containing MAR must be escorted along a designated route. The escort vehicle restricts the travel path and ensures that the vehicle or equipment complies with the posted speed limit so that the likelihood of a vehicle accident and fuel spill is limited. The escort vehicle shall be in front of the vehicle or equipment with a quantity of fuel > 100 gal.
There are no feasible cost-effective SSCs available, considering the limited life of this facility. Therefore, an SAC is required to perform this function. The action required by the SAC is the escort of vehicles/equipment that contain > 100 gal of flammable/combustible liquid within TA-54, Area G. This is an administrative function that does not rely on any SSCs for its performance.

Designated routes of travel will be established by procedure, and are required to be known by escort drivers. Due to the nature of TA-54, Area G operations and the need for various combinations of origination and destination points, designated routes may be modified, and the changes evaluated through the USQ program.

4.5.12.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- Flammable liquid inventory of vehicle and/or equipment that will travel within TA-54, Area G is determined.
- Travel route is designated for the vehicle.
- Escort is assigned to precede the vehicle with >100 gal total flammable liquid inventory

4.5.12.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

- Vehicles/equipment in transit within Area G with > 100 gal total flammable liquid inventory shall be escorted and shall follow a designated route of travel.
- Escort vehicle operators are trained on the proper procedure for escorting transport vehicles and the designated routes of travel. Procedures require an escort for vehicles and equipment with >100 gal of flammable liquids on board, and provide specific guidance on requirements for vehicle escorts.
- Escort of vehicles is well-defined and characterized in procedures so that operator actions are considered to be a low level of difficulty.
- The escort vehicle is inspected and maintained regularly in accordance with the vehicle maintenance program SMP.

The movement of vehicles/equipment with > 100 gal of flammable liquid with an escort is not a time-critical activity. It should not be affected by environmental conditions. If it is discovered that a vehicle or equipment with >100 gal of flammable liquid is traveling on TA-54, Area G without an escort, the activity can be suspended, the escort put in place, and the action can then be completed. The failure to implement the control does not necessarily result in the interaction of liquid fuel and radiological material, but raises the likelihood of interaction between liquid fuel and radiological material.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.
4.5.12.5 Controls (TSR)

This SAC has been written as a Directive Action AC, and ensures that vehicles and equipment with greater than a total of 100 gal (i.e., fuel tanks, hydraulics, fuel cans) are controlled so that performance of the safety function is accomplished. The control does not apply to emergency response vehicles.

4.5.13 Vehicle/Equipment Safety Control - Refueling Location

4.5.13.1 Safety Function

The safety function of this control is to reduce the frequency of a refueling accident involving a fuel pool fire from impacting TRU waste.

This SAC is designed to prevent a fuel pool fire initiated in a refueling location from affecting MAR. Maintaining a separation distance between the refueling location and any MAR reduces the likelihood that large liquid fuel pools can form in proximity to radiological waste and create a fire hazard to the MAR located in defined areas.

4.5.13.2 Specific Administrative Control Description

When a refueling location is designated within TA-54, Area G, TRU waste defined areas require a thermal separation distance from the refueling location. That is, a minimum separation distance per Section 4.5.2 must be maintained between the potential flame front and any TRU waste defined area. This separation distance ensures that the fuel pool will not engulf the TRU waste defined area, and ensures that the heat of the pool fire would not result in the ignition of TRU waste that is in proximity to the fuel pool.

Refueling vehicles typically enter TA-54, Area G weekly to provide fuel for both gasoline and diesel-powered equipment operated within the area. The refueling vehicle is typically parked at a location near the primary access point, and vehicles needing to be fueled are brought to this refueling location. If a TRU waste container defined area is in proximity to the refueling location, there is the potential that a fuel pool fire involving the refueling vehicle could affect TRU waste.

The separation distance does not apply to the hose connecting the refueling vehicle and the vehicle to be refueled. The refueling operation is attended and any leaks through the hose would be immediately addressed. The separation distance for the refueling location does not apply to LAAs.

The nature of TA-54, Area G and its operations requires flexibility in the use of liquid fuels. Therefore, design and installation of SSCs to safely deliver liquid fuels to all required locations within the facility is not practical. Even with an installed system, there remains the potential for fuel spills (e.g., pipe breaks, overflows, isolation) that could affect MAR. As an alternative, this SAC prohibits MAR within a separation distance (Section 4.5.2) of the maximum potential fuel spill that could occur within the facility.

A refueling location involving \( \leq 7 \) gal is not subject to the requirements of this SAC. Fuel pool fires of \( \leq 7 \) gal were determined to have minimal risk due to their short burn duration and limited MAR involvement (Chapter 3, Section 3.4.1.5.2).

This SAC does not rely on any specifically designed SSCs. Procedures are required to establish a refueling location, determine the potential extent of a fuel spill, and establish a separation distance from the refueling location.
4.5.13.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- The type of TRU waste containers (i.e., metal or non-metal) in a defined area in proximity to the refueling location is determined prior to establishing the refueling location.
- Thermal separation distance is established between a stationary refueling location and defined areas within TA-54, Area G based upon the type of TRU waste containers in the defined area and the fuel capacity of the refueling vehicle.
- Refueling locations are prohibited within the thermal separation distance established around the TRU waste container defined areas.

4.5.13.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

- Refueling locations with > 7 gal combustible/flammable liquids shall be separated from MAR in defined areas by the thermal separation distance specified in Table 4-5.

<table>
<thead>
<tr>
<th>Capacity of Refueling Vehicle at Refueling Location</th>
<th>Minimum Refueling Separation Distance to Defined Area with non-metal Waste containers (ft)</th>
<th>Minimum Refueling Separation Distance to Defined Area with only Metal Containers (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 7 gal and ≤ 100 gal</td>
<td>43</td>
<td>22</td>
</tr>
<tr>
<td>&gt; 100 gal and ≤ 500 gal</td>
<td>71</td>
<td>45</td>
</tr>
<tr>
<td>&gt; 500 gal and ≤ 5,000 gal</td>
<td>203</td>
<td>141</td>
</tr>
</tbody>
</table>

The change-out of a propane cylinder is excluded from this control because a propane leak will not result in a fuel pool fire. Also excluded is a refueling truck located downhill from a retrieval area. Unless fuel is spilled into a trench or pit, fuel pool fire will not impact the retrieval area. This control does not apply to the hose connected to the refueling vehicle and the refueled equipment because the refueling operation is attended to prevent catastrophic loss of fuel.

For refueling locations present within TA-54, Area G, defined areas in proximity to the refueling location shall be assessed for the container type (i.e., metal or non-metal). Based on this assessment, it shall be verified that the refueling location is not placed within the thermal separation distance established for that defined area. This is not a time-critical activity that would adversely affect implementation of this SAC.

Restricting the refueling tanker to specific, designated refueling locations that meet the thermal separation distance requirements, and prohibiting MAR on vehicles undergoing refueling, reduces the consequences and likelihood of a large fuel fire impacting the waste containers.
Transport vehicles containing TRU waste may pass by a refueling location without the requirement for a separation distance. This is judged to be acceptable because other controls are imposed upon the TRU waste transport vehicle, such as an escorted rolling roadblock with high-MAR transports, and the transient period of time that the TRU waste transport vehicle will pass a refueling location.

Operators are trained on the separation distance control, the procedures for establishing a refueling location with a separation distance, and maintaining a separation distance between the stationary refueling location and the TRU waste defined area.

Workers are trained on this SAC and the procedures for establishing refueling locations and the applicable separation distances. Before the establishment of a defined area, operators confirm that, for the waste type in the defined area, the separation distance will not be violated.

The setup of the separation distance requires procedural compliance and engineering confirmation of the established separation distance. Establishment of the separation distance is not time-critical and the location, in general, will be repeatedly used so that operators are familiar with the control. Once the separation distance is established and confirmed, verification is required, which is considered to be a low level of difficulty.

No equipment is required to support this activity. Implementation of this SAC may utilize signage or other indicators along the roadways during the presence of the refueling location. Procedures would be relied upon to ensure that this SAC is properly implemented.

Establishing a separation distance around a stationary refueling location is not a time-critical activity and the movement of TRU waste transports is not time-critical. Therefore, there is adequate time to ensure compliance with this SAC. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should not be affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.13.5 Controls (TSR)

This SAC has been written as an LCO to ensure that a thermal separation distance is maintained so that performance of the safety function of this control is accomplished.

Prior to establishing each refueling location, and prior to the establishment of or change in status of a defined area, a SR is necessary to

- Verify that a refueling location with > 7 gal combustible/flammable liquids is separated from MAR in a defined area by the thermal separation distance specified in Table 4-5.

4.5.14 Vehicle Refueling Prohibition

4.5.14.1 Safety Function

The safety function of this control is to reduce the likelihood of a fire from a refueling accident involving MAR on a TRU waste transportation vehicle.
4.5.14.2  Specific Administrative Control Description

The refueling of a TRU transportation vehicle is prohibited when MAR is on board the TRU waste transportation vehicle.

This control is not applicable to propane-fueled forklifts.

Accident analyses indicate that fuel pool fires involving TRU MAR result in significant dose consequences to the worker, the collocated worker, and the public. Precluding refueling of the TRU transportation vehicle while it is loaded with MAR reduces the probability that the TRU transportation vehicle will be involved in a fuel pool fire, and eliminates the possibility of a fuel pool fire occurring with MAR on board during refueling.

The enabling events that must occur for the fuel pool fire include an accident with the refueling process resulting in a fuel spill that develops into a fuel pool, and the concurrent presence of an ignition source.

4.5.14.3  Functional Requirements

The implementation of this SAC is accomplished through compliance with the prohibition on refueling of a TRU waste transportation vehicle when the vehicle has a MAR inventory on board.

4.5.14.4  Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is to not subject a TRU waste transportation vehicle to refueling if the vehicle has a TRU MAR inventory on board.

Procedures prohibit the refueling of a loaded TRU waste transportation vehicle.

The activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

The prohibition of refueling a MAR-loaded TRU waste transportation vehicle is not a time-critical activity and is not expected to be affected by environmental conditions. However, refueling a TRU waste transportation vehicle with a TRU waste inventory on board creates unnecessary increased risk. A refueling operation is a uniquely hazardous situation with the opportunity for fuel to be spilled directly under or around the TRU waste transportation vehicle, thus squarely placing a MAR inventory in the vicinity of a fuel pool through carelessness and with no other mishap, impact, or accident conditions. Refueling a TRU waste transportation vehicle does not necessarily result in the interaction between the fuel inventory and the TRU waste material. The enabling event of spilled fuel and the concurrent presence of an ignition source must also occur for a fuel pool fire to result. However, compliance with this SAC eliminates any likelihood of a refueling accident and resulting fuel pool fire occurring in the vicinity of a TRU waste transportation vehicle.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required.

4.5.14.5  Controls (TSR)

This control has been written as a Directive Action AC in the TSRs.
4.5.15 **Doublepacking TRU Waste Drums with MAR ≥ 200 PE-Ci During Trenches A-D Retrieval Activities**

### 4.5.15.1 Safety Function

The safety function is to reduce radiological consequences of an accident by limiting the amount of MAR affected by thermal or mechanical insults.

Fires, deflagrations, and impacts to TRU waste containers with high radiological content (PE-Ci) were determined to result in adverse radiological consequences. Doublepacking of high-MAR TRU waste drums significantly reduces the amount of radiological material released.

### 4.5.15.2 Specific Administrative Control Description

High-MAR TRU waste drums are required to be doublepacked when stored above ground at TA-54, Area G. Many drums that are currently stored below ground in Trenches A through D are known to contain > 200 PE-Ci. These drums are not currently doublepacked (as required for above-ground drums), and cannot be doublepacked until they have been removed from the trench. Upon removal from an uncovered culvert, any drum with ≥ 200 PE-Ci is doublepacked before another drum is retrieved. Depending on the integrity of a retrieved drum with ≥ 200 PE-Ci, doublepacking may require the retrieved drum to be overpacked with a single TRU waste container (if the retrieved drum itself is of sound integrity) or with two successive TRU waste containers (if the retrieved drum is not of sound integrity).

A metal container of sound integrity nested within another metal container of sound integrity (i.e., doublepacked) is credited for reducing the fire damage ratio to 0.1 per DOE-STD-5506-2007 [DOE 2007]. To limit the amount of MAR subject to release in an accident, doublepacking of each retrieved drum with MAR ≥ 200 PE-Ci must be completed before retrieval of an additional drum.

This control credits the structural integrity of the safety-significant TRU waste containers. A container of sound integrity enclosed within a second container of sound integrity is required to accomplish the required function of limiting the amount of material released from the container in the event of an accident.

Failure of the doublepack would result in the inability to complete the action required by the SAC. The drums that serve as a doublepack are credited safety-significant design features in several accident scenarios. Their use is governed by the Training and Qualification, Quality Assurance, Conduct of Operations, and Configuration Management programs.

### 4.5.15.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- Determine the radiological inventory (i.e., PE-Ci) of each TRU waste drum in trenches A through D.
- Determine the structural integrity of each TRU waste drum.
- If the TRU waste drum meets the definition of a TRU container of sound integrity, then place a TRU waste drum with ≥ 200 PE-Ci radiological inventory into an overpack drum and install a drum lid.
• If the TRU waste drum is not of sound integrity, then place the TRU waste drum with ≥ 200 PE-Ci radiological inventory into an overpack drum, install a drum lid, place the overpack drum into another overpack container, and install a lid.

4.5.15.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

• TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D shall be doublepacked prior to retrieval of an additional TRU waste drum in the defined area.

TRU waste containers are required to be evaluated for radiological content. This determination is accomplished through generator data or through measurement using TA-54, Area G assay equipment. Verification that TRU waste drums ≥ 200 PE-Ci are doublepacked is required to ensure compliance with this SAC.

TRU waste containers are required to be evaluated for structural integrity in accordance with DOE-STD-5506-2007 [DOE 2007]. This determination is accomplished through inspection of the container in accordance with DOE-STD-5506-2007 inspection criteria. If the container is not of sound integrity, overpacking is required before doublepacking. Verification that the TRU waste is packaged within two independent containers of sound integrity is required to ensure compliance with this SAC.

There is adequate time for setup of the retrieval operation to accommodate doublepacking of TRU waste drums ≥ 200 PE-Ci as required. In addition, assay operations are planned activities that permit setup of the operation to perform doublepacking as required. Doublepacking is performed in accordance with a procedure upon which operators have been trained. Therefore, human factors should have minimal adverse effect on operations.

Procedures are prepared and workers are trained on the procedures for identification of high-MAR containers, structural integrity inspection, and doublepacking operations. The facility verifies and documents that the container to be doublepacked is of sound integrity. Because the doublepacked container is stored until its remediation and/or shipment from LANL, and is not exposed to ambient environmental conditions, the inner doublepacked container is presumed to remain of sound integrity, so no further inspection is required of the inner doublepacked container.

Doublepacking is well-defined and characterized in procedures so that operator actions are considered to be a low level of difficulty.

The TRU waste containers are visually inspected for structural integrity without the aid of equipment. The DOE-STD-5506-2007 [DOE 2007] inspection criteria are general in nature (e.g., no obvious signs of rusting), and, therefore, do not lend themselves to evaluation by any instrumentation.

Performance of doublepacking is not a time-critical activity (e.g., required completion in minutes). High-MAR containers shall be isolated within hours of discovery to minimize the consequences of any anticipated impacts. The time constraints are not sufficient to adversely affect the completion of doublepack activities. Environmental conditions should not have an impact.

These activities are not time-constrained, and may be performed as necessary to support TA-54, Area G activities. They should be minimally affected by environmental conditions.
Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

The failure to perform the requirements of this SAC for a given high-MAR container does not result in a loss-of-confinement event. This control reduces the consequences of a loss-of-confinement accident. The failure to perform the requirements of this SAC could result in adverse consequences to workers in the event of an accident.

### 4.5.15.5 Controls (TSR)

For TRU waste drums associated with waste retrieval in Trenches A through D, this control is written as a Directive Action AC in the TSRs. The control ensures that TRU waste drums with \( \geq 200 \) PE-Ci are controlled so that the safety function of this control is fulfilled.

### 4.5.16 Elevated Waste Movements and Critical Lifts - Spotter for TRU Waste Container Lifts > 4 ft

#### 4.5.16.1 Safety Function

The safety function of this control is to reduce the frequency for container puncture, drops, toppling, and impacts resulting in release of radiological material.

#### 4.5.16.2 Specific Administrative Control Description

There are multiple acceptable methods for reducing the likelihood of container damage during handling and transport of TRU waste containers. The TRU waste containers are located in many locations and configurations, thereby preventing the installation of a common SSC to prevent interactions with TRU waste containers. Therefore, this control is implemented as a SAC.

Handling and transport of TRU waste containers is required during various receipt, retrieval, handling, examination, and shipping activities. Lifts of greater than 4 ft above the ground surface directly below the TRU waste container have the potential to result in collisions with other impediments, assuming that the operator’s field of vision is impaired due to the position of the raised load. Therefore, lifts of containers that are expected to exceed 4 ft require the presence of a spotter to assist in observing the activity and directing the movements while the load is raised. Observation of these movements provides assurance that potential obstructions are identified and the raised load is safely maneuvered about the obstacle.

There are no SSCs specifically associated with the implementation of this SAC, as this control is designed to prevent the collision of TRU waste containers being handled or transported with other objects. The equipment or vehicle being used to lift the containers does not affect the implementation of this SAC.

There are no SSCs whose failure would result in losing the ability to identify lifts expected to exceed 4 ft and/or to assign a spotter to observe and direct the activity.

There is no physical information required to implement this administrative control.

#### 4.5.16.3 Functional Requirements

The functional requirements to meet this SAC are as follows:
The anticipated lift height for handling or transport of a TRU waste container must be determined prior to the lift.

If the anticipated lift height is greater than 4 ft above the ground surface directly below the TRU waste container, then a spotter is assigned to the lift activity.

The assigned spotter is responsible for directing the vehicle/equipment operator around obstructions.

4.5.16.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

- A spotter shall be present for TRU waste container lifts planned to exceed 4 ft but $\leq 12$ ft lift height.

TRU waste container lifts are required to be evaluated for anticipated lift heights. If it is determined that a lift could result in a lift height of greater than 4 ft above the ground surface directly below the TRU waste container, then a spotter is required to be specified and assigned to the lift activity. The spotter is expected to observe the activity and direct the movements of the elevated TRU waste containers to prevent collision with other objects.

TRU waste container lifts are planned activities that do not require prompt setup and performance. Therefore, there is adequate time for evaluating the anticipated lift, identifying the need for a spotter, and assigning an individual to the activity to observe the container movements.

Workers are trained on the evaluation of lift activities and the identification of the need for spotters. Procedures provide the responsibilities of assigned spotters.

Lift activities are well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

Performance of lifts is not a time-critical activity. Actions to reduce the likelihood of a container impact must be completed prior to the lift activity. The failure to properly evaluate an activity for a lift of greater than 4 ft, or to assign a spotter, does not in and of itself result in a loss-of-confinement event.

Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and are not affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.16.5 Controls (TSR)

This control has been written as a Directive Action AC in the TSRs.
4.5.17 Elevated Waste Movements and Critical Lifts – Critical lifts > 12 ft or MAR > 150 PE-Ci

4.5.17.1 Safety Function

The safety function is to reduce the frequency of load drops resulting in release of radiological material.

4.5.17.2 Specific Administrative Control Description

Lifting of TRU waste containers is required during various receipt, retrieval, handling, examination, and shipping activities. Lifts of greater than 12 ft have the potential to result in significant damage to the lifted container if it is dropped. Therefore, lifts of containers where the minimum drop height (e.g., distance between the lowest point on the container and the first surface immediately below the container) is expected to exceed 12 ft are controlled to reduce the likelihood of a container drop. The minimum lift height requiring a critical lift plan is set at 12 ft because DOE-STD-5506 [DOE 2007] evaluates drops from the fourth tier of stacked drums (nominally 12 ft) to be low impact and to result in a damage ratio of 0.1 or less [LANL 2010]. Planning of these lifts provides assurance that potential obstructions within the load path are minimized, that lifting equipment is inspected and in proper working condition, and that the load is properly rigged. This planning reduces the likelihood of a container drop. This SAC requires preparation and approval of a critical lift plan for lifts of TRU waste containers greater than 12 ft in height. MLU payload lifts greater than 12 ft, or with MAR > 925 PE-Ci, are not subject to this control, and are instead subject to the more rigorous control in Section 4.5.18.

SSCs are not available in locations where TRU waste containers may be required to be lifted to a height of >12 ft above the ground surface directly below the TRU waste container, such as in Pit 9. Due to the limited lifetime of TA-54, Area G, the design, construction, testing, and maintenance of such a facility is not practical. Additionally, lifts of >12 ft may still be required to be performed at other locations, (e.g., MLU loading operations for payloads with MAR ≤ 925 PE-Ci; see Section 4.5.18) within TA-54, Area G. Therefore, this control is implemented as a SAC.

There are no SSCs whose failure would result in losing the ability to prepare and approve a critical lift plan.

There is no physical information necessary to implement this administrative control.

4.5.17.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- Determine the anticipated lift height for a lift of a TRU waste container.
- If the anticipated lift height is greater than 12 ft above the ground surface directly below the TRU waste container, then prepare a critical lift plan.

4.5.17.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions are as follows:

1. A critical lift plan shall be used for planned lifts of the TRU waste container > 12 ft above the ground surface directly below the TRU waste container. (Exception: MLU payloads with MAR > 925 PE-Ci are not allowed to be lifted > 12 ft. – see Section 4.5.18.)
2. A critical lift plan shall be used for planned lifts of FRPs with MAR ≥ 150 PE-Ci.
The accident analysis indicates that the drop of an FRP with MAR > 150 PE-Ci waste will result in dose consequences to the public that are close to Moderate. If it is determined that a lift could result in a lift height of greater than 12 ft between the low point of the container and the nearest surface immediately below the container, then a critical lift plan is required to be prepared and approved before the performance of the lift. The critical lift plan shall identify the planned path of load movement, rigging requirements, and equipment inspections to be completed before performance of the lift.

TRU waste container lifts are planned activities that do not require prompt setup and performance. Therefore, there is adequate time for evaluating the anticipated lift, identification for the need for a critical lift plan, preparation and approval of the lift plan, and performance of the lift in accordance with the approved plan.

Workers are trained on the evaluation of lift activities and the identification of the need for critical lift plans. Procedures provide guidance for preparing, approving, and implementing critical lift plans. Although a critical lift activity may be complex, the activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

The equipment required to support this activity is simple in nature. The inspection of the equipment before use ensures operation of the equipment to perform its required function. Signs of degradation (e.g., wear, broken fibers, damaged equipment) indicate that an SSC may not perform its function if required. Degraded equipment is repaired or discarded and replaced.

Performance of critical lifts is not a time-critical activity. Actions to reduce the likelihood of a container drop must be completed before the lift. The failure to properly evaluate an activity for a critical lift or the failure to prepare and approve a critical lift plan does not, in and of itself, result in a container drop event.

TRU waste container activities may occur in a domed structure or a building, or external to any structure. Since these activities are not time-constrained, they may be performed as necessary to support TA-54, Area G activities and should be minimally affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.17.5 Controls (TSR)

This control has been written as a Directive Action AC in the TSRs.

4.5.18 Mobile Loading Payload Lifts

4.5.18.1 Safety Function

The safety function is to prevent a mobile loading payload from dropping on top of another payload or a defined area containing TRU waste, and to minimize consequences by limiting the MAR involved in an accident.

During mobile loading payload lifts, there is a potential to drop the lifted payload onto another payload, resulting in high consequences to all receptors due to container breach and release of radiological material.
4.5.18.2 Specific Administrative Control Description

This SAC reduces the probability of drop of a mobile loading payload during lifting where the drop could fall onto other TRU waste, resulting in a container breach and a significant release of radiological material. It also reduces the likelihood of dropping high MAR mobile loading payloads, thereby reducing the MAR involved in single payload drops.

Lifting of payloads using mobile equipment such as wheel or track-mounted cranes and forklifts is required during packaging and shipping activities. Controls are imposed to ensure that these lifts are performed safely. Drops of mobile loading payloads may be considered high-energy impacts and require application of a high damage ratio and high ARF × RF values, resulting in high-consequence calculations for accident analysis. Precluding the lifting of a mobile loading payload over any other MAR reduces the consequences of a drop, since it eliminates MAR above that which is involved in the mobile loading payload lift. Limiting the MAR for high elevation lifts limits the consequences of single payload drop.

Application of the lift controls identified in this SAC reduces the risk of such accidents occurring by reducing the probability of such an event.

4.5.18.3 Functional Requirements

The functional requirements of this SAC are as follows:

- Verification that the lift involves a mobile loading payload.
- Verification that no MAR will be located under the mobile loading payload in the mobile loading payload lift path of travel during the lift.
- Verification that payloads to be lifted > 12 ft contain ≤ 925 PE-Ci.

4.5.18.4 Specific Administrative Control Evaluation

The performance criteria required to meet functional requirements and credited safety functions is as follows:

- Mobile loading payloads shall not be lifted over TRU waste. Excluded from this is a payload within a Type B container.
- Mobile loading payloads with MAR > 925 PE-Ci shall not be lifted more than 12 ft, measured from the bottom of the payload to the nearest surface below.

The implementation of this SAC will be ensured by facility procedures executed by trained and qualified individuals to prohibit movement of mobile loading payloads over TRU waste while performing a mobile loading payload lift.

Mobile loading payload lifts are not time-critical activities. The details of these activities are not affected by environmental conditions.

The failure to implement this control does not necessarily result in a dropped mobile loading payload during a lift evolution, but failure to implement this control does increase the likelihood that a mobile loading payload could be dropped onto other TRU waste during lifting.
Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.18.5 Controls (TSR)

This control has been written as a Directive Action AC in the TSRs.

4.5.19 Stationary Fire Watch during Hot Work Control

4.5.19.1 Safety Function

The safety function is to reduce frequency for ignition of flammables/combustibles.

During the performance of activities in TRU waste storage areas, there is a potential to ignite combustible materials that could involve TRU waste materials in a fire accident.

4.5.19.2 Specific Administrative Control Description

To reduce the likelihood of a fire event, each activity to be performed within a TRU waste storage area is evaluated for hot work activities. If hot work (e.g., welding, grinding or cutting of metal, or other operations that produce flames or spark) is to be performed, then a stationary fire watch is assigned to observe the activity.

Performance of hot work activities within a TRU waste storage area has the potential to ignite a fire. The stationary fire watch in these areas reduces the probability that a hot work spark initiator may ignite combustibles or cause a fuel pool fire if there is spilled fuel.

TA-54, Area G is primarily an open-air facility, with minimal SSCs available for preventing fires or mitigating the consequences thereof. Due to the limited life span of this facility and the unavailability of SSCs capable of reducing fire risk, administrative controls are required to perform the risk reduction. Therefore, this control is implemented as a SAC.

This SAC is solely an administrative function that relies on no SSCs for its performance. Therefore, there are no SSCs whose failure would result in losing the ability to perform the actions required by this SAC. This SAC assumes that combustible materials are controlled in accordance with the SAC on control of transient combustible fuel packages and in accordance with the Fire Protection Program SMP.

There is no physical information necessary for the performance of this SAC.

4.5.19.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- Evaluate work activity for potential of hot work within a TRU waste storage area.
- If hot work is anticipated, then assign a stationary fire watch.

4.5.19.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:
• Hot work activities in TRU waste storage areas shall be monitored by a stationary fire watch.

Work activities to be performed within a TRU waste storage area that do not directly affect the handling, transport, or storage of TRU waste containers are required to be evaluated for generation of heat and/or sparks that could lead to the ignition of combustibles within the area. If it is determined that an activity could result in the ignition of a fire, then a stationary fire watch is required to be established before the performance of the activity. A stationary fire watch is not required to be present during periods of inactivity. The stationary fire watch is expected to observe the activity for potential ignition sources or incipient fires and respond to conditions. A stationary fire watch is not expected to extinguish fires but to initiate notification of appropriate personnel.

Hot work activities are planned activities that do not require prompt setup and performance. Therefore, there is adequate time for evaluating the anticipated activity, identification for the need for hot work, placement and/or arrangement of work activity, and assignment of a stationary fire watch to the activity.

Workers are trained on the evaluation of work activities and the identification of the need for hot work. Procedures provide guidance for setting up the hot work activity (if any) and establishment and maintenance of a stationary fire watch.

Setup of a hot work activity and establishment of a stationary fire watch is a relatively simple process. The activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

No equipment is required for evaluating a work activity for hot work and no equipment is necessary to perform a stationary fire watch, unless the stationary fire watch is trained and willing to extinguish small fires. In the latter case, the locations of fire extinguishers are readily known. The stationary fire watch performs the activity of monitoring the hot work and alerting appropriate personnel of the potential for fire ignition or the presence of an incipient fire.

Performance of hot work is not a time-critical activity. Preventing the ignition of a fire by limiting heat sources or removing combustible/flammable material before the activity is the primary means of preventing a fire event. If an incipient fire is detected by the stationary fire watch, they must promptly alert appropriate personnel required to mitigate the consequences of the fire event. The failure to properly evaluate an activity for hot work or failure to maintain a stationary fire watch does not, in and of itself, result in a fire event.

Work activities may occur in a domed structure or a building, or external to any structure. Since these activities are not time-constrained, they may be performed, as necessary, to support TA-54, Area G activities and should be minimally affected by environmental conditions.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.19.5 Controls (TSR)

This control has been written as a Directive Action AC and ensures that work activities within TRU waste storage areas are evaluated for potential hot work and a stationary fire watch is established for the performance of any hot work activity within the affected defined area.
4.5.20 Projected Above-Ground Inventory

4.5.20.1 Safety Function

This control protects the assumptions of the inventory statistical analysis used in the Area G BIO accident analyses.

4.5.20.2 Specific Administrative Control Description

The Area G BIO hazard and accident analyses was originally developed based on a statistical analysis that considered the above-ground inventory of March 2009 and the Pit 9 underground inventory of June 2009, using the container MAR loading algorithms of DOE-STD-5506 [DOE 2007] to bound all analyses. The Area G BIO was revised in April 2013 based on a more recent statistical analysis [LANL 2013] that used the projected above-ground inventory as of July 2013. Consistent with the original BIO analysis, the more recent statistical analysis was also based on the MAR loading algorithms of DOE-STD-5506.

Activities involving retrieval of underground waste from Trenches A through D may skew the inventory statistics, since several drums in Trenches A through D have MAR values > 200 PE-Ci and are of 100% combustible waste matrix.

Before underground TRU waste retrieval activities are performed at Trenches A through D, the projected above-ground inventory is verified to ensure that the inventory remains bounded by the approved hazard and accident analysis.

The projected above-ground inventory will be based on anticipated shipments of TRU waste containers to WIPP from Area G, anticipated newly generated waste based on the most recent year’s receipt of TRU waste containers from LANL generators of nuclear waste, and the identified Trenches A through D drums that are planned to be retrieved. Of these, the retrieval activity is the most expedient to adjust. Once the projected above-ground inventory is generated, a DOE-STD-5506 [DOE 2007] statistical analysis will evaluate the maximum container MAR in a drum, the 99th percentile value, the 95th percentile value, the mean value of the container MAR, as well as the waste matrix distribution. The projected inventory is allowable if the evaluated quantities in the statistical analysis are less than those analyzed in Table 3-14, Chapter 3 of the Area G BIO. If any of these values are higher than those in Table 3-14, then those values are used in spreadsheet calculations to determine if the dose consequences for bounding accidents are less than those in Section 3.4 of the Area G BIO. If the dose consequences are higher than those analyzed in the Area G BIO, then the projected retrieval strategy must be adjusted for the Trenches A through D drums. If the dose consequences are equal to or lower than those analyzed in the Area G BIO, then the projected retrieval plan may be carried out.

4.5.20.3 Functional Requirements

The following functional requirements are necessary for performance of this SAC:

The projected above-ground inventory will be based on the following:

- Newly generated waste from TA-55 and other LANL facilities, based on the most recent year’s receipts of TRU waste and with consideration of TA-55 new waste packaging strategies to increase the average MAR within a TRU waste container
- Planned retrieval activities
- Anticipated shipments of TRU waste containers from TA-55
• Appropriate application of waste characterization algorithms for all the above, based on guidance from DOE-STD-5506 [DOE 2007].

4.5.20.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions is as follows:

• Ensure that the projected above-ground inventory of TRU waste at Area G remains bounded by the values used in the Area G approved BIO accident analysis.

Retrieval activities have the greatest potential to significantly impact the MAR assumptions in the accident analysis. Other anticipated activities that could have an impact include shipments and receipts. The appropriate application of statistical guidance from DOE-STD-5506 [DOE 2007] will determine the Area G above-ground TRU inventory to ensure that it remains within the defined limits of the current, approved Area G BIO given planned retrieval activities.

Facility procedures and available assay data will provide the necessary information for the performance of the estimates and calculations necessary to determine the projected above-ground inventory of TRU waste at Area G.

Analysis of available information and performance of the necessary calculations is considered to be a moderate level of difficulty. Configuration management and inventory data for all waste received, shipped, or retrieved from underground storage support compliance with this SAC.

The determination of projected above-ground TRU waste inventory of Area G is an ongoing activity and is not a time-critical activity. The failure to maintain Area G above-ground inventory of TRU waste does not result in an adverse event, but potentially raises the consequences of an accident, if an accident were to occur.

The determination of the projected above-ground Area G TRU inventory is an activity not affected by environmental conditions.

Calculations are necessary to appropriately apply TRU waste inventory configuration information (e.g., doublepack or POCs) to the statistical determination guidance provided in DOE-STD-5506 [DOE 2007], which will allow provision of a conservative value for Area G above-ground TRU waste inventory MAR. Performance of this SAC does not depend on SSCs.

4.5.20.5 Controls (TSR)

This control has been written as a Directive Action AC and ensures that Area G above-ground TRU waste inventory is maintained within the Area G above-ground TRU waste inventory limits identified in the approved BIO accident analysis, including all planned retrieval activities.

4.5.21 Prohibitions on Opening Sealed Inner TRU Waste Packages Discovered Within a TRU Waste Container During SSSR Activities

4.5.21.1 Safety Function

During SSSR activities, a prohibition on opening sealed inner TRU waste packages protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.
4.5.21.2 Specific Administrative Control Description

Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened, except as allowed by the control described in section 4.5.25. Sealed inner TRU waste packages contain TRU waste and are

- Metal or glass containers with
  - A positive mechanical locking mechanism such as a metal screw-on lid; or
  - A metal locking, bolted, or snap-on lid.

The following inner package types, regardless of volume, may be remediated during SSSR because there is no concern for hydrogen build-up within the package:

- any plastic container with any lid;
- any container with a plastic lid;
- any container without a gasket (e.g., containers with slip lids, paint cans, and other similar containers of any volume);
- any container with a slip-on lid (with or without a gasket);
- any container that does not contain TRU waste; and
- fiberboard containers of any volume.

4.5.21.3 Functional Requirements

The performance criterion required to meet functional requirements and credited safety functions is as follows:

- Ensure that TRU waste packages that are discovered within TRU waste containers during SSSR activities and have the potential to experience deflagration are not opened.

The SSSR activities will include the opening of TRU waste containers and the repackaging of the contents. This control will ensure that sealed inner waste packages are not opened and will reduce the potential for deflagration of the inner containers.

4.5.21.4 Specific Administrative Control Evaluation

This control applies to all sealed inner TRU waste packages with the potential for deflagration and ensures that they will not be opened. Deflagration of a sealed container is most likely when the container is opened. This prevents the worker from being exposed to a deflagration hazard due to a build-up of a flammable (hydrogen) gas mixture within the waste package. During waste remediation, several other types of inner packages may be encountered and are not subject to hydrogen build-up. These inner packages, as listed above, are not sealed or do not contain TRU waste, so the build-up of a flammable gas mixture is not feasible. Hydrogen bounce-back studies at Savannah River Site [WSRC 2007] indicate that hydrogen will diffuse through plastic, thus supporting the concept that any plastic container with any lid, or any container with a plastic lid, will not build up hydrogen.

Procedures prohibit the opening of inner sealed waste packages.
The activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

The prohibition does not create a time-critical activity and is not expected to be affected by environmental conditions.

4.5.21.5 Controls (TSR)

This control has been written as a Directive Action AC and ensures that workers are protected from the consequences of deflagration as a result of opening sealed inner waste packages.

4.5.22 Retrieval Area Unvented TRU Waste Drum Isolation Requirement and Stacking Prohibition

4.5.22.1 Safety Function

The safety function of this control is to reduce the likelihood and radiological consequences of a sympathetic deflagration, and the likelihood of inadvertent unvented drum toppling leading to a deflagration.

4.5.22.2 Specific Administrative Control Description

After an unvented drum is removed from its underground storage configuration at a retrieval area, the unvented drum shall not be stacked, and shall be immediately placed into an overpack/doublepack, or placed in an isolation area until inserted into an overpack, or until a lid restraint is applied for its transfer to an isolation area within the above-ground unvented drum storage area or until the drum is vented.

Unvented TRU waste drums in underground storage are in a stacked array, so this SAC does not apply to these unvented drums. When an unvented TRU waste drum is retrieved from its underground storage configuration or from its stacked array, it is brought to ground level, not stacked, and isolated until it is overpacked or doublepacked. The unvented TRU waste drum can be transferred to the Area G storage array within an overpack or doublepack, or a lid restraint can be applied for its transfer to an isolation area for unvented drums within the above-ground storage area.

Isolating and not stacking unvented TRU waste drums provides for safe storage of the containers until they are passively vented or overpacked/doublepacked. Overpacked drums provide an additional volume for the unvented drum to relieve its pressure without resulting in unvented drum lid loss and ejection of contents, even if an internal deflagration were to occur [DOE 2007]. This SAC is necessary to provide administrative compensatory measures while the containers are in an unvented condition. Facility procedures define what is considered to be an unvented TRU waste drum, and specify the actions to be taken by an operator upon the discovery of an unvented TRU waste drum.

To ensure that the isolated unvented TRU waste drums are not impacted by normal operations, a 15-ft exclusion area for non-essential personnel and activities minimizes the probability that any drum moving or handling operations could inadvertently impact the stored unvented drums, causing their deflagration.

The 15-ft exclusion area distance is measured from the outermost edge of the drums in the isolation area. The 15-ft exclusion area around the perimeter of the isolation area is derived from consideration of an accident involving a drop/tip over of a third-tier pallet of drum and forklift into the exclusion area. If it is presumed that the ends of the forklift tines are at the outside rim of the exclusion area, the forklift tines are at the height required to remove a third-tier pallet, and the third-tier pallet and forklift fall over, the
pallet will fall a maximum of approximately 11 ft within the exclusion zone. In this improbable, bounding drop/tip-over accident, a 4-ft distance is still maintained between the dropped pallet and the edge of the isolation area. A 15-ft exclusion area is the maximum separation distance that can be readily implemented at Area G for the storage of unvented waste drums.

The Retrieval Area Unvented Drum Isolation Requirement and Stacking prohibition is designated as an SAC, since there are no feasible cost-effective SSCs available to accomplish the credited safety functions.

There are no boundaries or interface points with any SSCs relevant to the safety functions. The action required by the SAC is the isolation of unvented drums and the prohibition on stacking. This is an administrative function that does not rely on any SSCs for its performance.

There are no physical parameters associated with the performance of this SAC.

4.5.22.3 Functional Requirements

The functional requirement to meet this SAC is as follows:

The following functional requirements are necessary for performance of this SAC:

- The vented status of retrieved TRU waste drums is determined.
- If not immediately overpacked/doublepacked, retrieved unvented TRU waste drums are isolated by one of the following methods:
  - Isolate by establishing a limited activity zone around the drum’s location.
  - Move drum to a separate location and establish a limited activity zone around the drum’s location (i.e., container is individually isolated).
  - Move drum to an isolated container area with a limited activity zone around the area (i.e., drum is isolated as part of group of unvented drums).
- Retrieved unvented TRU waste drums are not stacked.

4.5.22.4 Specific Administrative Control Evaluation

The performance criterion required to meet the functional requirements and credited safety functions is as follows:

- Ensure that drums that are unvented are isolated and not stacked.

Observation of the drum and installed vents, if any, is required to ensure that the functional requirement for isolating and not stacking unvented drums is met.

Implementation of this SAC requires that retrieved TRU waste drums that have the potential to accumulate combustible gas are isolated and not stacked.

Upon observation that a retrieved TRU waste drum is not vented, an operator will take action to place the unvented drum into an overpack/doublepack, or ensure that the suspect container is isolated and not stacked. Following isolation of the retrieved unvented TRU waste drum, the facility may take further action to install a lid restraint or place it in an overpack/doublepack. This activity is considered a low level of difficulty.
The isolation of a retrieved unvented TRU waste drum is not a time-critical activity. While the activity should be completed in a timely manner, the unvented drum would require an additional upset to cause it to deflagrate.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.22.5 Controls (TSR)

This control has been written as a Directive Action AC and ensures that workers are protected from the consequences of deflagration from an unvented drum.

4.5.23 Acetylene Cylinder Control

4.5.23.1 Safety Function

The safety function of this control is to reduce the likelihood of an acetylene cylinder explosion that could impact MAR.

4.5.23.2 Specific Administrative Control Description

The SAC is established to protect against potential acetylene explosions due to improper storage or use of acetylene, including flashback through connected torches or regulators into the cylinder. This SAC prohibits the storage or use of acetylene cylinders inside or within 50 feet of defined areas where MAR is present, to reduce the likelihood of such a phenomenon.

4.5.23.3 Functional Requirements

The SAC prohibits the storage or use of acetylene cylinders inside or within 50-feet of defined areas where MAR is present. There are no boundaries or interface points with any SSCs relevant to the safety function delivered by this SAC. This is an administrative function that does not rely on any SSCs for its performance. Hence, there are no physical parameters associated with the performance of this SAC.

4.5.23.4 Specific Administrative Control Evaluation

Acetylene cylinders create a unique explosion hazard due to the potential for flashback through connected torches or regulators into the cylinder. Acetylene cylinders can also represent a potential hazard when improperly stored because they may be more vulnerable to physical insults or other sources of energy which could cause a cylinder breach and explosion. As such, the storage or use of acetylene cylinders in defined areas where MAR is present, or within 50-feet of those defined areas is prohibited. Due to their infrequent use at Area G, and the standard industry practice of storing compressed gas cylinders in designated areas away from other hazards, the control of acetylene cylinders through this SAC provides acceptable mitigation of the hazard without requiring specific performance criteria or surveillance requirements.

4.5.23.5 Controls (TSR)

The acetylene cylinder control has been written as a Directive Action AC in the TSRs.
4.5.24 Stationary Fire Watch During SSSR Activities

4.5.24.1 Safety Function

The safety function of the Stationary Fire Watch During SSSR Activities SAC is to reduce the consequences of fire.

4.5.24.2 Specific Administrative Control Description

To reduce the consequences of a fire during SSSR operations involving exposed waste, a continuous stationary fire watch is assigned to observe the operations. The stationary fire watch is a trained individual equipped with fire blankets, Metal X and ABC fire extinguishers, as appropriate, to extinguish an incipient fire. Because the stationary fire watch is located in the SSSR area and is dedicated to prevent or extinguish a fire, the consequences of an incipient fire involving exposed waste are significantly reduced.

TA-54, Area G is primarily an open-air facility, with minimal SSCs available for preventing fires or mitigating the consequences thereof. Due to the limited life span of this facility and the unavailability of SSCs capable of reducing fire risk, administrative controls are required to perform the risk reduction. Therefore, this control is implemented as a SAC.

This SAC is solely an administrative function that relies on no SSCs for its performance. Therefore, there are no SSCs whose failure would result in losing the ability to perform the actions required by this SAC. This SAC assumes that combustible materials are controlled in accordance with the SAC on control of transient combustible fuel packages and in accordance with the Fire Protection Program SMP.

There is no physical information necessary for the performance of this SAC.

4.5.24.3 Functional Requirements

The functional requirements to meet this SAC are as follows:

- Evaluate SSSR operation to determine if it will involve exposed waste.
- If exposed waste is anticipated, then assign a stationary fire watch.

4.5.24.4 Specific Administrative Control Evaluation

The performance criterion required to meet functional requirements and credited safety functions are as follows:

- A continuous Stationary Fire Watch is required in the SSSR process area whenever TRU waste is exposed.

SSSR operations involve the handling of combustible material and the use of potential ignition sources that could result in a fire involving exposed TRU waste. As such, a continuous stationary fire watch is required during SSSR operations whenever exposed waste is present. The stationary fire watch will be positioned near operations and will be a trained individual equipped with fire blankets, Metal X and ABC fire extinguishers, as appropriate, to protect exposed MAR if a fire begins and to extinguish the fire. The stationary fire watch is also expected to mitigate the consequences should a fire begin. The stationary fire watch is continuous and required when TRU waste is exposed, i.e. is outside of a metal container and not covered with fire retardant material (e.g. fire blankets or other fire retardant material, fire-retardant plastic). The stationary fire watch is performed in accordance with Laboratory policy and is a relatively
simple process. The activity is well-defined and characterized in procedures, so that operator actions are considered to be a low level of difficulty.

Preventing the ignition of a fire by controlling the use of heat sources and minimizing the presence of combustible/flammable material during SSSR operations is the primary means of preventing a fire event. If an incipient fire is detected by the stationary fire watch, they must promptly alert appropriate personnel required to mitigate the consequences of the fire event. The failure to properly implement or maintain a stationary fire watch does not, in and of itself, result in a fire event.

Compliance with this SAC is not dependent on time-critical human performance and resource availability. Therefore, formal engineering calculations are not required to document the ability of personnel to obtain resources and perform the required activities within an assumed time period.

4.5.24.5 Controls (TSR)

This control has been written as a Directive Action AC and requires a continuous Stationary Fire Watch in the SSSR process area when TRU waste is exposed. The stationary fire watch will be a trained individual equipped to extinguish incipient fires. The SAC is consistent with the alternate controls presented in Table 6.4.1-1 of DOE STD-5506 [DOE 2007]. As a preferred control, the Standard recommends that hotwork be prohibited when combustible MAR is present. The nature of the SSSR activities renders that control impractical. As an alternative, the Standard suggests that the combustible MAR be protected during hotwork (e.g. fire blankets or other fire retardant material, non-combustible containers). The use of a stationary fire watch is the most practical way to protect the combustible MAR in an SSSR process area.

4.5.25 Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities

4.5.25.1 Safety Function

The safety function of this SAC is to reduce the likelihood and consequences of a deflagration involving sealed containers with bolted lids/flanges that will be opened during SSSR operations.

4.5.25.2 Specific Administrative Control Description

This SAC consists of a suite of controls that are established to reduce the likelihood and consequences of a deflagration during SSSR operations involving the opening of sealed containers with bolted lids/flanges. This SAC requires the following:

1. Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts.
2. Workers and the sealed container shall be grounded or bonded prior to loosening the lid/flange bolts.
3. Loosening the lid/flange bolts shall be performed using non-sparking processes or tools.
4. The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange and allow venting without completely removing the bolts.
5. The container shall be positioned such that the opening(s) is at the high point of the container.
6. Spark-generating operations shall not be resumed until the container has vented and the hydrogen levels at the openings are measured and demonstrated to be below the LFL (4% for hydrogen).

The controls specified above reduce the likelihood of a deflagration involving a sealed container with bolted lids/flanges, and also reduce the potential consequences should a deflagration occur during the opening process. Given the many different potential types and configurations of sealed containers with bolted lids/flanges that may be processed through SSSR, there is no single feasible cost-effective SSC available that can be applied to safely control the opening process. Therefore, this control is implemented as a suite of directive action SACs.

This SAC is not applicable to other types of sealed containers that may be encountered during SSSR operations including compressed gas cylinders, aerosol cans, etc.

4.5.25.3 Specific Administrative Control Functional Requirements and Evaluation

For each control element, Table 4-6 identifies the minimum functional requirements for fulfilling the safety functions described in Section 4.5.25.1, Safety Function. The table also identifies the performance criteria required to meet the functional requirements for each control element, and an evaluation of each control element to meet the performance criteria.

4.5.25.4 Controls (TSR)

The suite of controls related to the opening of sealed containers with bolted lids/flanges during SSSR involves a combination of equipment usage and operator actions when venting sealed containers under normal conditions. Therefore, this control is established as a suite of directive action SACs.
### Table 4-6. Functional Requirements and Evaluation of Controls related to Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities

<table>
<thead>
<tr>
<th>Control Description</th>
<th>Safety Function</th>
<th>Functional Requirements</th>
<th>Performance Criteria</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts.</td>
<td>Reduce the likelihood of a deflagration by eliminating a source of ignition.</td>
<td>Operations in the SSSR Area that can generate a spark (e.g., metal cutting or grinding) are halted before the lid/flange bolts on the sealed container are loosened.</td>
<td>The performance criterion for halting spark-producing operations in the SSSR Area is to prevent the unintentional ignition of flammable gas that may vent from the sealed container when the lid/flange bolts are loosened.</td>
<td>Stopping all spark generating operations removes an initiator for deflagration. As such, the worker actions to implement this control are considered to be a low-level of difficulty.</td>
</tr>
<tr>
<td>Workers and the sealed container shall be grounded or bonded prior to loosening the lid/flange bolts.</td>
<td>Reduce the likelihood of a deflagration by eliminating a source of ignition.</td>
<td>The workers and the sealed container are connected to ground or bonded prior to loosening the lid/flange bolts.</td>
<td>The performance criterion for grounding or bonding is to ensure that the workers and the sealed container are at substantially the same electrical potential in order to eliminate sparking as a possible ignition source.</td>
<td>The safety function of the ground or bonding is to reduce the probability for a spark during the opening of a sealed container and as the container is venting, thereby minimizing the potential for igniting a potentially flammable atmosphere. As such, this control is considered to be a low-level of difficulty.</td>
</tr>
<tr>
<td>Loosening the lid/flange bolts shall be performed using non-sparking processes or tools.</td>
<td>Reduce the likelihood of a deflagration by eliminating a source of ignition.</td>
<td>The process or tools used to loosen the lid/flange bolts do not produce sparks.</td>
<td>The use of non-sparking processes or tools prevents the occurrence of sparks, thereby preventing the ignition of a potentially flammable atmosphere.</td>
<td>The use of non-sparking processes or tools prevents the occurrence of sparks, thereby preventing the ignition of a potentially flammable atmosphere. The non-sparking properties of the tools are inherent in their design and not likely to change over time. As such, this control is considered to be a low-level of difficulty.</td>
</tr>
<tr>
<td>Control Description</td>
<td>Safety Function</td>
<td>Functional Requirements</td>
<td>Performance Criteria</td>
<td>Evaluation</td>
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<tr>
<td>The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange to allow venting without completely removing the bolts.</td>
<td>Reduce the consequences of a deflagration by preventing ejection of the lid/flange.</td>
<td>The lid/flange bolts are loosened sufficiently to break the lid/flange seal thereby allowing the container to vent without completely removing the bolts. The bolts provide a lid/flange restraint to prevent worker injury due to a deflagration or overpressurization event.</td>
<td>The bolts are loosened sufficiently to break the seals and allow venting without completely removing the bolts. The bolts provide a lid/flange restraint to prevent worker injury in the event of an energetic event.</td>
<td>The bolts are loosened sufficiently to break the seals and allow venting without completely removing the bolts. The bolts provide a lid/flange restraint to prevent worker injury in the event of an energetic event. As such, this control is considered to be a low-level of difficulty.</td>
</tr>
<tr>
<td>The container shall be positioned such that the opening(s) is at the high point of the container.</td>
<td>Reduce the likelihood of a deflagration by ensuring that the container is properly vented.</td>
<td>The container is positioned such that the opening(s) is at the high point of the container to allow for effective venting of hydrogen or other flammable gases.</td>
<td>The container must be positioned such that the opening(s) is at the high point to allow for effective venting of the hydrogen.</td>
<td>The container must be positioned such that the opening(s) is at the high point to allow for effective venting of the hydrogen. As such, this control is considered to be a low-level of difficulty.</td>
</tr>
<tr>
<td>Spark-generating operations shall not be resumed until the container has vented and the hydrogen levels at the openings are measured and demonstrated to be below the LFL (4% for hydrogen).</td>
<td>Reduce the likelihood of a deflagration by eliminating a source of ignition.</td>
<td>Spark-generating operations can resume once the hydrogen level at the opening of the container is measured and demonstrated to be below the LFL (4% for hydrogen).</td>
<td>Measurements at the container openings are performed to demonstrate that the hydrogen levels are below the LFL before resuming spark-generating operations which helps to reduce the likelihood of a deflagration.</td>
<td>If measurements at the container openings demonstrate that the hydrogen levels are below the LFL, spark-generating operations may be resumed. The requirement that the hydrogen levels are measured and demonstrated to be below the LFL before resuming spark-generating operations ensures that deflagration is not a potential. As such, this control is considered to be a low-level of difficulty.</td>
</tr>
</tbody>
</table>
4.6 REFERENCES


LANL 2010 AD-NHHO-10-373, *Submittal of Justification for Page Changes to Modify Section 5.6.8.1 Drum Drop Height and Handling Limits Specific Administrative Controls*, Rev. 1, Los Alamos National Laboratory, Los Alamos NM, December 2010

LANL 2011a SB-DO:CALC-11-014, Rev. 1, *Calculation for Radiant Energy at a Distance Away from Object for “Ordinary” Combustibles and Pool Fires*, Los Alamos National Laboratory, Los Alamos, NM, August 2011

LANL 2011b CALC-11-TA-54-AREAG-009, Rev. 0, *Accident Analysis Fuel Flow Rate Determination*, Los Alamos National Laboratory, Los Alamos, NM, June 2011


NMED 2008  *Compliance Order of Consent*, New Mexico Environment Department, Santa Fe NM, June 2008


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<td>Accident Analysis</td>
</tr>
<tr>
<td>AC</td>
<td>administrative control</td>
</tr>
<tr>
<td>ARF</td>
<td>airborne release fraction</td>
</tr>
<tr>
<td>BG</td>
<td>Bolas Grande</td>
</tr>
<tr>
<td>BIO</td>
<td>Basis for Interim Operation</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CMP</td>
<td>corrugated metal pipe</td>
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<td>CoC</td>
<td>Certificate of Conformance</td>
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<tr>
<td>DF</td>
<td>design feature</td>
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<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>DR</td>
<td>damage ratio</td>
</tr>
<tr>
<td>FRP</td>
<td>fiberglass-reinforced plywood</td>
</tr>
<tr>
<td>HA</td>
<td>Hazard Analysis</td>
</tr>
<tr>
<td>HalfPACT</td>
<td>half-TRUPACT</td>
</tr>
<tr>
<td>HE-RTR</td>
<td>High Energy Real-Time Radiography</td>
</tr>
<tr>
<td>HW</td>
<td>hazardous waste</td>
</tr>
<tr>
<td>ISI</td>
<td>in-service inspection</td>
</tr>
<tr>
<td>LAA</td>
<td>low-activity area</td>
</tr>
<tr>
<td>LANL</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>LCO</td>
<td>limiting condition for operation</td>
</tr>
<tr>
<td>LLW</td>
<td>low-level waste</td>
</tr>
<tr>
<td>MAR</td>
<td>material-at-risk</td>
</tr>
<tr>
<td>MLLW</td>
<td>mixed low-level waste</td>
</tr>
<tr>
<td>NDA</td>
<td>nondestructive assay</td>
</tr>
<tr>
<td>NDE</td>
<td>nondestructive examination</td>
</tr>
<tr>
<td>NNSA</td>
<td>National Nuclear Security Administration</td>
</tr>
<tr>
<td>NPH</td>
<td>Natural Phenomena Hazard</td>
</tr>
<tr>
<td>NRC</td>
<td>Nuclear Regulatory Commission</td>
</tr>
<tr>
<td>PE-Ci</td>
<td>plutonium equivalent curies</td>
</tr>
<tr>
<td>PISA</td>
<td>Potentially Inadequate Safety Analysis</td>
</tr>
<tr>
<td>POC</td>
<td>pipe overpack container</td>
</tr>
<tr>
<td>QA</td>
<td>quality assurance</td>
</tr>
<tr>
<td>RANT</td>
<td>Radioassay and Nondestructive Testing</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
<tr>
<td>RF</td>
<td>respirable fraction</td>
</tr>
<tr>
<td>SAC</td>
<td>specific administrative control</td>
</tr>
<tr>
<td>SC</td>
<td>safety class</td>
</tr>
<tr>
<td>SMP</td>
<td>safety management program</td>
</tr>
<tr>
<td>SR</td>
<td>surveillance requirement</td>
</tr>
<tr>
<td>SS</td>
<td>safety-significant</td>
</tr>
<tr>
<td>SSC</td>
<td>structure, system, and component</td>
</tr>
<tr>
<td>SSSR</td>
<td>sort, segregate, size reduction, and repackaging</td>
</tr>
<tr>
<td>SWB</td>
<td>standard waste box</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Area</td>
</tr>
<tr>
<td>TDOP</td>
<td>ten-drum overpack</td>
</tr>
<tr>
<td>TRU</td>
<td>transuranic</td>
</tr>
<tr>
<td>TRUPACT</td>
<td>Transuranic Package Transporter</td>
</tr>
<tr>
<td>TSD</td>
<td>transportation safety document</td>
</tr>
<tr>
<td>TSR</td>
<td>Technical Safety Requirement</td>
</tr>
<tr>
<td>USQ</td>
<td>unreviewed safety question</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic compound</td>
</tr>
<tr>
<td>WAC</td>
<td>Waste Acceptance Criteria</td>
</tr>
<tr>
<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
</tr>
</tbody>
</table>
Chapter 5 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The Technical Safety Requirement (TSR) document constitutes an agreement between the U.S. Department of Energy (DOE) and Los Alamos National Laboratory (LANL) regarding safe operation of Technical Area (TA)-54, Area G. The TSRs were derived from the analysis in this Basis for Interim Operation (BIO) as described in this chapter, building on the control functions that were determined to be essential in Chapters 3, Hazard and Accident Analyses, and Chapter 4, Safety Structures, Systems, and Components (SSCs). In addition to those TSRs that are explicitly derived from Chapter 3 and Chapter 4, several other mandatory Safety Management Programs (SMPs) are included in the TSRs to ensure the safe operation of TA-54, Area G.

The TSRs consist primarily of the following:

- Limiting Conditions for Operation (LCO) necessary to maintain the operations within the safety analysis basis
- Administrative Controls (ACs) for administrative requirements necessary to control operation of the facility, including commitments to SMPs and Specific Administrative Controls (SACs)
- Requirements for passive Design Features (DFs) (safety-class and safety-significant Structures, Systems, and Components [SSCs])

5.2 REQUIREMENTS

The regulatory requirements that establish the safety basis for the facility, and that were used in preparing this chapter, include the following:

- DOE G 423.1-1A, Implementation Guide for Use in Developing Technical Safety Requirements [DOE 2010a]
5.3 TECHNICAL SAFETY REQUIREMENT COVERAGE

This chapter describes the type of TSR coverage to be implemented for each control that is carried over to the separate TSR document. It summarizes all identified safety-class and safety-significant SSCs, SACs, and programmatic ACs (TSR-ACs) to be covered in the TSR document. Chapter 4 discusses the safety-class and safety-significant SSCs and SACs that were identified in the Hazard Analysis (HA) and Accident Analysis (AA) in Chapter 3. Chapter 4, Sections 4.3, 4.4 and 4.5, provides the complete discussion of the safety functions, functional requirements, performance criteria, and applicable TSR controls for the identified safety-class and safety-significant SSCs SACs, respectively.

Chapter 4, Tables 4-1 and 4-3 summarize the credited controls, the associated safety functions, and the associated TSR controls for the design basis accidents and the unique and representative HA events.

5.4 DERIVATION OF FACILITY MODES

The modes identified for TA-54, Area G are based on the modes for nonreactor nuclear facilities defined in DOE G 423.1-1A [DOE 2010a]. The primary mission of Area G has been processing, storing, and disposing of solid radiological waste. The current mission at Area G includes retrieving and processing older waste in preparation for transport to the Waste Isolation Pilot Plant (WIPP) and for terminating the role of TA-54, Area G as a transuranic (TRU) waste facility.

To aid in compliance with the TA-54, Area G LCOs, operational modes are established to provide a safe, structured approach to Area G operations. Modes reflect the relative hazards associated with different facility or process configurations, categorize the requirements placed on the facility as a convenience for operator control, and aid the Operations staff in determining when an LCO is applicable. In addition, modes provide a convenient way to ensure the implementation of all required controls per process area because the controls may vary with each mode. If equipment performs a safety function, but the safety function is not required in certain modes, it would be inefficient to require the equipment to be operable when it is not needed.

The modes are Cold Standby, Warm Standby, and Operation (see Table 5-1). The hierarchy of modes, from the lowest to the highest in relation to hazards, is listed in sequential order in the preceding sentence. Certain requirements and characteristics will be present during each mode. The mode definition addresses the actual performance or the capability of the specific Area G area to conduct its intended function. These definitions allow equipment or an operation to be started or stopped as needed, but still remain in one of the defined modes.

Defined areas may have independently assigned modes. The defined areas within TA-54, Area G may have differing material-at-risk (MAR) and potentially differing operating conditions at different times; therefore, modes and mode requirements vary across Area G, and no one mode applies to Area G as a whole. A mode is not assigned to Area G because the MAR associated with low-level waste (LLW)/mixed low-level waste (MLLW), hazardous waste (HW), tritium-contaminated waste, or TRU waste will be present in Area G until closure.
Table 5-1  TA-54, Area G Mode Definitions

<table>
<thead>
<tr>
<th>MODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLD STANDBY</td>
<td>In Cold Standby mode the above-ground MAR has been removed from the applicable defined area, except for surface contamination and sources used for equipment calibration.</td>
</tr>
<tr>
<td>WARM STANDBY</td>
<td>In Warm Standby mode, the MAR within the defined area shall be in a safe configuration, except for surface contamination and sources used for equipment calibration and facility-generated radioactive waste.</td>
</tr>
<tr>
<td>OPERATION</td>
<td>In Operation mode, all activities involving LLW, MLLW, HW, tritium waste, tritium-contaminated waste, or TRU waste are allowed within the defined area.</td>
</tr>
</tbody>
</table>

5.5  TECHNICAL SAFETY REQUIREMENT DERIVATION

Based on the HA and AA, a set of LCOs and the associated SRs are required to ensure control of the radiological material inventory at specific locations within TA-54, Area G. No safety limits or limiting control settings are required. TSR coverage will also be required for DFs identified as major contributors to defense-in-depth and as barriers to significant releases.

All other controls or systems identified in the HA and AA will be addressed in relevant SMPs (e.g., Fire Protection Program) or SACs outlined subsequently. DOE-STD-1186-2004 [DOE 2004] was used as the basis for identification of SACs.

5.5.1  LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

Chapter 3 identifies a number of TSR LCOs requiring coverage in the TSRs. These LCOs are associated with SSCs and LCO format SACs. This section provides a brief description of the LCO, the LCO statements, and the corresponding SRs. As shown in Chapter 4, Table 4-3, the LCOs requiring coverage include the following:

- Radiological Inventory Management (LCO 3.1.1 to LCO 3.1.6/SAC)
- TRU Waste Drum Doublepack (LCO 3.1.7/SAC)
- Thermal Separation Distances (LCO 3.2.1/SAC)
- Control of Transient Combustibles – Fuel Package Limit (LCO 3.2.2/SAC)
- Control of Liquid Run-On (LCO 3.2.3/SAC)
- Combustible/ Flammable Liquid Controls in Defined Areas and associated Thermal Separation Distance (LCO 3.3.1/SAC)
- Above-Ground Unvented TRU Waste Drums (LCO 3.4.1/SAC)
- Unvented TRU Waste Drum Handling and Transport (LCO 3.4.2/SAC)
- Vehicle/ Equipment Safety Control – Refueling Location (LCO 3.5/SAC)
5.5.1.1 Radiological Inventory Management (LCO 3.1.1-3.1.6/SAC)

The TA-54, Area G site has several defined areas where MAR inventory can be distributed. Because the site’s main purpose has been the storage of TRU waste in support of LANL’s programmatic missions, the total MAR limit allowed at this site has historically been large. With the imminent closure of the Area G site as a TRU waste storage facility, the above-ground MAR limit of 57,000 plutonium equivalent curies (PE-Ci) is still required. Newly generated TRU waste is accepted, and underground waste containers must be retrieved; this MAR inventory must be balanced against the disposition of legacy TRU waste containers and, their removal from the site.

The defined areas within Area G and associated MAR limits are identified in Chapter 3, Table 3-6, of this BIO.

Multiple defined areas can be established within Area G, and, as long as each defined area meets its associated controls (e.g., MAR limits and thermal separation distances), there should be no interaction between defined areas beyond that analyzed in Chapter 3.

The radiological waste inventory controls restrict the quantity of radiological material that may be present within individual defined areas, on a radioactive waste transportation vehicle, and at the Area G site. The radiological waste inventory controls serve to maintain operations within the assumptions of this BIO. They also limit the potential offsite dose consequences during postulated accident scenarios.

The accident analysis considers three basic types of contaminated waste matrices: dispersible/combustible solids, dispersible/non-combustible solids, and nondispersible non-combustible solids. Rather than establish and track inventory limits for each type of contaminated waste material, a conversion factor may be used. The conversion factor is multiplied by the MAR of a waste container in a non-combustible waste matrix. The resultant *equivalent combustible waste* MAR value is counted against the defined area’s MAR limit.

A storage area or process area may contain intermingled low-level or mixed waste containers within the area, in addition to TRU waste containers. The MAR limit applies to all radioactive waste within the area, except facility-generated job waste that has not yet been characterized as low-level waste.

Because some sealed sources stored or used at Area G are not certified to withstand all credible accident conditions, sealed source inventory is counted against the above-ground TRU waste MAR limits. Only sealed sources that are stored within closed pipe overpack containers (POCs) may be excluded from the inventory.

Limiting the quantity of radiological material available is a means for controlling the consequences of the HA and AA. Based upon the activities being conducted, areas were defined within the Area G site. Each area has a MAR inventory limit, which is discussed in Chapter 3. However, the total MAR inventory limit for the entire site remains below 57,000 PE-Ci.

Requiring that all above-ground MAR be located inside a defined area appropriate to the waste and container type helps to ensure that operations involving the storage or processing of MAR is consistent with the BIO analysis assumptions regarding the release locations for postulated accidents.
LCO: Radiological waste inventories shall be limited as specified in Chapter 3, Table 3-6, and all above-ground MAR shall be located inside a defined area appropriate to the waste and container type.

**Surveillance Requirements:**

- Verify that in process MAR in each sort, segregate, size reduction, and repackaging (SSSR) area is \(\leq 18\) PE-Ci equivalent combustible waste prior to opening of TRU waste container(s) in each SSSR Area (SR 4.1.1.1).
- Verify that staged MAR in each SSSR area is \(\leq 18\) PE-Ci equivalent combustible waste prior to introducing TRU waste container(s) in each SSSR Area (SR 4.1.1.2).
- Verify quarterly that the total exposed tritium-contaminated waste MAR inventory at Area G is \(\leq 3,000\) tritium Ci (SR 4.1.2.1).
- Verify quarterly that the total exposed LAA MAR at Area G is \(\leq 100\) PE-Ci (SR 4.1.2.2).
- Verify the MAR in an LAA is covered with \(\geq 3\) inches of overburden fill material, or equivalent, prior to declaring radioactive waste in an LAA buried (SR 4.1.2.3).
- Inspect overburden on buried radioactive waste within active LAAs for signs of significant erosion, subsidence, or other signs of loss of cover, monthly (SR 4.1.2.4).
- Verify that the MAR inventory on a Transportation Vehicle with only compliant metal containers is \(\leq 1,100\) PE-Ci TRU waste prior to vehicle movement (SR 4.1.3.1).
- Verify that the MAR inventory on a Transportation Vehicle with one or more non-compliant or non-metal containers is \(\leq 615\) PE-Ci TRU waste prior to vehicle movement (SR 4.1.3.2).
- Verify that the MAR inventory on a Transportation Vehicle is \(\leq 35\) PE-Ci low-level waste or mixed low-level waste and 3,000 tritium curies prior to vehicle movement (SR 4.1.3.3).
- Verify that the MAR inventory on Transportation Vehicle is \(\leq 1,000,000\) tritium curies prior to vehicle movement (SR 4.1.3.4).
- Verify total TRU waste inventory in the defined areas within Building 54-412 is \(\leq 56\) PE-Ci equivalent combustible waste prior to introduction of MAR into a defined area within Building 54-412 (SR 4.1.4.1).
- Verify TRU waste inventory in the HE-RTR Process Area is \(\leq 1,100\) PE-Ci prior to introduction of MAR into the HE-RTR Process Area (SR 4.1.4.2).
- Verify TRU waste inventory in another individual Process Area is \(\leq 1,100\) PE-Ci prior to introduction of MAR into that individual Process Area (SR 4.1.4.3).
- Verify TRU waste inventory in the Pad 10 Process Area is \(\leq 4,000\) PE-Ci prior to introduction of MAR into the Pad 10 Process Area (SR 4.1.4.4).
- Verify quarterly that the TRU waste inventory in a storage area with one or more non-compliant metal or non-metal containers is \(\leq 2,000\) PE-Ci (SR 4.1.4.5).
- Verify quarterly that the TRU waste inventory in each storage area with only compliant metal containers is \(\leq 22,000\) PE-Ci (SR 4.1.4.6).
- Verify quarterly that the tritium waste inventory in each tritium area is \(\leq 1,000,000\) tritium Ci (SR 4.1.4.7).
• Verify monthly that TRU waste is not stored in a Building or Dome containing a SSSR Area (SR 4.1.4.8).

• Verify the planned retrieval in a retrieval area will only expose ≤ 1,500 PE-Ci prior to exposing MAR in the individual retrieval area (SR 4.1.5.1).

• Verify annually that the total above-ground TRU MAR inventory is ≤ 57,000 PE-Ci (SR 4.1.6.1).

• Verify annually that the total above-ground tritium waste inventory is ≤ 4,000,000 tritium Ci (SR 4.1.6.2).

• Verify annually that the calculated product of the actual above ground TRU waste inventory and the actual waste composition results in a composite source term ≤ 1.06 PE-Ci (SR 4.1.6.3).

• Verify annually that above-ground MAR is located inside a defined area appropriate to the waste and container type (SR 4.1.6.4).

5.5.1.2 TRU Waste Drum Doublepack (LCO 3.1.7/SAC)

Most of the inventory in TA-54, Area G is TRU waste contained in drums. The placement of a metal TRU waste container into another metal container provides additional protection against fires and internal deflagrations.

Above-ground TRU waste drums with ≥ 200 PE-Ci shall be doublepacked. Doublepacking consists of placing a metal (structurally sound) TRU waste container inside another, larger, passively vented metal (structurally sound) TRU waste container to provide an additional barrier between the radioactive waste and the environment. This reduces the source term that is released in any event, and therefore reduces the consequences to the public, collocated workers, and facility workers.

LCO: Above-ground TRU Waste Drums with ≥ 200 PE-Ci shall be doublepacked.

Surveillance Requirements:

• Verify quarterly that all above-ground TRU waste drums outside of retrieval areas with ≥ 200 PE-Ci are doublepacked. (SR 4.1.7.1) This verification may be accomplished through review of the Area G inventory database for those above-ground drums with ≥ 200 PE-Ci MAR.

This control does not apply to: 1) retrieval areas, which are addressed by a separate Directive Action SAC (SAC 5.7.3), 2) cemented or vitrified waste forms, 3) waste packaged in a POC, 4) during the temporary removal of a drum from a doublepack during repackaging or characterization with a High Efficiency Neutron Counter (HENC) or other NDE/NDA device, and 5) SSSR activities.

5.5.1.3 Thermal Separation Distances (LCO 3.2.1/SAC)

Each defined area within TA-54, Area G must be established by identifying and documenting the boundaries for the area. These boundaries may also be physically identified (e.g., a painted line marking the perimeter of an applicable area, a rope boundary, etc.) or be designated by a fixed structure (e.g., walls of a dome, or perimeter of a paved pad). In addition, the types of containers (e.g., metal versus non-metal) within the area that contain radiological material must be identified. Once the container type (i.e., metal or non-metal) is identified within a defined area, the MAR limit and applicable separation distance that must be maintained can be determined.
The following are considered examples of containers with metal exteriors:

- Drums
- Standard waste boxes (SWBs)
- Corrugated metal pipes (CMPs)
- Metal boxes
- Transportainers
- SeaLand containers
- Tritium containers
- Ten-drum overpacks

The metal containers that are not drums are expected to perform as well as a metal drum (e.g., thermal response during a fire) due to the metal wall thickness of these other containers.

The following are considered examples of non-metal containers for determining thermal separation distances (containers that are considered combustible construction):

- Plastic-wrapped waste
- Wood boxes/ metal-encased wood boxes
- Fiberglass-reinforced plywood (FRP) boxes

This LCO is applicable to the following Defined Areas:

- TRU Storage Areas,
- Process Areas
- Tritium Areas,
- SSSR Areas, and
- Retrieval Areas

The following are excluded from the separation distance requirement:

- Bolas Grande (BG) spheres/ metal spheres
- CMPs
- The distance between exposed MAR and the impediment for liquid fueled retrieval equipment located at Pit 9 and Trenches A-D.
- Low Activity Areas.

The separation distance requirement does not apply to metal spheres/ BG spheres because they are robust containers and are not anticipated to result in releases. The separation distance requirement does not apply to CMPs because the dose consequences would be negligible for accidents affecting this type of containment, as discussed in BIO Chapter 3, Section 3.3.2.3.2.1.K. The requirement does not apply to the
distance between exposed MAR and the impediment for liquid-fueled equipment at Pit 9 and Trenches A-D, which are addressed by a separate LCO SAC (LCO 3.2.3).

The separation distance requirement does not apply to Low Activity Areas. For postulated fire scenarios, the safety analysis does not credit thermal separation distances to mitigate potential radiological releases from Low Activity Areas.

Defined areas will be established by procedure that may involve a means of marking the boundaries of the defined areas. The thermal separation distance that must be maintained is determined by the type of container (e.g., metal containers, non-metal containers, or a mixture of containers), but may be conservatively implemented as the measured distance between the marked boundaries of the defined areas. If the container types within the defined area change, the separation distances would need to be verified for the revised container types.

In the event of a pool or combustible fire, the analysis assumes that the leading/outer edge of the fire is separated from containers by the separation distance. Fuel pool fire analysis methods typically assume a circular spill geometry. Due to variations in the actual geometry of a fuel spill, when the separation distance for a particular defined area is established, it must account for the potential fuel spill geometry within the defined area. To supplement the thermal separation distance requirements, the following additional controls help to limit the spread of fuel spills into or within the defined area:

- Limited quantities of combustible/flammable liquids within the defined area (LCO 3.3.1)
- Defined area topography or liquid impediments (e.g., berm, ditch, trench) to fix the leading edge of the location of a potential pool fire (LCO 3.2.3)

LCO: Thermal Separation Distances shall be as follows:

1. TRU Storage Areas, Process Areas and Retrieval Areas containing only metal containers and all Tritium Areas shall have the following Thermal Separation Distances:

<table>
<thead>
<tr>
<th>Thermal Separation Distance with no Liquid Impediment</th>
<th>OR</th>
<th>Thermal Separation Distance with an established Liquid Impediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 ft</td>
<td></td>
<td>7 ft</td>
</tr>
</tbody>
</table>

2. TRU Storage Areas, Process Areas and Retrieval Areas containing one or more non-metal containers shall have the following Thermal Separation Distances:

<table>
<thead>
<tr>
<th>Thermal Separation Distance with no Liquid Impediment</th>
<th>OR</th>
<th>Thermal Separation Distance with an established Liquid Impediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>43 ft</td>
<td></td>
<td>24 ft</td>
</tr>
</tbody>
</table>

3. An SSSR Area shall have the following Thermal Separation Distances:
<table>
<thead>
<tr>
<th>With non-metal containers</th>
<th>OR</th>
<th>With non-metal containers with an established stationary fire watch</th>
<th>OR</th>
<th>With only metal containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 ft.</td>
<td></td>
<td>10 ft</td>
<td></td>
<td>10 ft</td>
</tr>
</tbody>
</table>

**Surveillance Requirements:**

- Verify monthly, and prior to changing the container type in a TRU Storage Area, Process Area, Tritium Area, SSSR Area, or Retrieval Area, that minimum thermal separation distances are met (SR 4.2.1.1).
- Verify liquid impediments are capable of containing or diverting 100 gal of liquid, upon initial establishment of a liquid impediment (SR 4.2.1.2).
- Verify monthly that established liquid impediments remain capable of containing or diverting 100 gal of liquid (SR 4.2.1.3).

**5.5.1.4 Control of Transient Combustibles – Fuel Package Limit (LCO 3.2.2/SAC)**

The combustible fuel package load size of 100 lb limits the radiant energy thermal output of the fire at a distance of 3 ft to levels below 45 kW/m², and at a distance of 9 ft to levels below 10 kW/m², to prevent a release of MAR from metal or non-metal containers, respectively. This control reduces the likelihood of a fuel package being involved in a fire and reduces the consequences of a fire by limiting fire progression within a defined area and the amount of MAR involved.

The control applies to ordinary combustible materials other than radioactive waste that are introduced into an applicable defined area. Combustible materials that constitute part of a waste package or are introduced to remediate waste packages in situ, once affixed to the waste package, are considered to be part of the radioactive waste package and not subject to this control. Packaging and shipping materials and contamination control materials required for radiation protection are not included in this control.

Accumulations of transient combustible materials up to 20 lb in a location are not considered to constitute a fuel package due to their minimal weight. Fires involving these de minimis quantities of materials are not likely to spread and would include minimal involvement of waste containers. The weight of fuel packages located inside metal containers with a closed lid (e.g., closed metal cabinets, boxes, or drums) may be factored at 20% of the actual weight of transient combustible materials comprising the fuel package for the purposes of demonstrating compliance with the 100-lb limit. For example, a fuel package consisting of 200 lb of transient combustible materials located within a closed metal box may be treated as a 40-lb fuel package for the purpose of compliance with LCO statement 2a. This treatment is consistent with recommendations from the Society of Fire Protection Engineers for combustible materials inside closed non-fire rated metal enclosures.

**LCO:** Within applicable defined areas and their associated thermal separation distances, fuel packages shall be controlled as follows:

1. Fuel packages shall be attended, or
2a. Each fuel package shall be ≤ 100 lb of transient combustible material, and
2b. Fuel packages shall be $\geq 9$ ft away from non-metal waste containers and other fuel packages, and

2c. Fuel packages shall be $\geq 3$ ft away from metal containers.

This LCO does not apply to fuel packages in transit, or to combustible/ flammable liquids which are controlled by a separate LCO SAC (LCO 3.3.1). Stored non-metal waste containers such as FRPs, and radiological barrier devices and area boundary markers (e.g., rope, plastic stanchions, and signs) are not counted as transient combustible fuel packages. In addition, this LCO does not apply to Low Activity Areas.

**Surveillance Requirements:**

- Verify weekly that within applicable defined areas and their associated thermal separation distances:
  1. Each fuel package is $\leq 100$ lb of transient combustible material, or is attended (SR 4.2.2.1).
  2. Fuel packages are $\geq 9$ ft away from non-metal waste containers and other fuel packages, or are attended (SR 4.2.2.2).
  3. Fuel packages are $\geq 3$ ft away from metal containers, or are attended (SR 4.2.2.3).

- Verify shiftly, that for fuel packages that do not meet LCO statements 2a, 2b, and 2c, the fuel packages are attended (SR 4.2.2.4).

**5.5.1.5 Control of Liquid Run-On (LCO 3.2.3/SAC)**

The accident analysis involving a fuel pool fire credits a thermal separation distance from the edge of a fuel pool fire to a TRU defined area. In the case of Pit 9 and Trenches A-D during retrieval activities, a berm, curb, slope, ditch and/or equivalent liquid flow impediment is used to limit the spread of any fuel spilled from liquid fueled retrieval equipment. These impediments are sized to contain or divert the maximum fuel capacity of the retrieval equipment so that spilled fuel will not flow into the pit or trench. By keeping any spilled fuel diverted or contained above grade, the liquid impediments prevent the radiant heat flux from a potential fuel pool fire from impacting waste containers located at a lower elevation within the pit or trench.

LCO: Liquid impediments shall be established between liquid-fueled retrieval equipment and the edge of Pit 9/ Trenches A through D, during Operation and Warm Standby, except during reconfigurations needed to accommodate relocation of the retrieval equipment.

**Surveillance Requirement:**

- Verify that liquid impediments are capable of containing or diverting the full liquid fuel capacity of the retrieval equipment stationed at the retrieval area, prior to the start of retrieval activities and after relocation of liquid-fueled retrieval equipment at an active retrieval area (SR 4.2.3.1).
- Verify monthly that established liquid impediments remain capable of containing or diverting the full liquid fuel capacity of the retrieval equipment stationed at the retrieval area (SR 4.2.3.2).
5.5.1.6 Combustible/Flammable Liquid Controls in Defined Areas and Associated Thermal Separation Distance (LCO 3.3.1/SAC)

Most TRU waste container activities within defined areas are performed using electric or propane-powered equipment, although electric forklifts are inefficient and do not function well over the rough terrain of the Area G environs. Fuel pool fires are not possible when using this type of equipment. However, normal operations (e.g., maintenance, painting, decontamination) within defined areas require the use of small quantities of combustible/flammable liquids. Fuel pool fires of \( \leq 7 \text{ gal} \) were determined to have minimal risk due to their short burn duration and limited MAR involvement. During normal operations, 7 gal diesel or any other flammable liquid is an adequate volume to allow for these routine activities while maintaining a low risk.

Infrequently, liquid-fueled vehicles and/or equipment (e.g., diesel forklifts, manlifts) are required to perform activities in a container storage area. Therefore, it is necessary that liquid-fueled vehicles be permitted in the container storage area, which increases the likelihood of fuel pool fires during these infrequent and limited-duration activities. It is postulated that an event could occur that would rupture a fuel tank or hydraulic reservoir of a vehicle/equipment. The total combustible/flammable liquid quantity (e.g., fuel, hydraulics, lubricant) of a single forklift is conservatively estimated to be 100 gal. To protect the initial assumption of a 100-gal maximum fuel pool fire, individual vehicles/equipment are permitted to enter a defined area as long as the total liquid combustible/flammable fuel quantity is \( \leq 100 \text{ gal} \), and quantities of combustible/flammable liquids > 7 gal are attended. Attendance of the vehicle/equipment ensures that someone is available to observe any adverse event (e.g., fuel spill or leak) involving the vehicle/equipment and respond to mitigate it.

The following are excluded from the requirements of this LCO:

- Propane, since it is not considered a liquid fuel in the AA.
- TRU waste container contents.
- LLW/MLLW waste container contents.
- The liquids contained in equipment used for the NDA/NDE activity.
- Combustible/flammable liquids with a flammability rating of 0 and 1.
- The area within liquid impediments surrounding liquid fueled retrieval equipment located at Pit 9 and Trenches A through D.
- Low Activity Areas

LCO: The following combustible/flammable liquid controls shall be met in an individual defined area and its associated thermal separation distance, where applicable:

1a. For defined areas containing only metal containers: Volumes \( > 7 \text{ gal} \) shall be attended, or

1b. For defined areas containing non-metal containers: All combustible/flammable liquids shall be attended, and,

2. The total volume shall be \( \leq 100 \text{ gal} \).

The applicability of the thermal separation distance requirement to a given defined area is established in LCO 3.2.1.
Surveillance Requirements:

- Verify that combustible/flammable liquid volumes > 7 gal intended for introduction in each defined area and associated thermal separation distance containing only metal containers are attended, prior to introducing the combustible/flammable liquid into the applicable defined area and/or associated thermal separation distance (SR 4.3.1.1).

- Verify that all combustible/flammable liquids in each defined area and associated thermal separation distance containing non-metal containers are attended, prior to introducing the combustible/flammable liquid into the applicable defined area and/or associated thermal separation distance (SR 4.3.1.2).

- Verify that the total volume of combustible/flammable liquids in each defined area and associated thermal separation distance is ≤100 gal prior to introducing combustible/flammable liquid into the applicable defined area and/or associated thermal separation distance (SR 4.3.1.3).

5.5.1.7 Above-Ground Unvented TRU Waste Drums (LCO 3.4.1/SAC)

This LCO requires that above-ground TRU waste drums are passively vented, or that unvented TRU waste drums are placed in an access-restricted isolation area and not stacked. Closed metal TRU waste drums permit the buildup of combustible gases. Physical interactions with such drums can result in the ignition of the combustible gas, resulting in a deflagration with the potential for lid ejection. Typically, one or more passive vents are installed in each TRU waste drum to allow for atmospheric breathing.

The majority of TRU waste drums that are readily accessible (i.e., above ground) are vented. Unvented TRU waste drums and SWBs are isolated and not stacked. It is anticipated that unvented drums will be discovered during TA-54, Area G activities. The determination of a TRU waste drum's vent status requires observation of the container. Observation of above-ground TRU waste drums is a continuing activity, as part of normal operations of Area G. A separate SR for verification of drum vent status is not required because the Hazardous Material and Waste Management Program requires that facility procedures direct operators to inspect drums (compliant, metal TRU waste containers) for vents when the containers are transported or handled. Upon observation that an above-ground TRU waste drum is not vented, an operator will take action to ensure that the suspect container is isolated and not stacked. The facility may take further action to have the container vented or to place it in an overpack/doublepack.

TA-54, Area G will be removing TRU waste drums from Trenches A through D and from Pit 9. It is assumed that these drums are unvented until the vents are installed or until it is determined that they are vented. Drums in Trenches A through D are stacked two high. Containers in Pit 9 are stacked several tiers high. Discovery of stacked drums in Pit 9 or Trenches A through D does not require immediate action, as this condition is anticipated and the static condition of the drums does not increase the existing risk. LCO 3.4.1 does not apply during retrieval of below-ground waste from Pit 9 or Trenches A through D. Upon removal of a drum from its discovered stacked condition, unvented drums are isolated and not stacked, or are overpacked/doublepacked. Future handling and transport of the TRU waste drums that are retrieved will be performed in accordance with LCO 3.4.2.

Some TRU waste containers, by design and/or construction (e.g., FRPs, SeaLand containers), are passively vented (i.e., do not permit buildup of volatile/flammable gases) and do not require the installation of additional physical vents to meet this LCO. The containers are not leak-tight, and therefore any gas generated within the container would be diluted over time.

Some TRU waste containers that, by their robust design and/or construction, are designed to withstand an explosion do not require the installation of physical vents to meet this LCO. These containers are capable
of preventing the release of radiological material, and therefore the buildup of contained volatile/flammable gases is not of concern. Per DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, which cites results of Idaho Drum Deflagration Tests, containers of sound integrity that are overpacked, SWBs, direct loaded RH canisters with welded lids, and RH canister with nested metal drums can be credited to prevent lid loss and ejection of material during a deflagration. The DOE-STD-5506-2007 cites the following: “For SWB, RH canister with nested metal drums, and the overpacked drum, a significant release from the potential venting through the outer container seal is not expected.”

LCO: Unvented TRU waste drums that are above-ground shall be:

1. Located in an access-restricted isolation area, and
2. Not stacked

This LCO does not apply to retrieval areas and drum venting process areas.

Surveillance Requirements:

- Verify weekly that unvented TRU waste drums that are above-ground are located in an access-restricted isolation area and the isolation area includes a 15-ft separation distance (SR 4.4.1.1).
- Verify weekly (when unvented TRU waste drums are present in the isolation area), and after an unvented drum is placed in the isolation area, that unvented TRU waste drums in the isolation area are not stacked (SR 4.4.1.2).

The control for isolating an unvented drum retrieved from underground storage is implemented in the TSRs in SAC 5.7.7.

### 5.5.1.8 Unvented TRU Waste Drum Handling and Transport (LCO 3.4.2/SAC)

Unvented TRU waste drums at rest are unlikely to deflagrate. The TRU waste container inspection activities, and minor movements to attach or remove a lid restraining device, or other blast mitigation device, are not anticipated to cause container deflagration. This is based on DOE-STD-5506 [DOE 2007], which cites results of Idaho Drum Deflagration Tests. All of the test results taken together indicate that minor movements of unvented drums will not cause a drum to deflagrate.

A deflagration could result in ejection of the lid and some portion of the container contents. A lid restraint would limit the energy of the lid and/or material being ejected, as some portion of the energy would be expended in dislodging or breaking the lid restraint. A shielding/engineered barrier would divert the ejected lid and/or material from striking a worker, and give the worker time to react. A safe standoff distance would expend the energy of the ejected lid and/or material before it reaches the worker. Lid restraints, shields, and separation distance provide protection from physical injury but do not necessarily mitigate the radiological risk to workers. The confinement of radiological material limits its dispersal and thereby reduces the quantity of radiological material available for worker uptake. The Radiation Protection Program specifies worker controls for work near unvented TRU waste drums.

This LCO provides a mechanism to manage unvented TRU waste drums, most likely legacy, that may be found within the drum storage areas or are found to contain a hydrogen concentration > 8% by volume through WIPP Waste Acceptance Criteria (WAC) head-space gas analysis testing. Drums without a vent, or with an obviously degraded vent, are considered unvented because they may be sufficiently sealed to allow the accumulation of flammable gas. Other TRU waste containers at TA-54, Area G may not have a
vent. However, either these containers do not have the capability of providing enough of a seal to contain any hydrogen build-up, or they are so robust that they would be able to withstand the effects of a deflagration. All of these other TRU waste containers without a vent are capable of providing containment for the radiological contamination. These containers include SeaLand containers (cargo containers), transportainers, metal boxes, SWBs, metal-encased wood boxes, metal spheres, BG spheres, FRPs, plastic-wrapped waste, and CMPs.

Unvented drums have been discovered in the general population of above-ground TRU waste containers. During the retrieval of containers from Trenches A through D and Pit 9, all metal containers (e.g., 30- and 55-gal drums) will be treated as unvented until they are vented or overpacked. To prepare a drum for transport from one location to another, a worker may need to perform minor movements to position a container for inspection and the attachment or removal of a lid restraining device or other blast-mitigation device. These activities are not considered handling or transport, are necessary to prepare a drum for transport, and are considered unlikely to result in a drum deflagration.

Lid restraints provide a means to restrain a drum lid in the event of a deflagration. The restraint is not required to keep the lid in place during all anticipated deflagrations, but is relied upon to prevent the energetic transport of the lid beyond the deflagration site.

A safe standoff distance provides a means to prevent serious physical injury to the worker from the blast wave, and to limit exposure to radiological material released by the deflagration. The standoff distance also allows workers beyond this distance time to react to the accident and evacuate before receiving a significant airborne radiological dose.

Shielding/engineered barriers direct the path of flying debris away from personnel. Forklifts with enclosed cabs meet this requirement due to the large area presented by metal components (e.g., forklift mast) located between the drum and the forklift operator, as well as the cab construction, that will effectively deflect flying debris.

There are multiple acceptable methods for reducing the consequences of an unvented drum deflagration. The circumstances of an activity will determine which method is best for the given situation. While a specific SSC (e.g., standoff distance or shielding/engineered barrier) may be used, the decision of which method to use is administrative.

LCO: During handling (other than minor movement) of unvented TRU waste drums, a lid restraining device shall be installed.

Unvented TRU waste drums being transported shall:

1. Have a lid-restraining device installed, and

2a. Have shielding/engineered barrier between the unvented TRU waste drum and the worker, or

2b. Maintain a safe standoff distance ≥ 30 ft between the unvented TRU waste drum and the worker.

In addition to the lid restraint, the use of shielding/engineered barriers or a safe standoff distance is required for the protection of workers when transporting an unvented TRU waste drum. Transport from one building, dome, or pad to another may require lifting with a forklift or travel over rough roadways or uneven surfaces that increase the likelihood for significant shaking or impact to the transported drum. Only the lid restraint is required when handling an unvented TRU waste drum (e.g., using a drum hauler to move a drum from an isolation area to the drum venting area within the same building, dome, or pad), because an impact sufficient to cause a deflagration is extremely unlikely during handling.
This LCO is not applicable during minor movements of unvented TRU waste drums. The minor movement necessary to allow attachment of a lid restraining device, or other blast-mitigation device is unlikely to cause an impact that could lead to a deflagration.

**Surveillance Requirements:**

Verify that unvented TRU waste drums being handled or transported meet the following, prior to initiating an unvented TRU waste drum handling or transport activity:

1. Have a lid-restraining device installed (SR 4.4.2.1), and

Verify that unvented TRU waste drums being transported also meet the following, prior to initiating an unvented TRU waste drum transport activity:

2a Have shielding/ engineered barrier between the unvented TRU waste drum and the worker, or

2b Maintain a safe standoff distance ≥ 30 ft between the unvented TRU waste drum and the worker. (SR 4.4.2.2).

**5.5.1.9 Vehicle/ Equipment Safety Control - Refueling Location (LCO 3.5.1/SAC)**

Liquid-fueled vehicles/ equipment are required to perform certain operations within TA-54, Area G. Refueling operations increase the likelihood for a fuel spill, which could result in a pool fire if an ignition source were present. Transport of the liquid fuel to a refueling location within Area G also increases the likelihood for a vehicle/ equipment accident with subsequent fuel spill and fire if an ignition source is present. In the event of a pool fire near radiological material, a release of that material could result. Therefore, refueling operations are required to occur at a location sufficiently separate from MAR to ensure that a pool fire would not subject the radiological material to a heat flux that would result in ignition of the waste material.

A refueling location can be established near the TA-54, Area G access point. This refueling location eliminates the likelihood for a refueling event affecting MAR. However, future activities may require establishment of a refueling location farther into the site. The location would need to meet the requirements of this control to prevent a refueling event from affecting MAR. In this case, the refueling vehicle would need to pass near stored waste to access the temporary refueling location.

This control can be met by restricting the refueling tanker to specific designated refueling locations that meet the Minimum Refueling Separation Distance, based on the shortest distance from the boundary of a designated vehicle/ equipment refueling location to the boundary of the nearest defined area. To account for the radius of an actual fuel pool spill, this Minimum Refueling Separation Distance takes into consideration the fuel capacity of the refueling vehicle. This control applies when a refueling vehicle with a capacity of > 7 gal liquid fuel is present in the refueling location.

**LCO:**

Minimum Refueling Separation Distances between vehicle/ equipment refueling locations and defined areas shall meet the following criteria:
### Minimum Refueling Separation Distances

<table>
<thead>
<tr>
<th>Capacity of Refueling Vehicle at Refueling Location</th>
<th>Minimum Refueling Separation Distance to DEFINED AREA* with non-metal WASTE containers (ft)</th>
<th>Minimum Refueling Separation Distance to DEFINED AREA* with only METAL CONTAINERS (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 7 gal and ≤ 100 gal</td>
<td>43</td>
<td>22</td>
</tr>
<tr>
<td>&gt; 100 gal and ≤ 500 gal</td>
<td>71</td>
<td>45</td>
</tr>
<tr>
<td>&gt; 500 gal and ≤ 5,000 gal</td>
<td>203</td>
<td>141</td>
</tr>
</tbody>
</table>

*This control is applicable to Area G Defined Areas (excluding LAAs) when a refueling vehicle with a capacity of > 7 gal liquid fuel is present in the refueling location.

This control is not applicable to refueling locations involving only propane cylinders. The separation distance is not applicable to the hose between the refueling vehicle and the vehicle/equipment undergoing refueling, or to refueling vehicles located downhill from the retrieval areas.

**Surveillance Requirements:**

- Verify Minimum Refueling Separation Distances are met prior to the establishment of a new refueling location or modifying the boundaries of an existing refueling location, and prior to the establishment of a defined area, or change of container type within a defined area (SR 4.5.1.1).

### 5.5.2 ADMINISTRATIVE CONTROLS

A number of ACs were identified as requiring coverage in the TA-54, Area G TSRs. The SACs in an LCO format are discussed in Section 5.5.1. Directive Action SACs are discussed in Section 5.5.2.1. The SAC safety function and SAC statements requiring TSR coverage are identified, and a brief discussion of the basis for the SAC is provided.

In addition, a number of programmatic ACs are identified in Chapter 3. The programmatic ACs and associated SMPs are discussed in Section 5.5.2.2. A brief discussion of the SMP and associated programmatic AC statement requiring coverage in the TSRs is provided.

#### 5.5.2.1 Specific Administrative Controls

Directive Action SACs are identified in Section 5.7 of the TSRs. Several other identified SACs have been written in an LCO format and are discussed in Section 5.5.1. The following SACs apply when the applicable defined areas are in Operation mode or Warm Standby mode. When the applicable, defined areas are in Cold Standby, no MAR inventory is present and the SAC is not applicable.

**5.5.2.1.1 Stationary Fire Watch during Hot Work – Specific Administrative Control**

**Safety Function:** The safety function of the hot work SAC is to reduce the likelihood for ignition of flammables/combustibles.

**Control Description:** Hot work activities in TRU container storage areas shall be monitored by a stationary fire watch.
**Basis:** Some TRU waste in TA-54, Area G is contained in FRPs or other containers that are flammable and/or combustible. These containers are permitted to be stored in TRU non-metal container storage areas that limit the radiological inventory (PE-Ci) of the area and therefore, protect the assumptions of the accident analysis and the derived consequences. Hot work activities (e.g., welding, grinding or cutting of metal, or other operations that produce sparks or flame) being performed in the TRU non-metal container storage areas have the potential to ignite a fire. Other areas where metal containers are stored may also require hot work activities. The stationary fire watch in these areas reduces the probability that a hot work spark initiator may cause a fuel pool fire if there is spilled fuel. To reduce the likelihood of a fire event, activities where hot work is to be performed within a TRU storage area are identified. If hot work is to be performed, then a stationary fire watch is assigned to observe the activity.

The stationary fire watch provides stationed personnel for the purpose of making fire safety observations (e.g. presence of ignition sources, changes in combustible loading, unauthorized activities, and situations that could increase the potential or consequences of a fire). The stationary fire watch is performed according to Laboratory policy.

**5.5.2.1.2 Vehicle Refueling Prohibition – Specific Administrative Control**

**Safety Function:** The safety function of this control is to reduce the likelihood of a fire from a refueling accident involving MAR on a Transportation Vehicle.

**Control Description:** The refueling of Transportation Vehicles is prohibited when MAR is on the Transportation Vehicle. This control does not apply to propane-fueled forklifts.

**Basis:** The safety basis indicates that fuel pool fires involving TRU MAR result in significant dose consequences to all receptors. An accident involving a fuel leak during refueling, with a subsequent spark, is identified in the safety basis as a significant fuel pool fire that can involve waste. The implementation of this control prevents the occurrence of this hazard scenario when Transportation Vehicles are being fueled. Propane-fueled forklifts are exempted from this control because the propane within the fuel tanks on forklifts will not pool if spilled and, therefore, will not form a fuel pool as analyzed in the accident analysis.

**5.5.2.1.3 Doublepacking TRU Waste Drums with MAR ≥ 200 PE-Ci during Trenches A through D Retrieval Activities – Specific Administrative Control**

**Safety Function:** The safety function is to reduce radiological consequences by limiting the amount of MAR affected by thermal or mechanical insults.

**Control Description:** TRU waste drums ≥ 200 PE-Ci retrieved from Trenches A through D shall be doublepacked before retrieval of an additional TRU waste drum in the defined area.

**Basis:** Many containers that are currently stored in Trenches A through D are known to contain MAR > 200 PE-Ci. These containers are not currently doublepacked and cannot be doublepacked until they are removed from the trench. Therefore, when a culvert is uncovered, the container is examined to determine its integrity. Upon removal from an uncovered culvert, any drum with ≥ 200 PE-Ci is doublepacked before another drum is retrieved. Depending on the integrity of a retrieved drum with ≥ 200 PE-Ci, doublepacking may require the retrieved drum to be overpacked with a single TRU waste container (if the retrieved drum itself is of sound integrity) or with two TRU waste successive containers (if the retrieved drum is not of sound integrity).
Metal TRU waste containers with higher PE-Ci values that are doublepacked provide a mitigative function by reducing the effective MAR involved in the event. This control addresses fire, deflagration, loss of confinement, external, and NPH events. Based upon the types of activities that may be conducted within an area (e.g., storage or processing) it was determined that limiting the quantity of radiological material that may be involved in any one process upset is an effective means for controlling the risk. With high MAR containers being doublepacked, the material available for release is limited and, therefore, reduces the consequences to the public, collocated workers, and facility workers.

5.5.2.1.4 Escort of High MAR TRU Waste Transport within TA-54, Area G – Specific Administrative Control

Safety Function: An escorted rolling roadblock for the Transportation Vehicle reduces the likelihood for a vehicle accident involving radioactive waste and impact to stored radioactive waste containers.

Control Description: Transportation Vehicles, excluding forklifts, which meet or exceed the following limits shall be escorted by a rolling roadblock (i.e., escort vehicle in front and back):

1. Any Transportation Vehicle with compliant metal containers containing > 800 PE-Ci.
2. Any Transportation Vehicle with one or more non-compliant metal or non-metal containers > 450 PE-Ci.

Basis: To reduce the risk associated with high MAR on a Transportation Vehicle, this control is implemented to escort the Transportation Vehicle with a rolling roadblock. A Transportation Vehicle with high MAR includes a vehicle with metal containers with > 800 PE-Ci, or a vehicle with non-metal containers with > 450 PE-Ci. A rolling roadblock consists of an escort vehicle in front of and another behind the Transportation Vehicle. The escort minimizes the potential for another vehicle impacting the Transportation Vehicle with the high MAR and also ensures compliance with the 15-mph posted speed limit at which the Transportation Vehicle travels to minimize the potential for the Transportation Vehicle causing an accident.

Designated routes of travel will be established and documented, and are required to be known by escort drivers. Due to the nature of TA-54, Area G operations and the need for various combinations of origination and destination points, designated routes may be modified and the changes evaluated through the Unreviewed Safety Question (USQ) program.

Transport vehicles that are operating under the LANL Transportation Safety Document (TSD) are not subject to this control. Consistent with the interface between a nuclear facility at LANL and the LANL TSD, the TSD governs and applies during transport along public roads and until the vehicle comes to a complete stop at the required location for unloading and receipt acceptance of a waste container at the Area G occurs.

5.5.2.1.5 Escort of Transportation Vehicle between TA-54, Area G and RANT – Specific Administrative Control

Safety Function: The safety function of this control is to reduce the frequency of vehicle accidents resulting in fuel interaction with MAR during transport of MAR between Area G and the Radioassay and Nondestructive Testing (RANT) Facility entrance gate.
Control Description: The Transportation Vehicles with MAR onboard shall be escorted by a rolling roadblock (i.e., escort vehicle in front and back) between TA-54 Area G and the RANT entrance gate.

Basis: The rolling roadblock escort for the Transportation Vehicle transporting MAR between TA-54, Area G and RANT reduces the likelihood for a vehicle accident involving radioactive waste that has the potential for high consequences to the public. The rolling roadblock vehicle escort minimizes the potential of another vehicle impacting the Transportation Vehicle, while also minimizing the speed of the Transportation Vehicle to reduce the potential of its causing an accident. This control is not required within the RANT boundary (i.e., inside the RANT entrance gate) because the Transportation Vehicle must travel at a low speed to turn into or out of the RANT yard.

5.5.2.1.6 Escort of > 100-Gal Flammable Liquid Inventory Vehicles within TA-54, Area G – Specific Administrative Control

Safety Function: The safety function is to reduce the likelihood of fuel interaction with MAR during vehicle transports with > 100 gal of flammable liquid on board.

Control Description: Vehicles/Equipment in transit with > 100 gal total flammable liquid inventory shall be escorted, and follow a designated route.

Basis: Controls on vehicles/equipment with greater than a total contained 100-gal fuel inventory (including the vehicle’s fixed fuel tank capacity and any transported containers of flammable liquid) minimize the likelihood that an accidental fuel spill and fire would occur in the vicinity of MAR and result in a release of radiological material. Drivers with vehicles or equipment with the capacity to contain more than 100 gal may not be familiar with the TA-54, Area G site. The large-fuel-capacity vehicles/equipment that are required to pass near defined areas containing MAR must be escorted along a designated route. The escort vehicle restricts the travel path and vehicle/equipment speed so that the likelihood of a vehicle accident and fuel spill is limited.

Designated routes of travel will be established and documented, and are required to be known by escort drivers. Due to the nature of TA-54, Area G operations and the need for various combinations of origination and destination points, designated routes may be modified, and the changes evaluated through the USQ program.

5.5.2.1.7 Retrieval Area Unvented TRU Waste Drum Isolation Requirement and Stacking Prohibition – Specific Administrative Control

Safety Function: The safety functions of this control are to reduce the likelihood of a sympathetic deflagration, and the likelihood of inadvertent unvented drum toppling, leading to a deflagration.

Control Description: After an unvented drum is removed from its underground storage configuration at a retrieval area, the unvented drum shall not be stacked, and shall be inserted into an overpack/doublepack immediately, or placed in an isolation area until it is inserted into an overpack/doublepack, or until a lid restraint is applied for its transfer to an isolation area within the above-ground storage area, or the drum is vented.

Basis: At Pit 9, an unvented drum is removed from its underground storage configuration after it has been physically removed from its position in the uncovered, stacked storage array. At Trenches A through D, an unvented drum is removed from its underground storage configuration after it has been physically removed from its position within the cask.
At the retrieval area, not permitting unvented drums to be stacked prevents sympathetic deflagrations from occurring and prevents an unvented drum from toppling from an upper tier. An unvented drum can deflagrate if mechanically insulted or toppled from a stack. Prohibiting the stacking of unvented drums prevents sympathetic deflagrations and reduces the likelihood for an unvented drum to be toppled, leading to a deflagration. The isolation of unvented drum within a limited-activity area reduces the likelihood for an unvented drum to be inadvertently impacted by nearby work activities (e.g., forklift operations).

Isolating and not stacking unvented drums provide for the safe storage of the containers until they are passively vented or overpacked/doublepacked, or a lid restraint is applied. This SAC is necessary to provide administrative compensatory measures while the containers are in an unvented condition.

5.5.2.1.8 Elevated Waste Movements and Critical Lifts – Specific Administrative Control

Safety Function: The safety function of the elevated waste movement and critical lift requirements is to reduce the frequency for container puncture, drops, toppling, and impacts resulting in release of radiological material.

Control Description: A spotter shall be present for TRU waste container lifts planned to exceed 4 ft but ≤ 12 ft lift height.

- A spotter shall be present for TRU waste container lifts planned to exceed 4 ft above the ground surface directly below the TRU waste container, but less than or equal to 12 ft lift height above the ground surface directly below the TRU WASTE container.
- A critical lift plan shall be used for planned lifts of the TRU waste container > 12 feet above the ground surface directly below the TRU waste container.
- A critical lift plan shall be used for planned lifts of FRPs with MAR > 150 PE-Ci equivalent combustible waste.

Basis: A control is in place for a spotter to be present for TRU waste container lifts planned to exceed 4 ft above the ground surface directly below the TRU WASTE container, but ≤ 12 ft lift height. This control ensures that a spotter is present for lift operations during elevated (e.g., stacking/unstacking, loading/unloading) placement/removal of TRU waste containers.

Use of a spotter for anticipated lift heights > 4 ft helps to direct the vehicle/equipment operator around obstructions and prevent drops, punctures and impacts with TRU waste containers.

Lifting of TRU waste containers is required during various receipt, retrieval, handling, examination, and shipping activities. Lifts of > 12 ft have the potential to result in significant damage to the lifted container if dropped. The minimum lift height requiring a critical lift is set at 12 ft because DOE-STD-5506 evaluates drop drops from the 4th tier of stacked drums (nominally 12 ft) to be low impact and to result in a damage ratio of 0.1 or less [DOE 2007 and LANL 2010a]. Therefore, lifts of containers where the minimum drop height (e.g., distance between lowest point on container and the first surface immediately below the container) is expected to exceed 12 ft are planned to reduce the likelihood of a container drop. Planning of these lifts provides assurance that potential obstructions within the load path are minimized, that lifting equipment is inspected and in proper working condition, and that the load is properly rigged. This planning reduces the likelihood for a container drop. This SAC requires the preparation and approval of a critical lift plan for lifts of > 12 ft in height.
The accident analysis indicates that the drop of an FRP with MAR > 150 PE-Ci will result in dose consequences to the public that are Moderate. The critical lift plan associated with lifting drums is not based on a MAR limit.

The critical lift plan ensures that the equipment used is authorized for the load lifted, equipment is maintained, and operators are trained and qualified for the equipment they use to perform the lifts. A critical lift plan for planned crane lifts of TRU waste loads and FRPs reduces the likelihood of load drops, thereby preventing potential TRU waste container or FRP breaches or spills.

5.5.2.1.9 Mobile Loading Payload Lifts – Specific Administrative Control

Safety Function: The safety function of this control is to prevent a mobile loading payload from dropping on top of another payload or a defined area containing TRU waste, to minimize consequences by limiting the MAR involved in the accident.

Control Description: Mobile loading payloads shall not be lifted over TRU waste, excluding another payload within a Type B container. Mobile loading payloads with MAR > 925 PE-Ci shall not be lifted more than 12 ft, measured from the bottom of the payload to the ground.

Basis: The accident analysis indicates that a payload drop onto another payload, or the drop of payloads with MAR above 925 PE-Ci, could result in unacceptably high consequences to receptors. This lift control mitigates consequences to only involve a release those from the dropped payload, and not from the impact of other TRU WASTE containers. A payload that is inside a Type B container is protected from an impact-related material release. A 12 ft limit was selected as the height restriction for High MAR payloads because the minimum lift height requiring a critical lift is set at > 12 ft. DOE-STD-5506 evaluates drop drops from the 4th tier of stacked drums (nominally 12 ft) to be low impact and to result in a damage ratio of 0.1 or less [DOE 2007 and LANL 2010a].

5.5.2.1.10 Projected Above-Ground Inventory – Specific Administrative Control

Safety Function: This control protects the assumptions of the inventory statistical analysis used in the Area G BIO accident.

Control Description: Verify that projected Area G above-ground inventory statistics results in an inventory that is bounded by the approved hazard and accident analysis prior to underground TRU waste retrieval activities at Trenches A through D.

Basis: The Area G BIO used a statistical approach per guidance in DOE-STD-5506 [DOE 2007]. The retrieval of underground waste from Trenches A through D may skew the inventory statistics because several of the Trenches A through D drums have MAR values > 200 PE-Ci and are of a 100% combustible waste matrix.

The implementation of this SAC will ensure that the hazard and accident analysis bounds current and/or forecasted inventories due to Trenches A through D retrievals.

The projected above-ground inventory will be based on anticipated shipments of TRU waste containers to WIPP from Area G, anticipated newly generated waste based on the most recent year’s receipt of TRU waste containers from LANL generators of nuclear waste, and the identified Trenches A through D drums that are planned to be retrieved. Once the projected above-ground inventory is generated, a DOE-STD-5506 [DOE 2007] statistical analysis will evaluate the maximum container MAR in a drum, the 99th percentile value, the 95th percentile value, the mean value of the container MAR, and the waste matrix...
distribution. An allowable projected inventory is if the evaluated quantities in the statistical analysis are less than those analyzed in Table 3-14 in Chapter 3. If any of these values are higher than those in Table 3-14, then these values are used in spreadsheet calculations to determine if the dose consequences for bounding accidents are less than those in Section 3.4 of the Area G BIO. If the dose consequences are higher than those analyzed in the Area G BIO, then the projected inventory to be retrieved must be adjusted for the Trenches A through D. If the dose consequences are equal to or lower than those analyzed in the Area G BIO, then the projected retrieval plan may be carried out.

5.5.2.1.11 Pole Mounted Transformer Distance from TRU Waste Storage Areas – Specific Administrative Control

Safety Function: The safety function of this SAC is to preserve the initial conditions in the accident analysis that a post-seismic fire will not involve non-metal storage areas and to reduce the likelihood of post-seismic fire in TRU waste areas caused by a pole mounted transformer falling onto waste containers during a seismic event.

Control Description: Pole mounted transformers shall be located a safe distance away from TRU waste container storage areas as determined by the height of the pole-mounted transformers. If the pole mounted transformer contains flammable/combustible liquids (i.e., with a flammability rating greater than 1), the safe distance is the height of the transformer, the radius of the fuel pool based on the volume of the fuel within the transformer, and a thermal separation distance to protect the TRU waste container storage areas. Alternatively, a liquid impediment, capable of preventing the run on of liquid equal to the volume of the fluid within the transformer, may be used between the potential location of the downed transformer and the TRU waste storage area.

Basis: The accident analysis for a seismic event and post-seismic fire presumes that a pole mounted transformer will not topple onto a TRU waste container storage area, causing spilled flammable liquid contents to ignite. If the transformer catches on fire after falling, an ensuing fuel pool fire may be sufficient to propagate a fire within the TRU waste storage area, resulting in high consequences. This control protects the assumption of this analysis.

This control does not apply to pad-mounted or floor-mounted transformers, as these do not present the same seismic toppling concern as elevated, pole mounted transformers. The control also does not apply to transformers containing only Class IIIIB combustible liquid. Such liquids have a National Fire Protection Association (NFPA) 704 Flammability Rating of 0 or 1, or (if a Flammability Rating is not available for a particular liquid), have a flashpoint of 200 °F or higher. These liquids require considerable preheating under all ambient temperature conditions, before ignition and combustion can occur. Transformer liquids of this type will not start a fire, do not present the same fire hazard as flammable/combustible liquids with a lower flash point temperature, and are not subject to this control.

This control is implemented through an evaluation to determine the required separation distance and/or liquid impediment between pole mounted transformers and TRU waste storage areas.

5.5.2.1.12 Prohibitions on Opening Sealed Inner TRU Waste Packages Discovered within a TRU Waste Container during SSSR Activities

Safety Function: During SSSR activities, a prohibition on opening sealed inner TRU waste packages protects workers from significant injury due to a possible deflagration as a result of a flammable gas concentration in sealed inner TRU waste packages.
Control Description: Sealed inner TRU waste packages found within a parent TRU waste container during SSSR activities shall not be opened except as allowed by the control described in Section 5.5.2.1.18.

Sealed inner TRU waste packages contain TRU waste and are:

- Metal or glass containers with
  - a positive mechanical locking mechanism, such as a metal screw-on lid; or
  - a metal locking, bolted, or snap-on lid.

The following inner package types, regardless of volume, may be remediated during SSSR because there is no concern for hydrogen build-up within the package:

- any plastic container with any lid;
- any container with a plastic lid;
- any container without a gasket (e.g., containers with slip lids, paint cans, and other similar containers of any volume);
- any container with a slip-on lid (with or without a gasket);
- any container that does not contain TRU waste; and
- fiber board containers of any volume.

Basis: Sealed inner TRU waste packages that are metal or glass and have metal lids, as indicated above, are not to be opened during SSSR activities. This prevents the worker from being exposed to a deflagration hazard due to build-up of a flammable (hydrogen) gas mixture within the waste package. The prohibition is an important assumption of the hazard evaluation. To protect this assumption in the hazard evaluation, the prohibition on opening sealed inner TRU waste packages is a specific administrative control for worker protection. During waste remediation, several other types of inner packages have been encountered and are not subject to hydrogen build-up. These inner packages, as listed above, are not sealed or do not contain TRU waste, so the build-up of a flammable gas mixture is not feasible. Hydrogen bounce-back studies at Savannah River Site indicate that hydrogen will diffuse through plastic, thus supporting the concept that any plastic container with any lid, or any container with a plastic lid, will not build up hydrogen [WSRC 2007].

5.5.2.1.13 Acetylene Cylinder Control

Safety Function: The control reduces the likelihood of an acetylene cylinder explosion that involves MAR. It is a safety class equivalent specific administrative control.

Control Description: The storage or use of acetylene cylinders is prohibited inside or within 50 feet of defined areas where MAR is present.

Basis: Acetylene cylinders create a unique explosion hazard due to the potential for flashback through connected torches or regulators into the cylinder. Acetylene cylinders can also represent a potential hazard when improperly stored because they may be more vulnerable to physical insults or other sources of energy which could cause a cylinder breach and explosion. As such, the storage or use of acetylene cylinders in defined areas where MAR is present, or within 50-feet of those defined areas is prohibited A 50-foot standoff from defined areas is a requirement of this SAC because the distance bounds the most
conservative thermal separation distance from any type of waste container (i.e., metal or non-metal) established by the safety analysis and described in Section 5.5.1.3. Due to their infrequent use at Area G, and the standard industry practice of storing compressed gas cylinders in designated areas away from other hazards, the control of acetylene cylinders through this SAC provides acceptable mitigation of the hazard without requiring specific performance criteria or surveillance requirements.

5.5.2.1.14 Non-Sparking Equipment/Process During Venting

Safety Function: The use of non-sparking equipment/processes when penetrating the lid of an unvented TRU waste drum, during its venting, reduces the likelihood of a deflagration by reducing the likelihood of a mechanically-induced (frictional) spark that could ignite a flammable gas mixture that may exist within the unvented TRU waste drum.

Control Description: The equipment or process used to penetrate the lid of an unvented TRU waste drum must be of the type that does not produce mechanically-induced sparks. A vented 55-gallon, 85-gallon, or 110-gallon TRU waste drum that contains an unvented inner drum is considered an unvented drum for the purposes of this SAC.

Basis: During the venting process, there is a potential to ignite flammable gases within the unvented drum, resulting in a deflagration with ejection of debris. When penetrating the lid of an unvented TRU waste drum, during its venting, the equipment/process used must be of the type to minimize generation of a mechanical spark (e.g., non-sparking tools; use cold drilling, controlled speed drilling, or drum punch). By their use, the likelihood of a spark occurring is minimized. Preventing the occurrence of sparks will minimize the likelihood that a flammable gas mixture can ignite within the unvented TRU waste drum, and lead to a deflagration. For the Nuclear Filter Technology Drum Venting System, the drill speed must be below 640 rpm. The use of rotational drill speeds below 640 rpm has been determined to meet the safety function [LANL 2012c]. The BIO credits this control for reducing the frequency of a deflagration during venting. Due to their widespread industrial use, non-sparking tools are procured, installed, and maintained in accordance with standard industrial practices applied to such devices; their management through the SAC provides acceptable mitigation of the hazard without requiring specific performance or quality criteria for those devices.

5.5.2.1.15 Blast-Mitigation Device During Venting

Safety Function: The use of a blast-mitigation device during venting reduces the potential radiological consequences to all potential receptors in the event of a deflagration during the venting of an unvented TRU waste drum.

Controls Description: An unvented TRU waste drum with MAR $\leq$ 480 PE-Ci equivalent combustible waste shall use a blast-mitigation device (e.g., doublepack, DVS enclosure or lid restraint). An unvented TRU waste drum with MAR > 480 PE-Ci equivalent combustible waste shall use a doublepack as a blast-mitigation device. A vented 55-gallon, 85-gallon, or 110 gallon TRU waste drum that contains an unvented inner drum is considered an unvented TRU waste drum for the purposes of this SAC.

Basis: A blast-mitigation device such as a doublepack, DVS enclosure, or lid restraint protects against lid loss, thus mitigating dose consequences. For unvented TRU waste drums with MAR $\leq$ 480 PE-Ci equivalent combustible, the BIO credits the use of blast mitigation devices as safety-significant. The blast mitigation devices are used to lower the ARF*RF from that of unconfined burning to one of confined burning. Section 4.4.3.1 of DOE-STD-5506 describes confined and unconfined burning. Confined burning is defined as burning of MAR inside a drum that has lost the seal and/or the lid. DOE-STD-5506 refers to DOE-HDBK-3010-94 which states that even waste placed together in a pile without bag
containment forms a loosely agglomerate package of sorts. DOE-STD-5506 concludes: “Therefore, combustion of TRU wastes that is contained in drums or boxes, meets the definition of packaged waste, even when these containers have suffered lid degradation or loss.” In fact, the derivation of the ARF and RF for confined burning, in section 5.2.1.1 of DOE-HDK-3010, Vol. 1, is based on results from waste contained in a cardboard box. The descriptions within DOE STD 5506 and the DOE-HDBK-3010 confirm that measures that prevent the waste from being ejected, will provide confined burning.

For unvented TRU waste drums with MAR > 480 PE-Ci equivalent combustible waste, the BIO credits the use of a doublepack as a safety-class control to reduce the Damage Ratio and thus the source term by a factor of 10 (DR = 0.1) in addition to the reduction in ARF*RF described above for confined burning. A DOUBLPACK consists of a container of sound integrity overpacked by a second outer container of sound integrity. DOE-STD-5506 provides an inspection checklist for use in determining if a container is of sound integrity. However, for the purpose of using the DR for a DOUBLEPACK involved in a deflagration, an inner container capable of retaining hydrogen may be judged to be of sound integrity without inspection. If the container is not of sound integrity, no hydrogen is retained and the deflagration hazard is eliminated. Therefore, the assumption of sound integrity is conservative. As a result, the sound integrity of an unvented inner container does not need to be confirmed by inspection for the purpose of applying the definition of a DOUBLEPACK to a venting operation.

It is acceptable to use more than one blast-mitigation device (e.g., a lid-restraint on the drum that is then vented within the drum venting system chamber), as long as the device whose use is credited with consequence reduction meets the associated performance and quality requirements. The use of an additional blast-mitigation device may provide further defense-in-depth, but is not credited in the accident analysis, and is not required to meet the same requirements as the credited device. Due to their widespread industrial use, the blast-mitigation devices are procured, installed, and maintained in accordance with standard industrial practices applied to such devices; their management through the SAC provides acceptable mitigation of the hazard without requiring specific performance or quality criteria for those devices.

5.5.2.1.16 Standoff During Venting

Safety Function: The control reduces the potential consequences to facility workers in the event of a drum deflagration.

Control Description: Personnel SHALL be located ≥ 30 ft from the unvented TRU WASTE DRUM while it is being vented.

Basis: The 30 ft (radius) standoff distance serves two worker protection functions in the event of a deflagration during drum venting: 1) it helps to limit the potential inhaled radiation dose rate for facility workers (as derived in Appendix 3I of the BIO), and 2) it protects workers from serious injury from the blast wave (as derived in CALC-11-TA-54-AREAG-010).

Personnel necessarily must be within 30 ft of the drum prior to venting (e.g., set-up of drum in venting apparatus), but must maintain the ≥ 30 ft standoff distance during the venting. This standoff distance, in conjunction with a radiological contamination control environment (element of the Radiation Protection Program), provides a means to minimize the worker from being impacted by flying debris and limits the amount of radiological material available for uptake.

Since the deflagration hazard only exists during the actual venting (puncture), this control is only applicable during venting (e.g., activities such as setting up the drum do not have the potential to
puncture the drum and therefore the subsequent deflagration hazard does not exist, and the control is not applicable).

5.5.2.1.17 Stationary Fire Watch During SSSR Activities

**Safety Function:** The safety function of the Stationary Fire Watch During SSSR Activities SAC is to reduce the consequences of fire.

**Control Description:** A continuous Stationary Fire Watch is required in the SSSR process area whenever TRU waste is exposed.

**Basis:** SSSR processes involve the handling of combustible material. The STATIONARY FIRE WATCH is a trained individual equipped with fire blankets, Metal X, and ABC fire extinguishers, as appropriate, to extinguish an incipient fire. Because the STATIONARY FIRE WATCH is located in the process area and is dedicated to prevent or extinguish a fire, the consequences from an incipient fire involving exposed TRU WASTE are significantly reduced. A continuous STATIONARY FIRE WATCH is required whenever TRU WASTE is exposed in an SSSR process area.

TRU WASTE outside of a container is considered exposed. TRU WASTE covered by a fire blanket or other fire retardant material is sufficiently protected from a potential fire and is not considered exposed.

5.5.2.1.18 Controls for Opening Sealed Containers with Bolted Lids/Flanges During SSSR Activities

**Safety Function:** The safety function of this SAC is to reduce the likelihood and consequence of a deflagration involving sealed containers with bolted lids/flanges that are opened during SSSR operations.

**Control Description:** This SAC requires the following:

1. Spark-generating operations in the SSSR Area shall cease prior to loosening the lid/flange bolts.
   
   *Basis: Stopping all spark-generating operations removes an initiator for deflagration.*

2. Workers and the sealed container shall be grounded or bonded prior to loosening the lid/flange bolts.
   
   *Basis: All workers in the immediate vicinity of the container shall be grounded or bonded until measurements demonstrate that the hydrogen levels at the openings are below the LFL for hydrogen. The safety function of the grounding or bonding is to reduce the probability for a spark during the opening of a sealed container and as the container is venting, thereby minimizing the potential for igniting a potentially flammable atmosphere. Once the hydrogen levels at the openings are measured and demonstrated to be below the LFL (4% for hydrogen), the grounding or bonding is no longer required.*

3. Loosening the lid/flange bolts shall be performed using non-sparking processes or tools.
   
   *Basis: The use of non-sparking processes or tools prevents the occurrence of sparks, thereby preventing the ignition of a potentially flammable atmosphere.*

4. The lid/flange bolts of each lid/flange shall be loosened sufficiently to break the seal on the lid/flange and allow venting without completely removing the bolts.
5. The container shall be positioned such that the opening(s) is at the high point of the container.

Basis: The opening must be at the high point of the container for venting of hydrogen to be effective.

6. Spark-generating operations shall not be resumed until the container has vented and the hydrogen levels at the openings are measured and demonstrated to be below the LFL (4% for hydrogen).

Basis: If measurements at the container openings demonstrate that the hydrogen levels are below the LFL, spark-generating operations may be resumed. The requirement that the hydrogen levels are measured and demonstrated to be below the LFL before resuming spark-generating operations ensures that deflagration is not a potential.

5.5.2.2 Safety Management Programs Including Programmatic Administrative Controls

Based on the information in DOE-STD-1027-92 [DOE 1997], it was determined that the TA-54, Area G site is a Hazard Category 2 Non-Reactor Nuclear Facility because of the inventory and potential for criticality. The operational controls were developed to reduce the frequency and consequence of a credible accident leading to an uncontrolled release of radiological materials or hazardous materials. The credited controls consist of DFs, as well as controls preserving selected elements of the SMPs. The limits and controls specified in this section shall be incorporated into written procedures or instructions and approved by facility management.

5.5.2.2.1 Procedures

Procedures are established, implemented, and maintained in accordance with LANL requirements governing the conduct of operations. Facility-specific guidance for initiating, preparing, revising, reviewing, approving, controlling, and issuing operating procedures will be provided.

Procedures are not limited to those items specifically identified as procedure types (for example, operating, chemistry, system, test, surveillance, and emergency plan), but could include anything described in the safety basis that defines or describes activities or controls over the conduct of work. Changes to these activities or controls qualify as changes to procedures, as described in the safety basis, and, therefore, must be evaluated as a potential USQ.

5.5.2.2.2 Review and Audit

General

This section summarizes the programs that ensure independent oversight, safety review, USQ determination, and appraisal of safety performance in accordance with Laboratory procedures.

Management Self-Assessments

A program is implemented in accordance with LANL requirements, requiring that line management periodically review activities to ensure that they are conducted in a safe manner. The following are examples of elements that should be reviewed:
• Procedures
• USQ determinations
• Programs
• Building/facility changes and modifications
• Facility operation
• Maintenance and testing
• Laboratory, DOE, and industry issues with potential generic safety significance
• TSR compliance

Independent Reviews

Reviews are conducted by individuals independent of the line management organizations. The objective of the independent review program is to assist line management in assessing work performance and to identify areas for improvement. The following are examples of subjects that independent reviews should evaluate:

• TSR implementation
• USQ determinations
• Proposed changes to the TSRs
• Occurrence reports
• Configuration management program implementation

Audits

A Laboratory audit program is established and conducted by a group independent of the facility or operations personnel to assess whether operations are in accordance with the TA-54, Area G safety basis, including the TSRs and Laboratory requirements. Examples of subjects the audit program might include are as follows:

• Conformance with the TSRs
• Training and qualification of the facility and operations staff
• Program implementation
• Effectiveness of corrective actions
• Adherence to Quality Assurance (QA) Program requirements

5.5.2.2.3 Unreviewed Safety Question Program

The USQ program shall be implemented and maintained in accordance with the approved LANL Unreviewed Safety Question procedure [LANL 2009a, or successor document]. Annually, as required by 10 CFR 830.203 [CFR 2011b], a summary of all USQ determinations for changes that have been implemented since the last submittal shall be submitted to DOE.
5.5.2.2.4 Emergency Preparedness Program

An Emergency Preparedness Program is implemented and maintained at TA-54, Area G in accordance with LANL requirements (PD 1200 [LANL 2011a], or successor documents). The program addresses emergency preparedness planning, including the activation of emergency organizations, assessment actions, notification processes, emergency facilities and equipment, protective actions, training and exercises, and recovery actions. The program also relies on adverse conditions being recognized by workers and reported to the Operations Center, which notifies facility and site personnel and helps to direct the response. Elements of this program contribute to defense-in-depth in limitation of potential accident consequences for the public, the collocated worker, and the facility worker.

5.5.2.2.5 Nuclear Criticality Safety Program

The Nuclear Criticality Safety Program is implemented to preclude inadvertent nuclear criticality at TA-54, Area G. General limits and controls are applied to fissionable material operations to ensure subcritical configurations under all normal and credible abnormal conditions. The LANL Nuclear Criticality Safety Program is established, implemented, and maintained for Area G operations in accordance with LANL requirements (SD 130 [LANL 2009b], or successor documents). The Nuclear Criticality Safety Program establishes requirements for process-specific criticality safety evaluations and emergent nuclear criticality safety issues (e.g., special disposal conditions, safety evaluations, limits, repackaging, or SSSR activities that combine drum contents). Chapter 6 of this BIO provides additional discussion on the Nuclear Criticality Safety Program.

5.5.2.2.6 Fire Protection Program

A fire protection program is established, maintained, and implemented in accordance with LANL requirements (PD 1220 [LANL 2011b], or successor document). This program develops and maintains fire protection (e.g., proper housekeeping, control of combustibles, control of ignition sources, control of cutting, welding, and other hot work) and fire control measures (e.g., detection and alarm systems as available, stationary fire watches, fire-fighting equipment, fire-fighting personnel and responsibilities) for the protection of personnel and structures within TA-54, Area G. The Fire Protection Program provides information on the interface relationships between the Laboratory, Los Alamos County Fire Department, and National Nuclear Security Administration (NNSA).

The objective and purpose of the LANL fire protection program is to minimize the potential for the occurrence of a fire or related event; injury or loss of life from a fire or related event; fires that cause an unacceptable on-site or off-site release of hazardous or radiological material that could impact the safety and health of employees, the public, or the environment; unacceptable interruption of a DOE- and/or NNSA-designated vital program or loss of a LANL-designated mission-critical program or activity as a result of a fire or related event; property loss from a fire or related event exceeding the defined limits established by LANL; and fire damage to critical process safety controls and SSCs as established by the safety analysis. The program also ensures a yearly review, at a minimum, by the fire protection engineer of the TA-54, Area G facility.

The following are elements of the Fire Protection Program which contribute to defense-in-depth in the limitation of accident likelihood or consequences for the public, the collocated worker, and the facility worker:

- Ignition source controls are established within defined areas. These controls reduce the likelihood for ignition of flammables and/or combustibles.
• Non-combustible pallets are used for TRU metal container storage.
• Periodic inspections for housekeeping are conducted to minimize solid transient combustibles and vegetation control, to include inspection by the LANL Fire Protection Engineer.
• When used for maintenance activities, acetylene gas cylinders are equipped with flashback arrestors.

The Fire Protection Program also addresses fire detection, alarm, and suppression systems where installed. The Los Alamos Fire Department is available to respond to fire within TA-54, Area G.

5.5.2.2.7 Radiation Protection Program

A Radiation Protection Program is established, implemented, and maintained in accordance with LANL requirements (P 121 [LANL 2011c], or successor document). These documents comply with the requirements of 10 CFR 835 [CFR 2011c]. The Radiation Protection Program evaluates radiological conditions and processes for worker protection. Radiation protection training helps ensure that radiation doses are maintained as low as reasonably achievable at the TA-54, Area G site. These controls reduce radiological consequences due to exposure.

The following element of the Radiation Protection Program contributes to defense-in-depth in the limitation of accident consequences and is implemented by procedures:

• Venting of unvented drums will be performed within a contamination-controlled environment.

5.5.2.2.8 Maintenance Program

A program shall be implemented to ensure that SSCs are maintained to meet the performance criteria, functional requirements, and safety function established in the approved safety basis and associated engineering documentation.

The maintenance program is implemented to ensure that the facility SSCs are maintained and controlled so they continue to provide the safety functions, functional requirements, and performance criteria credited in the BIO. In-service inspections (ISIs) are covered under the maintenance program and are implemented to provide reasonable assurance that the DFs are inspected on a frequency sufficient to demonstrate they continue to meet the credited safety functions, functional requirements, and performance criteria in the BIO. Section 6 of the TSRs describes the required ISIs and their frequency for each DF. Facility procedures may determine additional inspections and/or specify frequencies at which they need to be performed. The maintenance program ensures that structural or functional degradation is detected to permit corrective action before the function of the SSC is compromised.
The TA-54, Area G Maintenance Program is established and maintained in compliance with the DOE-approved Laboratory Procedure P950, *Conduct of Maintenance*, or successor document, which asserts compliance with DOE Order 433.1B, *Maintenance Management Programs for DOE Nuclear Facilities* and provides details of the program and its implementation. A graded approach is applied towards implementing the requirements of the Order. Maintenance activities include all necessary supporting functions for ensuring that the facility continues to operate normally. Maintenance is a critical function to ensure reliability. The following are elements of the Maintenance Program which contribute to defense-in-depth in the limitation of accident likelihood or consequences for the public, the collocated worker, and the facility worker:

- Periodic inspection and maintenance of LANL vehicles and equipment (e.g., forklift and transport truck).

### 5.5.2.2.9 Configuration Management Program

The Configuration Management Program is established, implemented, and maintained for the TA-54, Area G site in accordance with Laboratory requirements (P 341 [LANL 2011d], or successor documents). The purpose of this program is to identify and document the technical baseline of configuration control items and to protect equipment integrity. Laboratory requirements ensure that changes to the technical baseline are properly identified, developed, assessed (technically reviewed and validated), approved, scheduled, implemented, and documented.

### 5.5.2.2.10 Quality Assurance Program

A QA Program is established, implemented, and maintained at the TA-54, Area G site in accordance with LANL requirements (SD 330 [LANL 2009c] or successor documents). The QA Program controls the integrity and reliability of safety-class/ safety-significant SSCs and implementation of other SACs and SMPs.

Although not specifically credited in the HA or AA to prevent or mitigate an event, this control is included to administratively control the TSRs based on DOE G 423.1-1A [DOE 2010a].

### 5.5.2.2.11 Vehicle/ Equipment Safety Controls

Vehicle/ equipment safety controls shall be established, implemented, and maintained to ensure that defined areas are protected and to ensure that these vehicles/equipment are maintained and operated in an effective, but safe manner.

The following are elements of the Vehicle/Equipment Safety Controls:

- Posted speed limit within Area G is \( \leq 15 \text{ mph} \).
- Electric-powered vehicles/equipment are charged in locations where hydrogen gas does not accumulate (e.g., domes, ventilated enclosures, outdoors).
- Vehicle crash barrier placement around areas that are non-high risk locations where TRU waste is stored.
5.5.2.2.12 Conduct of Operations

A Conduct of Operations program is established, implemented, and maintained in accordance with LANL requirements (P315 [LANL 2010b], or successor documents). The Conduct of Operations program addresses areas such as operations organization; shift operating practices, including training, turnover, and log-keeping; communications; investigations of abnormal events and notifications; lockouts and tagouts; and independent verification. Conduct of Operations addresses developing and implementing the controls needed to perform the work safely and securely.

Although not specifically credited in the HA or AA to prevent or mitigate an event, this control is included to administratively control the TSRs, based on DOE-G-423.1-1A [DOE 2010a].

5.5.2.2.13 Hazardous Material and Waste Management Program

Hazardous material and waste management controls shall be established, implemented, and maintained in accordance with LANL requirements. The program’s purpose is to control personnel exposure to hazardous material by identifying and limiting contact with hazardous material, adhering to established occupational exposure limits, implementing ACs and engineered controls, and using personal protective equipment. The program also ensures that above-ground TRU waste drums with \( \geq 200 \) PE-Ci are doublepacked through a SAC requirement.

The following items are elements of the Hazardous Material and Waste Management Program:

- **Overpack:** TRU waste drums in degraded, suspect degraded, or damaged condition (i.e., not in a good and unimpaired condition) are overpacked.

- **TRU Waste Container Inspection:** TRU waste is packaged in structurally sound, non-combustible containers, except as permitted in SSSR areas, or legacy waste (e.g., packaged in FRPs). The facility implements procedures that require operators to visually inspect TRU waste containers for integrity and/or vents when handling or transporting containers. These procedures require the identification of deficiencies and the implementation of the appropriate corrective actions.

  Note: Non-compliant, non-metal TRU waste containers are inspected when handled or transported to confirm that the TRU waste containers are not radiologically contaminated.

**Inspection for compliant, metal TRU waste containers of sound integrity:**

Compliant, metal TRU waste containers are inspected when handled to confirm that the TRU waste container is intact and shows no signs of degradation by inspecting for the following:

- The TRU waste container is not obviously degraded. **Discussion:** Obviously degraded means clearly visible and potentially significant defects in the TRU waste container or TRU waste container surface.

- There is no evidence that the TRU waste container is, or has been, pressurized. **Discussion:** Pressurization can be indicated by a fairly uniform expansion of the sidewalls, bottom, or top. Past pressurization can be indicated by a notable outward deflection of the bottom or top. Verify that the drum is not warped.

- There is no potentially significant rust or corrosion such that wall thinning, pinholes, or breaches are likely or the load-bearing capacity is suspect. **Discussion:** Rust is assessed in terms of its type, extent, and location. Pitting, pocking, flaking, or dark coloration characterizes potentially significant rust or corrosion. This includes the extent of the TRU
waste container surface area, cover, thickness, and if it occurs in large flakes or built-up (caked) areas. Rusted TRU waste containers may not meet inspection if:

- Rust is present in caked layers or deposits.
- Rust is present in the form of deep metal flaking or built-up areas of corrosion products. In addition, the location of the rust should be noted—for example, on a drum: top lid; filter region; locking chine; top one-third, above the second rolling hoop; middle one-third, between the first and second rolling hoops; bottom one-third, below the second rolling hoop; and on the bottom. The TRU waste containers may still be considered acceptable if the signs of rust are as follows:
  
  ❖ Some discoloration on the TRU waste container
  ❖ If rubbed, rust would produce fine grit or dust or minor flaking (such that wall thinning does not occur)

- There are no split seams, tears, obvious holes, punctures (of any size), creases, broken welds, or cracks. Discussion: TRU waste containers with obvious leaks, holes or openings, cracks, deep crevices, creases, tears, broken welds, sharp edges, or pits are either breached or on the verge of being breached.
- The TRU waste container is properly closed. Discussion: Inspect the fastener and fastener ring (chine), if applicable, for damage or excessive corrosion. Check the alignment of the fastener to ensure that it is in firm contact around the entire lid and that the TRU waste container will not open during transportation.

- There are no dents, scrapes, or scratches that make the TRU waste container’s structural integrity questionable, or that prevent the top and bottom surfaces from being parallel. Discussion: Deep gouges, scratches, or abrasions over wide areas are not acceptable. If the top and bottom surfaces are not parallel, this indicates that the container is warped. Dents should be examined to determine their impact on structural integrity.

- There is no discoloration, which would indicate leakage or other evidence of leakage of material from the TRU waste container. Discussion: Examine the TRU waste container regions near vents, top lid fittings, bottom fittings, welds, seams, and intersections of one or more metal sheets or plates. TRU waste containers will not meet inspection requirements if leakage is present.

- The TRU waste container is not bulged. Discussion: For the purposes of this examination, bulging is indicated by the following:
  
  - A fairly uniform expansion of the sidewalls, bottom, or top (e.g., in the case of a drum, either the top or bottom surface protrudes beyond the planar surface of the top or bottom ring)
  - A protrusion of the side wall (e.g., in the case of a drum, beyond a line connecting the peaks of the surrounding rolling hoops or a line between a surrounding rolling hoop and the bottom or top ring)
  - Expansion of the sidewall (e.g., in the case of a drum, such that it deforms any portion of a rolling hoop)

- The container is visually inspected to determine if the container is non-combustible.
Inspection for vents on compliant, metal TRU waste containers:

The container is visually inspected to determine if the container is properly vented. **Discussion:** For the purposes of this examination, a container is not properly vented if the venting mechanism is visually clogged or incapable of functioning properly, or if the container is bulged or pressurized. An installed WIPP-approved filter is not considered to block the vent.

The nature of drum handling/movement activities already requires constant surveillance of the drums. The SMP element for compliant, metal TRU waste container inspections ensures their confinement integrity and presence of a vent. Periodic inspections are performed based on procedural implementation. A representative sample of containers that are accessible should receive a visual inspection. The movement of containers is not required to perform a periodic inspection.

- **Waste Acceptance Criteria:** Radiological waste received at the TA-54, Area G site must comply with the LANL WAC [LANL 2012a, or successor document] or an approved LANL exception.
- **Inclement Weather Control:** Suspend outdoor activities associated with handling or transportation of radiological waste during inclement weather (e.g., sustained high winds, lightning, etc.).
- **Access Restrictions for the Isolation Area** (for Unvented TRU Waste Drums)

  The access restrictions for the Isolation Area are as follows:

  o Normal operations within the Isolation Area are restricted to only those necessary to disposition unvented TRU waste drums, such as applying or removing a lid-restraining device, performing head space gas sampling, or using a forklift to move or remove the unvented TRU waste drums, or performing surveillances and inspections for regulatory compliance.
  o To prevent inadvertent access to the area, barriers or posting will be placed around the Isolation Area.
  o A 15-ft exclusion area exists between areas of normal operations and the edge of the outermost unvented TRU waste drums in the Isolation Area.
- **Banding:** TRU waste drums on stacked pallets in the storage array will be secured (e.g., banded).
- **Sealed radioactive sources:** Sealed radioactive sources are part of an Area G source control policy that complies with the source control strategy specified in Article 431 of the DOE RadCon Manual, DOE/EH-0256T [DOE 1994], or successor document.
- **Secure Transport:** TRU waste containers will be secured during transport by motorized vehicle (e.g., forklift or truck).
- **Compressed gas cylinder handling:**
  o Compressed gas cylinders will be stored in designated locations when not in use. Proper storage minimizes the potential for cylinders from becoming missiles or an explosion occurring that impacts waste.
  o Compressed gas cylinders in storage, transport, or use will be secured. Securing cylinders reduces the probability that a cylinder could fall over and rupture the nozzle.
  o Compressed gas cylinders in storage will be closed with the valve cap secured. Closure of the valve prevents accumulation of flammable vapor which could lead to a vapor cloud
explosion, and the valve cap or guard prevents the nozzle from being ruptured or sheared, creating a missile. Some compressed cylinders are designed with a guard in lieu of a valve cap to protect the nozzle. The valve guard was qualitatively determined to provide the same protection as a valve cap.

### 5.5.2.2.14 Occurrence Reporting

An Occurrence Reporting Program shall be established, implemented, and maintained for reporting operational occurrences. Occurrence reports will be prepared in accordance with LANL requirements (P 322-3 [LANL 2011c], or successor document). This program satisfies the requirements of DOE M 232.1-2 [DOE 2003], in reporting operations information. Investigations of occurrences having environmental protection, safety, or health-protection significance are performed in compliance with DOE O 225.1B [DOE 2011a].

Although not specifically credited in the HA or AA to prevent or mitigate an event, this control is included to administratively control the TSRs based on DOE G 423.1-1A [DOE 2010a].

### 5.5.2.2.15 Training and Qualification

The TA-54, Area G site training and qualification program is established, implemented, and maintained in accordance with Laboratory requirements (P 781-1 [LANL 2011f], or successor document). The program ensures that personnel who are responsible for Area G site operations, building/facility operations, process operations, vehicle operation, maintenance, and technical support are trained and qualified/certified, as applicable, to accomplish their safety-related responsibilities. Line management ensures that personnel receive the training required.

The training program includes the following elements which contribute to defense-in-depth in the limitation of accident likelihood or consequences for the public, the collocated worker, and the facility worker:

- Personnel maintain applicable LANL qualifications for vehicle and equipment operation.
- Personnel are trained to recognize specific job hazards and associated controls.

### 5.5.2.2.16 Document Control

TA-54, Area G site operations and facility records (including TSR compliance documentation) shall be retained in accordance with the TA-54, Area G site QA Program and LANL requirements (P 1020-1 [LANL 2011g], or successor documents).

Although not specifically credited in the HA or AA to prevent or mitigate an event, this control is included to administratively control the TSRs based on DOE G 423.1-1A [DOE 2010a].

### 5.5.2.2.17 Minimum Staffing

Table 5-3 reflects the minimum staffing requirements for implementation of Area G TSRs. The minimum staff reflects the minimal number of individuals in designated positions to place and maintain the TA-54, Area G site in a safe and stable condition. Because of the nature of operations at Area G, removing individuals from an area stops activities that may initiate an event. In addition, staffing for normal operations is anticipated to be greater than the minimum staffing requirements. Therefore, staff would be available to perform routine SRs, or SRs could be scheduled when normal staffing is available. Performing normal and routine activities was not considered when determining the minimum staffing.
The TSR Required Actions with a Completion Time of *Immediately* were considered when determining the minimum staffing requirements. Since none of the credited controls assumed action within a short interval, this did not affect determination of the minimum staffing.

### Table 5.3  Minimum Staffing Requirements\(^{(5, 6)}\)

<table>
<thead>
<tr>
<th>Area G Status</th>
<th>SOS</th>
<th>Ops Center Operator</th>
<th>Stationary Fire Watch(^{(3)})</th>
<th>Nuclear Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>When MAR is present and TRU WASTE operational activities are being performed within Area G(^{(1)})</td>
<td>R(^{(6)})</td>
<td>R</td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td>When MAR is present and No TRU WASTE operational activities are being performed within Area G(^{(2)})</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>When No above ground TRU MAR is present within Area G</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

R = Required at TA-54  
C = On Call and Responds within 2 hr  
SOM = Shift Operations Manager  
SOS = Shift Operations Supervisor

\(^{(1)}\) TRU Waste operational activities are those that include active waste handling (e.g., container movement, characterization, processing, SSSR activities), in addition to passive storage.

\(^{(2)}\) Only passive storage of MAR (above ground and below ground), and support activities such as visual inspections, security patrols, freeze protection rounds, institutionally required fire department responses, and other activities not involving opening or handling of radioactive material are allowed.

\(^{(3)}\) If qualified, a Nuclear Operator may also fulfill minimum staff requirements for Stationary Fire Watch.

\(^{(4)}\) SOM may cover the SOS position.

\(^{(5)}\) Minimum staffing requirements, with 2-hr response times, accommodate off-shift hours when Area G is normally not staffed with onsite personnel.

\(^{(6)}\) Minimum staffing requirements may be less than the minimum requirement defined above for a period of time not to exceed 2 hrs in order to accommodate unexpected absence of on-duty personnel, provided immediate action is taken to restore the minimum staffing requirements. This is not applicable to “C” items listed in the Table.

### 5.6 DESIGN FEATURES

The following SSCs were identified in the HA and are listed in Chapter 3 as safety-significant or safety-class passive DFs. The descriptions are provided in Chapter 2, *Facility Description*, and Chapter 4, *Safety
Structures, Systems, and Components. Note that the vents on TRU waste containers are included in the discussion of the metal waste containers in Section 5.6.4 and are not discussed separately in Section 5.6.

The purpose of the DF section is to describe engineered safety features not covered elsewhere in the TSRs that, if altered or modified, would have a significant effect on safety. The following two areas are addressed in this section:

- DF performance criteria
- Mode/Area Applicability
- ISI actions and frequencies

The ISI is used to ensure compliance with the performance criteria, functional requirements, and safety functions identified for the SSC. The following generic issues are applicable to the ISI of DFs in this TSR:

- Frequency requirements for the ISI are identified for each DF (SSC).
- A 25% extension of the interval specified in the frequency is allowed to facilitate ISI scheduling and considers facility operating conditions that may not be suitable for conducting the ISI (e.g., transient conditions, or other ongoing surveillance or maintenance activities). This extension is not intended to be used repeatedly as an operational convenience to extend ISI frequency intervals beyond those specified.
- If an ISI determines that a DF does not meet its performance criteria, functional requirements, or safety function, that failure is new information, which shall be evaluated for initiation of the Potentially Inadequate Safety Analysis (PISA) process.
- ISIs do not have to be performed on DFs that are out of service or otherwise not required by the TSR.

5.6.1 VEHICLE BARRIERS AT HIGH-RISK LOCATIONS

The vehicle barriers prevent a vehicle impact with TRU waste at high-risk locations, and mitigate the consequences if a loaded transportation vehicle is prevented from impacting additional TRU waste at a high-risk location. The performance criteria for the vehicle barriers are as follows:

- At high-risk locations at TA-54, Area G, the vehicle barrier system (e.g., concrete barriers or alternate design) must be capable of stopping a vehicle (moving at a velocity $\leq 15$ mph) with a gross weight $\leq 150,000$ lb and an impact height of $< 40$ in.
- The barrier system must be placed to ensure that the final position of the barrier, after displacement/movement due to impact, will remain at or beyond the required thermal separation distance for the defined area at a high-risk location.

When vehicle barriers at a high-risk location require relocation, repair, or maintenance, access to the road approaching the high-risk location will be restricted so that no vehicle can make a perpendicular approach toward the defined area that is being protected. While the road closure is in effect, the defined area is not at high risk of vehicle impact.

Applicability: The vehicle barriers are required to meet the performance criteria when the defined area at the high-risk location being protected is in Operation or Warm Standby mode.
The ISI action and frequency is to inspect the physical integrity of the vehicle barrier system annually to identify any abnormalities (e.g., component deterioration, loose connectors, corrosion, cracks, etc.) that may prevent the system from meeting its performance criteria, and to review the vehicle barrier placement and designated routes to ensure that vehicle barriers are present at high-risk locations annually and before changes to designated routes are implemented and before establishing new defined areas.

Vehicle barriers at high-risk locations at TA-54, Area G are designated as safety-class SSCs based on their ability to prevent direct impacts between moving vehicles and TRU waste containers at Area G.

### 5.6.2 PIPE OVERPACK CONTAINERS (POCS)

The POCs are government-supplied equipment, and are credited in the safety basis to provide primary containment for high-activity waste material and mitigate releases of the radioactive material when the container is subjected to mechanical or thermal stresses from postulated accidents.

Pipe overpacks are procured according to specifications on their design capability. The capability of the pipe components to maintain structural integrity during hypothetical accident conditions is due to the design and material construction of the pipe overpack. Testing has demonstrated the ability of the pipe overpack to provide two significant control functions: (1) containment of fine particulate waste material during normal conditions of transport and hypothetical accident conditions, and (2) shielding.

Procurement specifications ensure that the POC can meet its control functions according to WIPP WAC criteria. Design specifications of the various types of POCs can be found in the WIPP WAC [DOE 2013]. The POC is used at Area G according to WIPP WAC specifications to ensure that it performs its control function for DR=0.1.

The performance criterion for the POC is as follows:

- POCs meet WIPP waste acceptance criteria for criticality control, shielding, and containment of waste material.

Applicability: The POCs are required to meet the performance criteria when they contain MAR.

Because the POCs are government-supplied equipment, the ISI that ensures performance criteria are met is the verification that the POC is procured to meet WIPP criteria prior to loading MAR into the POC at the Area G site.

The POCs are designated as safety-class SSCs to protect the assumption that only 10% of the MAR within the containers is credited. Without the DR=0.1 credit, based on the correct procurement of the POC, the basis for the facility to not count up to 90% of the MAR within a POC will not be valid.

### 5.6.3 TYPE B CONTAINERS

Type B containers, typically Transuranic Package Transporter (TRUPACT)-II or half-TRUPACT (HalfPACT) containers, are robust transportation containers designed to withstand accident conditions without releasing radioactive material.

As Area G works toward closure, waste forms may be encountered that require special Type B containers, such as the RH-72B or 10-160B containers. Under these circumstances, these various Type B containers may be used at Area G with valid NRC documentation which indicates that they fulfill the functional requirements and performance criteria.
The specific performance criteria for Type B containers are documented in the respective Safety Analysis Report for packaging.

**Applicability**: Type B containers are required to meet the performance criteria when they are sealed, with radiological material inside.

Type B containers are either government-supplied equipment (e.g., TRUPACT II or HalfPACT) or commercially supplied equipment (e.g., Model 10-160B). Because the containers are supplied by other such entities, the verification that the Type B container has a current inspection sticker or documentation of compliance provided by the manufacturer prior to loading of MAR into the Type B container is specified as the ISI to ensure the performance criteria are met.

Type B containers are designated as safety-class SSCs to protect the assumption that only 0% of the MAR within the sealed containers is credited. Without the DR=0.0 credit, the basis for the facility to not count the MAR within the Type B container will not be valid.

### 5.6.4 TRU WASTE CONTAINERS

The TRU waste in compliant metal containers, as discussed in Chapter 2, is packaged waste in structurally sound, non-combustible containers. The TRU waste in non-metal containers is also considered packaged, though the container may be constructed of combustible material.

The performance criteria for the TRU waste containers are as follows:

- **Structurally Sound**: Compliant TRU waste metal containers with sound integrity reduce the consequence and probability of mechanical effects to confined waste due to impact and spill events. A compliant TRU waste metal container is demonstrated to be of sound integrity based on the hazardous material and waste management controls in accordance with DOE-STD-5506 [DOE 2007] inspection criteria.

- **TRU Waste Packaging**: Packaged TRU waste is packaged to ensure that waste is agglomerated and burns as packaged waste, consistent with the criteria in DOE-HDBK-3010-94 [DOE 2000]. Packaging of TRU waste supports the application of the airborne release fractions (ARFs), respirable fractions (RFs), and DRs assumed in the AAs of fire events.

  Packaging of contaminated combustible waste includes relatively substantial packages such as metal containers and drums. However, less robust waste packages (e.g., FRPs), and even waste placed together in a pile without bag containment, forms a loosely agglomerated package that meets the intent of this control.

- **Non-combustible waste container**: Any closed waste container constructed of a non-combustible material (e.g., metal) is credited with limiting the propagation of fire between non-combustible containers in a TRU storage area. This attribute limits the consequences of a fire by limiting the amount of MAR involved.

**Applicability**: The TRU WASTE CONTAINERS are required to meet the performance criteria when they contain TRU WASTE MAR.

The ISI associated with the compliant metal TRU waste container is a semi-annual inspection of the exposed faces of the containers in above-ground facilities to check for leaks, significant corrosion, or significant damage according to the WIPP container inspection criteria cited in Section 5.5.2.2.13. The semi-annual ISI will inspect 10% of the Area G population of compliant metal TRU waste containers. To
provide a reasonable representation of the compliant container population, the sample of containers to be inspected will be selected from the inventory database, and a selected sample will not include containers that were included in the previous two inspections. If one or more inspected containers fail to meet the WIPP container inspection criteria, the failed container(s) will be remediated or handled as non-compliant containers, and a second 10% sample will be inspected.

The ISI involves an inspection of the exposed face of the drum, on the basis that the condition of the exposed face is indicative of the entire drum or is the part of the drum that would show the most degradation. This is because the unexposed faces are protected from environmental or operational impacts.

The ISI is applicable to a 10% sample of the population of the above-ground inventory of TRU metal containers. This is because handling and movement activities already require constant surveillance of the drums, especially for the presence of vents, given recent operational experience. Also, a TSR-AC requires the facility to implement procedures that require operators to visually inspect compliant metal TRU waste containers for integrity and/or vents when handling or transporting containers. As a result, there is no additional value to performing the inspection on a larger percentage of the above-ground inventory as an ISI.

Non-compliant metal or non-metal TRU waste containers are inspected when handled or transported to confirm that the TRU waste container shows no signs of radiological contamination, and are not subject to the ISI inspection for compliant TRU waste containers.

5.7 INTERFACE WITH TECHNICAL SAFETY REQUIREMENTS FROM OTHER FACILITIES

The Area G HA did not identify any formal TSR relationships between adjacent or nearby LANL facilities due to the remoteness of Area G; however, the waste transportation activities to Area G and from Area G to other LANL sites (excluding RANT) are accomplished under the safety controls provided in the TSD [LANL 2011h]. The TSR interface is defined by the delivery vehicle movement. As with all other nuclear facilities at LANL, the TSD governs and applies during transport along public roads and until the vehicle comes to a complete stop at the required location for unloading, and receipt acceptance of a waste container at the Area G occurs.

Transport of MAR from TA-54, Area G along Mesita del Buey Road to RANT are covered by this BIO, and involve a rolling roadblock escort control for transport between Area G and RANT. The escort is not required once the Transportation Vehicle passes the RANT boundary (i.e., the RANT entrance gate).

Waste containers shipped to TA-54, Area G that fail to comply with the Area G WAC [LANL 2012a, or successor document] are not accepted and are outside the scope of the Area G TSRs. If the waste containers must be accepted, they may have to be treated as non-metal containers, and the controls for non-metal containers would apply for receipt handling, transportation, and storage. For outgoing non-TRU shipments, the Area G TSR governs until the containers are secured on the transport vehicle and the shipment is accepted for transport. For Type B containers, the Area G TSRs apply to TRU containers until the containers are inside a Type B container and the respective Type B container’s lid is sealed.
5.8 REFERENCES


<table>
<thead>
<tr>
<th>Reference Code</th>
<th>Document Title and Details</th>
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<tr>
<td>LANL 2009b</td>
<td>SD 130, <em>Nuclear Criticality Program</em>, Los Alamos National Laboratory, Los Alamos NM, September 30, 2009</td>
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<tr>
<td>LANL 2009c</td>
<td>SD 330, <em>Los Alamos National Laboratory Quality Assurance Program</em>, Los Alamos National Laboratory, Los Alamos NM, July 9, 2009</td>
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<tr>
<td>LANL 2010a</td>
<td>AD-NHHO-10-373, Rev.1, <em>Submital of Justification for Page Changes to Modify Section 5.6.8.1 Drum Drop Height and Handling Limits Specific Administrative Controls</em>, Los Alamos National Laboratory, Los Alamos NM, December 2010</td>
</tr>
<tr>
<td>LANL 2011c</td>
<td>P 121, <em>Radiation Protection</em>, Los Alamos National Laboratory, Los Alamos NM, June 1, 2011</td>
</tr>
<tr>
<td>LANL 2012b</td>
<td>P 950, <em>Conduct of Maintenance</em>, Los Alamos National Laboratory, Los Alamos, NM, January 26, 2012</td>
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CHAPTER 6 PREVENTION OF INADVERTENT CRITICALITY
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### Acronyms and Abbreviations

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<thead>
<tr>
<th>Ans</th>
<th>American Nuclear Society</th>
</tr>
</thead>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>BIO</td>
<td>Basis for Interim Operation</td>
</tr>
<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>FGE</td>
<td>fissile gram equivalent</td>
</tr>
<tr>
<td>FOD</td>
<td>Facility Operations Director</td>
</tr>
<tr>
<td>LANL</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>NCS</td>
<td>nuclear criticality safety</td>
</tr>
<tr>
<td>NCSE</td>
<td>Nuclear Criticality Safety Evaluation</td>
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<td>NCSG</td>
<td>Nuclear Criticality Safety Group</td>
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<td>NCSP</td>
<td>Nuclear Criticality Safety Program</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Area</td>
</tr>
<tr>
<td>wt. %</td>
<td>weight percent</td>
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</tbody>
</table>
6.0 PREVENTION OF INADVERTENT CRITICALITY

This chapter provides information that supports the safety basis in accordance with the identified Safe Harbor from Table 2, Appendix A of 10 CFR 830, Subpart B [CFR 2011], which is the Department of Energy (DOE) Standard 3009-94, CN3 [DOE 2006]. All controls, administrative requirements, and engineered features have been reviewed (applying the eight criteria identified in DOE-STD-3007-2007 [DOE 2007], Section IV, Linkage to the Documented Safety Analysis) for possible inclusion in this Basis for Interim Operation (BIO). No administrative requirements or engineered features (active or passive) beyond the Nuclear Criticality Safety Program (NCSP) itself currently warrant elevation to the credited control set discussed in Chapter 4.

6.1 INTRODUCTION

The NCSP is established and maintained for Technical Area (TA)-54, Area G operations in accordance with Los Alamos National Laboratory (LANL) requirements, SD 130, Nuclear Criticality Program [LANL 2009], or successor documents. This institutional document implements requirements set forth in DOE Order 420.1B, Facility Safety [DOE 2005], which delineates DOE expectations for a criticality safety program.

The NCSP provides the fundamentals to establish and maintain the safety factors (with sufficient margins) used to prevent nuclear criticality accidents. The NCSP provides guidance for response to criticality safety infractions and for the possible needs of a criticality alarm system. The NCSP reviews and inspects fissionable material operations to ensure subcritical configurations in all normal and credible abnormal conditions in accordance with SD 130 [LANL 2009], or successor documents.

Using a graded approach, this chapter summarizes the essential features of the NCSP as it relates to safety at TA-54, Area G.

6.2 REQUIREMENTS

Mandatory requirements are identified in Contract No. DE-AC52-06NA25396 [LANL 2008], Part III, Section J, Appendix G, List of Applicable Directives. The requirements pertinent to this chapter have been identified in LANL documents to include:

- 10 CFR 830, Nuclear Safety Management [CFR 2011]
- DOE Order 420.1B, Facility Safety [DOE 2005]
- ANSI/ANS-8 series, Nuclear Criticality Safety, American National Standards Institute [various dates]

6.3 CRITICALITY CONCERNS

Processes at TA-54, Area G involve the handling of low-level waste, mixed low-level waste, hazardous waste, tritium-contaminated waste, and transuranic waste containers generated by various sites at LANL. Waste containers that are received into TA-54, Area G must meet the LANL waste acceptance criteria [LANL 2012b] or have an approved exception. The waste is commonly packaged in 55-gal drums, although other containers, such as standard waste boxes, are used as well. Typically, the contents of waste containers are composed of fissionable material contaminated items such as gloves, wipes, bags,
empty containers, filters, tools, dismantled process equipment, and laboratory vessels generated as byproducts of normal operations, as well as decommissioned gloveboxes. The fissionable material is present as contamination, typically small mass quantities of plutonium or uranium, heterogeneously and randomly distributed on or impregnated within the surfaces of the items being discarded.

Historically, waste containers at LANL generally contained an average mass of approximately 30 fissile gram equivalent (FGE) $^{239}$Pu, with very few loaded with greater than 300 FGE $^{239}$Pu. Uranium enrichments vary from depleted to highly enriched (greater than 80 weight percent [wt. %]). The plutonium is typically weapons-grade, which is about 6 wt. % $^{240}$Pu. The exception is waste generated by heat source program applications, which is primarily composed of $^{238}$Pu. Depleted uranium or $^{238}$Pu is not a practical criticality concern because, while fissionable, it is not fissile. Criticality accidents are judged to be incredible for individual processes at TA-54, Area G and, consistent with the terminology in ANSI/ANS 8.3 [ANSI 1997], the rollup of the risk from the individual processes is judged to yield a trivial risk of criticality for the entire facility.

The locations and processes are described in Chapter 2 of this TA-54, Area G BIO.

6.4 CRITICALITY CONTROLS

Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal process conditions. All fissionable material operations are evaluated in accordance with SD 130 [LANL 2009]. For operations determined to have significant quantities of fissionable material, a criticality safety evaluation is performed to ensure that the entire process will be subcritical as prescribed in SD 130 or successor document. A nuclear criticality safety evaluation (NCSE) is an assessment that may result in administrative requirements and engineered features that reduce the risk of an inadvertent criticality accident to an acceptable level. This risk reduction is achieved by a consensus agreement within the operating organization as to the administrative requirements and engineering features (controls) needed to establish the required safety margin. The preferred order is (1) engineering features, followed by (2) administrative requirements. Controls are therefore chosen to

- Reduce or eliminate the likelihood of an upset,
- Reduce or eliminate the consequence of an upset, i.e., ensure subcriticality after the upset has occurred, or
- Restrict and define the system (set boundaries for assessing normal and credible abnormal conditions) so as to make the analysis tractable.

6.4.1 ENGINEERING CONTROLS

Engineered features are determined when a requisite criticality safety evaluation is applicable. These controls are based on physical design limitations placed on equipment size, shape, and location, or on physical limitations of chemical processes. Such controls are known as engineered features. Engineered features require configuration management to prevent unauthorized changes from affecting the ability of the feature to function as intended. Requirements for engineered features are more fully described in SD 130 [LANL 2009], or successor documents.

6.4.2 ADMINISTRATIVE CONTROLS

Administrative requirements for criticality safety at TA-54, Area G rely on approved, written work control documents and on the action, judgment, responsibility, and training of personnel. The evaluations
identify and define process-applicable administrative requirements that are implemented through procedures and other work documents.

Restricting the quantity of fissionable mass is a common administrative requirement used to ensure criticality safety. Requirements for administrative controls are more fully described in SD 130 [LANL 2009] or successor documents.

6.4.3 APPLICATION OF DOUBLE CONTINGENCY PRINCIPLE

The fundamental LANL nuclear criticality safety (NCS) margin requirement, adopted from ANSI/ANS-8.1 [ANSI 2007], Section 4.1.2, Process Analysis, is

Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under normal and credible abnormal conditions.

Implementation, in the LANL NCS program, is achieved by application (as required by DOE 2007) of the Section 4.2.2, Double Contingency Principle recommendation in ANSI 2007:

Process designs should incorporate factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

When implemented correctly, these requirements work together to achieve the stated programmatic goal, i.e., prevention of nuclear criticality accidents. It is important to recognize that the possibility of malicious or intentional damage is not considered in establishing the required safety margin, as it is the purview of other programs, e.g., Human Reliability.

Note that, in certain situations, the double-contingency principle may be met by control of only a single parameter, such as in the application of the single parameter limits specified in ANSI 2007. In such a case, the second parameters are maximized to the limits allowed by the nature of the process. It is therefore not credible to lose control of the second parameters to such and extent that a criticality accident ensues, and control of only one parameter meets the double-contingency requirement.

The concept of the safety margin requirement and the consideration of the Double-Contingency Principle are described in SD 130 [LANL 2009] or successor documents.

6.5 CRITICALITY SAFETY PROGRAM

Establishing and implementing criticality safety under the NCSP is a line management responsibility, with significant support provided by the Nuclear Criticality Safety Group (NCSG). Oversight is provided by various review mechanisms such as focused or special review committees (e.g., the institutional Nuclear Criticality Safety Committee, the NCSG, management self-assessments, and external review entities). The Laboratory has long recognized the importance of a multifaceted criticality safety program to minimize the risk of a criticality accident.

The NCSP is implemented according to the criteria of SD 130 [LANL 2009], or successor documents.
6.5.1 CRITICALITY SAFETY ORGANIZATION

SD 130 [LANL 2009], or successor documents, delineates the expectations for a NCSP at TA-54, Area G and establishes, by program elements, the roles and responsibilities of personnel involved with operations with fissionable materials.

6.5.2 CRITICALITY SAFETY PLANS AND PROCEDURES

Document control and change control measures are employed to ensure that criticality safety plans and procedures are reviewed, properly approved, distributed, and used at the locations where fissionable materials are used, processed, or stored. The TA-54, Area G procedures discuss the process of requesting, receiving, and implementing requirements for changed or new activities.

The TA-55 Area G NCSP uses various types of procedures. As a part of the review and approval process, the NCSG reviews procedures involving processing, handling, staging, or transporting significant quantities of fissionable materials. Operating groups review their procedures periodically for content and correctness. Procedures are revised whenever a change is made to an operation.

6.5.3 CRITICALITY SAFETY TRAINING

Because of the nature of the operations and associated limits at TA-54, Area G, the workers handling the waste containers are not considered fissionable material handlers (i.e., their actions do not affect the criticality safety basis of the operations), with the exception of their compliance to the limits under their direct control. Therefore, operators are trained on the necessity for maintaining those parts of the limits under their direct control (e.g., storage configuration). This is accomplished at TA-54, Area G by direct inclusion of the relevant criticality safety controls into the applicable operating procedures and by training the operators to the procedures. Any safety training that further emphasizes these limitations, for example, Occupational Health and Safety or Technical Safety Requirements, serves as the conduit for ensuring that this information is reinforced to the operating personnel.

Those personnel in positions of management authority over the receipt of waste containers at TA-54, Area G, the Facility Operations Director (FOD), and/or the FOD designate that may direct workers must also receive training on the criticality safety limits in particular, and on the need to enforce the limits at the appropriate stage of waste container handling.

6.5.4 DETERMINATION OF OPERATIONAL NUCLEAR CRITICALITY LIMITS

The determination of operational NCS limits is based on the fundamental guidance for NCS from ANSI 2007, Section 4.1.2, Process Analysis, which states the following:

Before a new operation with fissionable materials is begun or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions.

An important aspect of the NCSE is the communication between the NCSG and operations personnel that includes determining the range and credibility of potential abnormal conditions (or credible upsets). The abnormal conditions are explicitly evaluated in terms of their effects on the parameters that affect criticality, such as mass, volume, concentration/density, moderation, reflection, poisons, enrichment, interaction (spacing), and geometry (shape). Criticality safety limits are developed jointly by operations personnel (including management as appropriate) and NCSG staff, and are process- or operation-specific.
The evaluations are performed using professional judgment and a graded approach for the particular activity. Evaluations may include, but are not limited to, comparison to experimental values, comparison to generally accepted subcritical or critical limits, simple computational methods, and computer code results.

The evaluations are peer-reviewed for adequacy and technical correctness. Completed evaluations are the basis of the criticality safety of the operations and, as such, belong to the operation’s owning organization. Copies are kept on file by the NCSG.

### 6.5.5 CRITICALITY SAFETY INSPECTIONS/AUDITS

Each operating organization assisted by the NCSG conducts periodic safety reviews of its operations that involve significant quantities of fissionable material. In addition, the Laboratory Nuclear Criticality Safety Review Committees perform reviews as outlined in directives, procedures, and charters required by the Director of the Laboratory. Results and recommendations are reported to the Office of the Director.

Criticality Safety inspection and audit requirements are described in SD 130 [LANL 2009], or successor documents. Auditing is performed by various organizations using ANSI/ANS 8.19 [ANSI 2005] criteria.

### 6.5.6 CRITICALITY INFRACTION REPORTING AND FOLLOW-UP

At the Laboratory, all criticality safety limit infractions are reviewed according to the applicable DOE orders and Laboratory program or procedure. These reviews are based on an evaluation of the criticality limit infraction. This process includes determining the severity of the infraction and reporting commensurate with the severity level in accordance with SD 130 [LANL 2009] and P 322-3, *Performance Improvement from Abnormal Events* [LANL 2012a], or successor documents. Lessons learned from operational experience and criticality-limit infractions are incorporated into NCSEs, as appropriate.

### 6.6 CRITICALITY INSTRUMENTATION

The need for a criticality alarm system shall be evaluated in accordance with SD 130 [LANL 2009], or successor documents. Installation of an alarm system implies a “nontrivial” risk of criticality. The purpose of an alarm system is to reduce risk to personnel. Evaluation of the overall risk should recognize that hazards may result from false alarms and subsequent sudden interruption of operations and relocation of personnel, ANSI/ANS-8.3-1997, *Criticality Accident Alarm System* [ANSI 1997].

Currently, TA-54, Area G does not use a criticality alarm system. Application of the *Process Analysis* requirement of ANSI/ANS-8.1 [ANSI 2007] requires that any single operation remain subcritical under normal and credible abnormal conditions. Criticality, therefore, can only be non-trivial (language required by ANSI/ANS-8.3 [ANSI 1997]) if the cumulative likelihood (due to the number and complexity of operations) rises to that level. For TA-54, Area G, it is the judgment, based on the simplicity of the operations, the nature of the operations (handling but not processing), and the number of operations, that cumulative likelihood of criticality is trivial. As an elaboration, criticality is precluded due to the nature of waste as compared to the computational model developed to analyze the criticality safety of the operations. Because all of the relevant parameters were maximized in the model, it is not possible for credible upsets at TA-54, Area G to create a more reactive condition that has been demonstrated to be subcritical. Therefore, a criticality alarm system is not required by ANSI/ANS 8.3, *Criticality Alarm System* [ANSI 1997].
6.7 REFERENCES


LANL 2009 SD 130, Nuclear Criticality Program, Los Alamos National Laboratory, Los Alamos, NM, September 2009.

LANL 2012a P322-4, Performance Improvement from Abnormal, Los Alamos National Laboratory, Los Alamos, NM, September 2012.