CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

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CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

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REVISION STATUS

CHAPTER	AFFECTED SECTIONS	REVISION	DATE
ES	All	20	8/2017
1	All	20	8/2017
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REVISION LOG

Rev.	Date	Chapters Affected	Description of Changes
0	12/2002	All Chapters	Initial Issue
1	11/2003	2, 3, 4, 5, 6	See Revision 14 for description of changes.
2	12/2003	ES, 1, 7-17	See Revision 14 for description of changes.
3	12/2004	ES, l, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 18	See Revision 14 for description of changes.
4	2/2006	ES, l, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 18, 18	See Revision 14 for description of changes.
5	6/2006	2, 3, 4, 5, 13, 18	See Revision 14 for description of changes.
6	10/2006	All Chapters	See Revision 14 for description of changes.
7	2/2007	All Chapters	See Revision 14 for description of changes.
8	11/2007	2, 3, 4, 5, 6, 16	See Revision 14 for description of changes.
9	5/2008	2, 3, 4, 5, 6, 14, 18	See Revision 14 for description of changes.
10	3/2009	All Chapters	See Revision 14 for description of changes.
11	2/2010	All Chapters	See Revision 14 for description of changes.
12	2/2011	All Chapters	See Revision 14 for description of changes.
13	2/2012	1, 2, 3, 4, 5, 6, 10, 11, 13, 15, 16, 18, 18	See Revision 14 for description of changes.
14	7/2012	ES, 2, 3, 4, 5, 6, 8	➢ Incorporated CRFs: HLW-CRF-12004, HLW-CRF-12006, HLW-CRF-12007 ➢ Revised to include Type I/II Waste Tank Chemical Cleaning including resolution of the PISA against F-Tank Farm Type I Waste Tank Chemical Cleaning process

Rev.	Date	Chapters Affected	Description of Changes
15	9/2013	All Chapters	➢ Incorporated CRFs: HLW-CRF-12008, HLW-CRF-12009, HLW-CRF-12011, HLW-CRF-12012, HLW-CRF-12013, HLW-CRF-13002, HLW-CRF-13004, HLW-CRF-13005, HLW-CRF-13007 ➢ Updated Minimum Staff requirements for Control Room Manager ➢ Deleted the H-Area Tank Farm – Chemical Addition System ➢ Clarified requirements for the Chemical Inventory Control Program and Table 3.3-5 ➢ Updated Table 3.4-1 for revised max ventilation flow values ➢ Added a degraded flow aspect for the Transfer Facility Ventilation Systems ➢ Revised the following Programs: Configuration Management, Structural Integrity, WAC, Prohibited Operations, Tank Fill Limit ➢ Modified operability statements and actions associated with transfer facility cell covers ➢ Clarified installed/portable diesel generator requirements

Rev.	Date	Chapters Affected	Description of Changes
16	6/2014	ES, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 14, 16, 18, 18	➢ Incorporated CRFs: HLW-CRF-14002, HLW-CRF-14003, HLW-CRF-14005, HLW-CRF-14006 ➢ Aligned Sub-Section titles to match DOE-STD-3009 where appropriate ➢ Updated References ➢ Clarified Unmitigated/Mitigated Progressions, Source Term derivations ➢ Clarified Aerosolization events ➢ Updated Table 5.9-1 for Administrative Controls ➢ Added Waste Tank Overheating scenario for waste tank annulus ➢ Deleted Waste Box Control Program ➢ Revised Static Waste Tank Overheating scenario to Not Credible ➢ Modified Process Area and Mode Applicabilities for jetting of sump ➢ Added new Conditions to facilitate maintenance during cell cover removal in pump pits and ventilated diversion boxes ➢ Updated list of external sources of liquid radioactive waste to the CSTF ➢ Revised verification methodology to conform to current Manual 2S requirements ➢ Made changes for resolution of PISA PI-2014-0001

Rev.	Date	Chapters Affected	Description of Changes
17	6/2015	All Chapters	➢ Incorporated CRFs: HLW-CRF-14007, HLW-CRF-14008, HLW-CRF-14009, HLW-CRF-14011, HLW-CRF-15001, HLW-CRF-15002, HLW-CRF-15003, HLW-CRF-15004, HLW-CRF-15005 ➢ Updated to new SRS Site Characteristics and Program Descriptions (SCPD) document ➢ Added sub headings to Chapter 3 ➢ Modified to recognize consolidation of 242-1F and 241-74F Control Rooms ➢ Removed Mechanical Cleaning for Type IV waste tanks ➢ Updated References ➢ Modified/clarified actions and supporting text for Event Response and Severe Weather Response ➢ Changed the Preventive Maintenance Program to the Nuclear Maintenance Management Program ➢ Updated portions of DSA Chapter 5 for TSR Methodology Manual Rev. 6 changes ➢ Modified Requirements Section in DSA Chapters 1 and 7-17 for consistent approach ➢ Added Prohibited Operation and clarified information regarding fuel powered vehicles/equipment (other than diesel powered) used within Building 299-H ➢ Added isolation requirements to consider system “non-continuous makeup capability” (electrical or mechanical isolation shall contain two independent means of isolation) ➢ Added information about accounting for analytical uncertainty ➢ Updated Low-Rem transfer criteria for Type IV waste tanks ➢ Modified Pump Run Program and Salt Dissolution/Interstitial Liquid Removal Program

Rev.	Date	Chapters Affected	Description of Changes
18	3/2016	ES, 2, 3, 4, 5, 6	➢ Incorporated CRFs: HLW-CRF-15006, HLW-CRF-15007, HLW-CRF-15008, HLW-CRF-15009 ➢ Updated text associated with Tank 16 to recognize tank has been filled with grout ➢ Updated Chapter 3 to recognize new Trapped Gas Release CHA ➢ Revised text to recognize pump speed evaluation of the Transfer Control Program ➢ Modified waste tank primary and annulus volumes based on changes to inputs ➢ Defined terms “settled sludge” and “slurried sludge” per new input ➢ Created new “Controls for Waste Tanks Undergoing Planned Gas Release Activities” subsection ➢ Revised “Waste Tank Quiescent Time Program” subsection

Rev.	Date	Chapters Affected	Description of Changes
19	6/2016	ES, 1, 2, 3, 4, 5, 6, 18	➢ Incorporated CRFs: HLW-CRF-16001, HLW-CRF-16002 ➢ Updated text associated with Tank 12 to recognize the tank has been closed and backfilled with grout. ➢ Modified text to recognize permitted time delay relays for alarms associated with Conductivity Probes. ➢ Revised text for clarifications associated with issues identified in the Extent of Condition review for the Waste Tank Siphon PISA. ➢ Revised text to address changes made to the Mercury Management Program and addition of new controls (Evaporator Mercury Monitoring LCO). Added new Evaporator Modes. This change resolves PISA PI-2015-0001. ➢ Updated References. ➢ Added discussion pertaining to the Tank 50 to Z-Area events in the NPH DBA Sections of Chapter 3. ➢ Added safety function for Very Slow Generation Tanks when receiving a steam jetted transfer. Modified LCO 3.8.1 for applicability of Very Slow Generation Tanks during receipt of a steam jetted transfer. ➢ Modified LCO 3.7.4 (Valve Box, Drain Valve Box, and HPFP Leak Detection Instruments) and created new LCO 3.7.14 (Valve Box, Drain Valve Box, and HPFP Level) to address residual waste levels. ➢ Revised basis discussion for restoring ventilation on pump tanks to account for the presence of the pump tank passive vent and dissolved hydrogen release from a steam jetted transfer from a source less than or equal to 1,200 gallons.

Rev.	Date	Chapters Affected	Description of Changes
20	8/2017	All Chapters	➢ Incorporated CRFs: HLW-CRF-16003, HLW-CRF-17001, HLW-CRF-17002, HLW-CRF-17003 ➢ Modified the status of the 242-16F Evaporator such that it is an "Inactive Location" per the DSA/TSR (does not require additional hazard/accident analysis). ➢ Modified the status of Valve Box 15/16 such that it is an "Inactive Location" per the DSA/TSR (does not require additional hazard/accident analysis). ➢ Updated ventilation system setpoints (and references) for closure of PISA PI-2016-0010 (Errors Associated with Waste Tank Purge Ventilation System "Degraded" Flow Calculation and Setpoints) and associated ESS (U-ESS-H-00012). ➢ Updated Work Product Disclaimer at the beginning of each DSA chapter to the new Disclaimer for AECOM N&E Technical Services, LLC. ➢ Clarified discussion pertaining to radiological versus chemical consequences and added new reference report (G-ESR-H-00232). ➢ Modified "non-waste" transfer definition/criteria with respect to chemical EGs. ➢ Clarified DSA use of radiolytic hydrogen generation rate for Type IV tanks. ➢ Added clarifying discussion to the Valve Box Explosion sub-DBA recognizing that a deflagration could occur for the Tank 40 VB and Tank 51 VB (when the waste material is ESP Sludge Slurry), but that the progression for this DBA (explosion with follow-on spill) is assumed to not occur for mitigated analysis and no consequences are attributed to a VB explosion. ➢ Modified reported "Tank 50" type consequence from the LPDT Cell explosion to the Tank 50 VB explosion. ➢ Added bases justifying why no change is necessary for "required setpoints" for ventilation flow related to in-leakage allowances permitted by Level 4 duct class.

CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 3

HAZARD AND ACCIDENT ANALYSES

Revision 20
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ACRONYMS AND ABBREVIATIONS

AA	Accident Analysis
ADMP	Advance Design Mixer Pump
AED	Aerodynamic Equivalent Diameter
AEGL	Acute Exposure Guideline Limit
AICC	Adiabatic, Isochoric, Complete Combustion
ALOHA	Areal Locations of Hazardous Atmospheres
AMAD	Activity Median Aerodynamic Diameter
ARF	Airborne Release Fraction
ARM	Area Radiation Monitor
ARP	Actinide Removal Process
ARR	Airborne Release Rate
ASME	American Society of Mechanical Engineers
BDBA	Beyond Design Basis Accident
BEU	Beyond Extremely Unlikely
BTU	British Thermal Unit
CDT	Contactor Drain Tank
CED	Cumulative Effective Dose
CEDE	Cumulative Effective Dose Equivalent
CFD	Computational Fluid Dynamics
cfm	cubic feet per minute
CHA	Consolidated Hazards Analyses
CHAP	Consolidated Hazards Analyses Process
CFR	Code of Federal Regulations
Ci	Curie
CLFL	Composite Lower Flammability Limit
cm	centimeter
COP	Clean Out Port
CRC	Cesium Removal Column
CRW	Chromate Cooling Water
CSMP	Commercial Submersible Mixer Pump
CSTF	Concentration, Storage, and Transfer Facilities
CTS	Concentrate Transfer System
CW	Co-Located Worker
DB	Diversion Box

ACRONYMS AND ABBREVIATIONS (continued)

DBA	Design Basis Accident
DBE	Design Basis Earthquake
DCF	Dose Conversion Factor
DCS	Distributed Control System
DDT	Deflagration To Detonation Transition
DEGADIS	Dense Gas Dispersion
DID	Defense-in-Depth
DOE	Department of Energy
DOT	Department of Transportation
DR	Damage Ratio
DSA	Documented Safety Analysis
DSS	Decontaminated Salt Solution
DWPF	Defense Waste Processing Facility
DWS	Dissolution Water Skid
EG	Evaluation Guideline
EM	Environmental Management
EPA	Environmental Protection Agency
ERIP	Encasement Riser Inspection Port
ERPG	Emergency Response Planning Guideline
ESP	Extended Sludge Processing
ETP	Effluent Treatment Project
FDB	F-Area Diversion Box
FPP	F-Area Pump Pit
FPT	F-Area Pump Tank
ft/sec	feet per second
FTF	F-Area Tank Farm
FW	Facility Worker
g	gram
gal	gallon
GDL	Gravity Drain Line
gpm	gallons per minute
HA	Hazard Analysis
HAZOP	Hazard and Operability

ACRONYMS AND ABBREVIATIONS (continued)

HC	Hazard Category
HDB	H-Area Diversion Box
HE	Hazard Evaluation
HEP	Human Error Probability
HEPA	High-Efficiency Particulate Air
Hg	Mercury
HLLCP	High Liquid Level Conductivity Probe
HLW	High Level Waste
HPFP	High Point Flush Pit
HPP	H-Area Pump Pit
HPT	H-Area Pump Tank
hr	hour
HRA	Human Reliability Analysis
HTF	H-Area Tank Farm
IAL	Inter-Area Line
IC	Initial Condition
ICRP	International Commission on Radiological Protection
$IDCF_i$	Inhalation Dose Conversion Factor
ITS	Important-to-Safety
IW	Inhibited Water
kg	kilogram
lbm	pound mass
L/D	Length to Diameter
LDB	Leak Detection Box
LEL	Lower Explosive Limit
LFL	Lower Flammability Limit
LOD	Lines of Defense
LPDT	Low Point Drain Tank
LPF	Leak Path Factor
LPS	Leak Probe Sleeve
LWPT	Late Wash Precipitate Tank
MACCS	MELCOR Accident Consequence Code System
MAR	Material at Risk

ACRONYMS AND ABBREVIATIONS (continued)

MBTU	Million British Thermal Units
MCU	Modular Caustic Side Solvent Extraction Unit
mg	milligram
MHA	Mitigated Hazard Analyses
MIC	Microbiologically Induced Corrosion
min	minute
ML	Maximum Likelihood
MLDB	Modified Leak Detection Box
MOI	Maximally Exposed Offsite Individual
MRT	Mercury Removal Tank
MST	monosodium titanate
N/A	Not Applicable
NFPA	National Fire Protection Association
NGS	Next Generation Solvent
NMMP	Nuclear Maintenance Management Program
NPH	Natural Phenomena Hazard
OEP	Onsite Evaluation Point
OSHA	Occupational Safety and Health Administration
OA	oxalic acid
PAC	Protective Action Criteria
PC	Performance Category
PCV	Pressure Control Valve
PEL-TWA	Permissible Exposure Limit - Time-Weighted Average
PLC	Programmable Logic Controller
PP	Pump Pit
ppm	parts per million
PRV	Pressure Relief Valve
psig	pounds per square inch gauge
PTA	Pulse Tube Agitator
PVV	Process Vessel Ventilation
rem	roentgen equivalent man
RF	Respirable Fraction

ACRONYMS AND ABBREVIATIONS (continued)

RF′	Release Fraction
rpm	revolutions per minute
RQ	Reportable Quantity
s	second
s/m^3	seconds per cubic meter
SAR	Safety Analysis Report
sec	second
SC	Safety Class
scfm	standard cubic feet per minute
SEHT	Strip Effluent Hold Tank
SHT	Solvent Hold Tank
SIH	Standard Industrial Hazard
SIRIM	Site Item Reportability and Issue Management
SMP	Submersible Mixer Pump
SPCC	Spill Prevention Control and Countermeasure
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SRSOC	SRS Operations Center
SS	Safety Significant
SSCs	Structures, Systems, and Components
ST	Source Term
STP	Standard Temperature and Pressure
t	time
TED	Total Effective Dose
TEDE	Total Effective Dose Equivalent
TEEL	Temporary Emergency Exposure Limit
THERP	Technique for Human Error Rate Prediction
TNT	Trinitrotoluene
TOA	Trioctylamine
TPB	tetraphenylborate
TPQ	Threshold Planning Quantity

ACRONYMS AND ABBREVIATIONS (continued)

TQ	Threshold Quantity
TRU	Transuranic
TSR	Technical Safety Requirement
VB	Valve Box
VFD	Variable Frequency Drive
vol. %	volume percent
WAC	Waste Acceptance Criteria
WCT	Waste Collection Tank
WOW	Waste on Wheels
wt. %	weight percent
yr	year

3.0 HAZARD AND ACCIDENT ANALYSES

3.1 INTRODUCTION

Chapter 3 identifies and assesses potential hazards associated with the operation of the Concentration, Storage, and Transfer Facilities (CSTF).

A Hazard Analysis (HA), performed for the facility, is the basis for identification of Safety Significant (SS) Structures, Systems, and Components (SSCs) and administrative controls to protect the Onsite worker. The term Hazard Analysis, or HA, as used throughout the Documented Safety Analysis (DSA) refers to the initial CSTF hazards analyses (Ref. 1) and supplemental hazards analyses (Ref. 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) performed thereafter. A Design Basis Accident (DBA) analysis, performed using the results of the HA, is the basis for the identification of Safety Class (SC) and SS SSCs and administrative controls to protect the Offsite public.

Reference 242 is an amalgamation of a number of Consolidated Hazards Analyses (CHA) for the Concentration, Storage and Transfer (CST) Facility which includes F-Tank Farm (FTF) and H-Tank Farm (HTF) (West and East) of the Savannah River Site (SRS) into one cohesive Consolidated Hazards Analysis (CHA) document. The processes considered in the CST Facility for the CHA include:

- Submersible Mixer Pump (SMP)
- Waste On Wheels (WOW)
- 241-96H Actinide Removal (96H)
- Modular Caustic Side Solvent Extraction Unit (MCU)
- Waste Tank Hydrolancing

Reference 265 is the CHA for the Dissolution Water Skid (DWS) which may be used to add water to a waste tank to dissolve saltcake.

Reference 266 is the CHA for the Chromate Water Deionizer which may be used to remove radioactive contaminates from the Chromate Cooling Water System.

Reference 274 is the CHA for Chemical Cleaning of Type I and II Waste Tanks.

Reference 281 is the CHA for Waste Tank Grouting.

Reference 290 is the CHA for Mercury Hazards in the CSTF.

Reference 293 is the CHA for Contaminated Rainwater Removal from a Waste Box.

Reference 295 is the CHA for Commercial Submersible Mixer Pumps (CSMPs).

Reference 300 is the CHA for 242-16H (2H) Evaporator Chemical Cleaning.

Reference 307 is the CHA for Trapped Gas Release.

3.1.1 HAZARD ANALYSIS

Accidents from the hazards associated with CSTF operations were postulated, and their frequency of occurrence and consequences were evaluated qualitatively in the HA (Ref. 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, 307). The HA performs the following functions:

- Systematically identifies and assesses the hazards that are present within the facility;
- Evaluates the potential for hazards to develop into accidents;
- Identifies a selected subset of accidents, designated DBAs, to be formally defined in Accident Analysis (AA); and
- Identifies the Lines of Defense (LOD) within the facility that form the basis for Defense-in-Depth (DID) against adverse consequences to the workers and public from accidents.

SSCs that make up LOD are considered in the analysis as candidates for SC or SS items but are not credited in the HA when evaluating the hazards. SS SSCs and credited administrative controls specific to HA events are identified and presented in Tables 3.3-13, 3.3-14, and 3.3-15. The applicability of the controls is discussed in Section 3.4 and Chapter 5. The items designated as SC or SS SSCs or requiring Technical Safety Requirement (TSR) controls are specified in Chapters 4 and 5.

Additionally, the HA postulates bounding accident scenarios resulting from these hazards and evaluates frequencies of occurrence and consequences in a qualitative/semi-quantitative, conservative manner. These scenarios are binned into one of eleven risk categories according to frequency of occurrence and severity of consequence. More rigorous analyses are performed for accidents with the potential to subject the public to risks that challenge the established Evaluation Guidelines (EGs).

3.1.2 ACCIDENT ANALYSIS

The accidents selected from the HA with potentially significant risks to the Onsite 2 worker and Offsite public (see Section 3.3.2.2.10) are presented in Table 3.3-17. Loss of Offsite Power was analyzed as a DBA independent of the initial HA (Ref. 1) process. Various events from the HA were not considered for analysis based on assumption defense, low/negligible consequences, and further assessment of credibility. Table 3.3-11 provides the rationale for the events not considered for additional analysis, and, hence, controls selection. The remaining events from the HA with potentially significant risks to the Onsite 2 worker and Offsite public are considered to be DBAs and are analyzed in Section 3.4.2. The DBAs also include Natural Phenomena Hazards (NPHs) and external events.

For each DBA, a detailed accident progression is defined, and the Onsite 2 worker and Offsite radiological or chemical consequences are analyzed quantitatively (qualitatively for cases that obviously exceed the Onsite 2 and challenge Offsite EGs) using reasonably conservative assumptions regarding the failure of SSCs, boundaries that could prevent or mitigate the release, as well as conservative treatments of the quantity and nature of the released material. Onsite 2 and Offsite consequences are compared to EGs. If the Offsite EGs are challenged or Onsite 2 EGs are exceeded, mitigative or preventive SSCs or administrative controls are credited (and subsequently controlled) as necessary to reduce these risks so that the EGs are not challenged/exceeded. These SSCs and administrative controls are identified as SS or SC items and are subject to TSR controls.

Subsequent to initial DBA development, many of the control room functions historically performed using the 242-1F, 241-74F, 242-1H, 241-74H, and 241-82H Control Rooms were transitioned to the 241-2H Control Room. Additionally, many of the control room functions historically performed using the 241-18F Control Room will be transitioned to the 241-2H Control Room (see Section 2.4.1.2). The effect of H-Area and F-Area control room consolidation was evaluated against the inputs and assumptions used in DBA preparation and no adverse impacts were identified (Ref. 215, 283).

The consequences from chemical releases, when coincident with a radiological release, are not quantified since they are either bounded by the consequences of the radiological release or the quantity and nature of the released material does not exceed the chemical EGs (Ref. 73, 239, 314). The chemical to radiological consequence comparison in Reference 239 was based upon the maximum solvent carryover concentrations from the Modular Caustic Side Solvent Extraction Unit (MCU) process to Tank 50 as discussed in Section 3.4.1.5.2. Per Reference 311 the chemical evaluation performed for the BOBCalix-based solvent components remains valid for Next Generation Solvent (NGS) components. SC and SS SSCs and controls that are required to limit any radiological consequences so that they do not challenge the radiological EGs for Offsite or exceed the radiological EGs for Onsite will also reduce the chemical consequences so that they do not exceed the chemical EGs.

The consequences from pure chemical releases that were not screened out in the HA (Ref. 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) have been determined to be Standard Industrial Hazards (SIHs), with the exception of elemental mercury vapor produced by the Waste Evaporators (see Section 3.4.2.21) and mercury vapor releases from operations involved with Type I/II Acidic Chemical Cleaning Waste Tanks and Chemical Cleaning Transfers. For operations involved with Type I/II Acidic Chemical Cleaning Waste Tanks and Chemical Cleaning Transfers, Reference 274 qualitatively determined that mercury exposure to personnel could exceed the applicable Onsite EGs only for the FW in the immediate vicinity of the event. Therefore, these HA events are not analyzed as a DBA and not included in Section 3.4.2.21. SS SSCs and controls for these mercury exposure related events are identified in Tables 3.3-14 and 3.3-15 to reduce the chemical consequences so that they do not exceed the chemical EGs. It is not the intention of the DSA to cover safety as it relates to the common industrial hazards in which national consensus codes and/or standards (e.g., Occupational Safety and Health Administration [OSHA] regulations) already define and regulate appropriate practices without the need for special analysis. The CSTF is designed to handle Standard Industrial Chemical

Hazards as described under Procedure Manual 4Q (Ref. 82), WSRC-IM-95-58 (Ref. 81), and Engineering Standards Manual WSRC-TM-95-1 (Ref. 83), which specify various consensus standards for chemical hazards, storage tanks, chemical process components, etc. regardless of functional classification (i.e., a non-SC or non-SS chemical storage tank would still have to meet these code requirements).

The DBA analysis, although quantitative in nature, is performed using a graded approach that employs a level of detail adequate to demonstrate that EGs for consequences are met with margin, but sufficient to depict safety of the facility in an appropriately conservative fashion. Thus, the magnitude of the analysis effort and the resultant level of detail in the presentation of accidents is dependent upon the particular DBA. The graded approach applied to DSA preparations and updates is intended to balance the need to provide adequate assurance to the Department of Energy (DOE) that a facility has sufficient controls to ensure safe operations while not being unrealistic or overly bounding in the analysis. Based on guidance from Reference 4, the reasonably conservative approach developed for use in the CSTF DSA development effort is discussed below.

3.1.2.1 Detection of Events

There are two cases where crediting of specific equipment is not required for detection of an event in developing the unmitigated accident scenario progression. The first of these is the obvious case of an energetic event such as an earthquake or detonation. In these cases, the occurrence of the event is felt, if not heard, and even in a remote control room such an event should trigger multiple indications, including radiation monitors, or other alarms due to equipment failure.

The second case is where multiple means or opportunities to detect an event exist. In this event, the significance of any one means of detection is limited. In addition, the simultaneous failure of multiple means of detecting the event would be considered unrealistic. The DSA describes the multiple means of detection available and the response to the indications without crediting a specific system or component.

3.1.2.2 Response to Events

When multiple means of preventing an event exist, and when there is sufficient time to implement these means, then an event may not be considered a DBA. Event durations are typically proposed to reflect the outside estimation of the time needed to prevent or mitigate an event. In the event there are multiple methods available to deal with a situation once detected, and there is sufficient time to make multiple attempts, then no specific means of mitigating or preventing the event are warranted, as the significance of any one means of mitigation or prevention is limited. In addition, the simultaneous failure of all these methods would be unrealistic. In this case, the DSA describes the multiple methods available and describes/justifies the time available to deal with the response without crediting a specific system or component.

3.1.2.3 NPH Scenarios

The Safety Strategy for the CSTF DSA (Ref. 112) refers to the DSA effort as "an extreme example of retrofitting upgraded Safety Basis requirements to an existing facility." Application of current design standards to the existing facility quickly becomes unproductive due to the difference in approach for development of barriers, as well as the variable condition of the equipment. For normal conditions (i.e., non-NPH), the Safety Strategy proposes the following approach for determining the availability of equipment.

When developing accident scenarios (progression), safety systems will be assumed to function within the design standards for SSCs (e.g., single active failures for SC components). For non-credited SSCs, where multiple failures (other than common mode failures) could impact the accident progression or consequences, the most significant failure of a non-credited SSC shall be determined and assumed to occur in the scenario. Other non-credited SSCs will be assumed to function at the bounding limit of their normal operating range (e.g., will not worsen the accident progression). The non-credited SSCs subject to failure will be described in the DSA (Chapter 2) and the most significant failure of a non-credited SSC will be identified in the accident progression discussion in Chapter 3. Passive SSCs are not assumed or required to satisfy single failure criteria.

Similarly, a reasonably conservative approach is applied for seismic events. While a seismic event presents a common mode failure, DOE-Standard (STD) -3009 also demands that analysis be "realistic." This indicates that compounded failures, coupled with the seismic initiating frequency, should not be considered as realistic beyond a certain point. For example, if the unrelated (other than the seismic-initiated) failure of several components must occur, then the event would be considered unrealistic. This position is supported by the guidance that selected SSCs should have a significant impact on the event, and that crediting "everything" dilutes the impact of safety designation.

3.1.2.4 Selection of Inputs and Assumptions

The Safety Strategy for the CSTF DSA (Ref. 112) establishes the following guidance for selection of inputs and assumptions: "Inputs and assumptions make up the basis for all safety analysis. Therefore, it is important to ensure the appropriate level of conservatism is factored into the selection of these values." The following criteria shall be used for the selection of input and assumption values. The objective of these criteria is to ensure the inputs selected are "reasonably conservative" values rather than "bounding." Bounding values may be used where they do not result in unrealistic results. Compliance with the criteria will be documented. The inputs and assumptions shall be:

- Conservative to documented operating range
- Conservative to documented operating experiences and past operational events
- Within the physical capabilities of the equipment and/or Operations Staff, including consideration of environmental conditions

- The degree to which the operating experience has been masked by controls will be considered when determining whether a parameter should be closer to the operating experience or to the physical capabilities
- Inputs and assumptions, which are coupled in the performance of the analysis, shall be collectively evaluated against the above criteria as well. For example, if the pump rate and time to detect and stop the leak are combined in the analysis to determine the largest spill, the spill volume should be compared to the above criteria as well.

3.1.3 CHAPTER ORGANIZATION

This chapter is prepared in accordance with 10 Code of Federal Regulations (CFR) 830 and DOE-STD-3009-94 (as referenced in 10 CFR 830) (Ref. 3, 4).

Summary descriptions of programs and analyses undertaken to assure and demonstrate the operational safety of the facility are presented in this chapter.

Section 3.2 identifies the design codes, standards, regulations, and orders that are used in establishment of the safety basis for the facility.

Section 3.3 describes the HA that identified the hazards and selected accident classes for those DBA scenarios identified. Included in Section 3.3 are presentations of the HA methodology and results, including Hazard Category (HC) and evaluation, DID, worker safety, environmental protection, accident evaluation, and identification of DBAs to be assessed further in the AA.

Section 3.4 presents the methodology and results of the accident analyses with the emphasis placed on accidents with significant consequences to the public. Section 3.4 also cites the SC and SS SSCs and administrative controls for which TSR protection was developed to assure the validity of assumptions made in the AA.

3.2 REQUIREMENTS

Design codes, standards, regulations, and DOE Orders required for establishing the facility safety basis specific to this chapter and pertinent to the safety analysis include the following:

- 10 CFR 830, Nuclear Safety Management (Ref. 3)
- 10 CFR 851, Worker Safety and Health Program (Ref. 301)
- DOE-STD-3009-94, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses (Ref. 4)
- DOE-STD-1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis Reports (Ref. 6)
- DOE-EM-STD-5502-94, Hazard Baseline Documentation (Ref. 13)
- DOE-HDBK-3010-94, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, Volume 1 (Ref. 14)
- Procedure Manual 11Q, Facility Safety Document Manual, Appendix A –Safety Analysis Criteria (Ref. 15)
- Procedure Manual E7, Conduct of Engineering and Technical Support (Ref. 16)
- WSRC-MS-92-206, Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for use in DOE Facilities (Ref. 17)
- DOE Order 420.1C, Chapter IV, Natural Phenomena Hazards Mitigation (including preceding revisions, as applicable) (Ref. 18)
- DOE-STD-1020-2016, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities (including preceding revisions, as applicable) (Ref. 19)
- DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines Criteria for Structures, Systems, and Components (Historical) (Ref. 20)

3.3 HAZARD ANALYSIS

This section describes the hazard analysis performed for FTF, HTF, the processes listed in Section 3.1 for the CST Facility, and 299-H facilities, collectively referred to hereafter as CSTF. The term HA as used throughout the DSA refers to the CSTF HA (Ref. 1) and supplemental HAs (Ref. 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) performed thereafter. An HA is the initial analytical effort and systematically presents an analysis of potential process-related, NPH, and external hazards associated with CSTF that can affect the public, the workers, and the environment due to single or multiple failures. The HAs utilized the Hazard and Operability (HAZOP) technique. The purpose of the HAZOP process is to review the CSTF and related components in a systematic fashion to determine whether process or design deviations can lead to undesirable consequences. This process is performed in accordance with guidance found in *Guidelines for Hazard Evaluation Procedures* (Ref. 21) or the *CHAP Program & Methods Manual* (Ref. 211). An HA considers the potential for both equipment failure and human error.

An HA provides a thorough, predominantly qualitative evaluation of the spectrum of risks to the public, the workers, and the environment due to accidents involving the identified hazards. It consists of two basic analytical activities: Hazard Identification and Hazard Evaluation (HE). HE entails the Unmitigated HA and the Mitigated HA. DOE-STD-3009-94 (Ref. 4) requires that an HA comprehensively do the following:

- Identify hazards
- Screen for common industrial hazards
- Identify potential events, event initiators, and dominant scenarios
- Estimate their frequencies and consequences
- Identify preventive and mitigative features
- Present the results in a risk matrix

Gross estimates of consequences and frequencies are performed in the HA such that attention is focused on those scenarios that are of greatest concern (i.e., highest risk). The focus of an HA is to systematically assess potential accidents in a facility as opposed to deriving mathematical expressions of risk.

Since the initial development of the CSTF HA, newer guidance/methodology, known as the Consolidated Hazards Analysis Process, has been developed and implemented (Ref. 211). This process is based upon the same technique (i.e., HAZOP) as the CSTF HA and the consequence evaluation levels (radiological and chemical) shown in Tables 3.3-3 and 3.3-4 are the same. The major difference in the newer methodology is that it includes the Process Hazards Review within its scope. Other notable differences include: 1) the use of the term Facility Worker (FW) and Co-Located Worker (CW) versus Onsite 1 and Onsite 2 (references to Onsite 2 will be construed to mean CW where applicable), which were used in the CSTF HA, and 2) the use of risk regions (A, A1, B, etc.) versus risk bins (1, 2, 3, etc.) (See Tables 3.3-20 and 3.3-21). The receptor terms and risk categories discussed in the remainder of this section, except where noted otherwise,

reflect that used specifically for the CSTF HA (Ref. 1) developed for this DSA. Tables 3.3-13, 3.3-14, and 3.3-15 contain the risk category for the applicable event.

Since the inception of the Consolidated Hazards Analysis Process (Ref. 211), guidance (e.g., risk schemes) has changed to reflect updated DOE requirements. The basic fundamentals of the HA process are presented in this section and the associated Controls Selection Criteria Matrices are presented in Tables 3.3-7, 3.3-8, and 3.3-9. Tables 3.3-20 and 3.3-21 and associated revisions to the DSA text were added to reflect revisions to the HA process that were incorporated in Reference 242. Subsequent CHAs (Ref. 265, 266, 274, 281, 290, 293, 295, 300, 307) contain the specific details of the methodology utilized and the specific Controls Selection Criteria Matrices that are applicable.

3.3.1 HAZARD IDENTIFICATION

Hazard Identification is divided into three steps: 1) division of the facility into "process locations," 2) HAZOP process, and 3) screening for common hazards.

3.3.1.1 Division of the Facility

The HAZOP Team divides the facility into "process locations" to facilitate hazard identification and evaluation. These process locations may be individual unit operations, individual or grouped facility systems, specific function(s), and/or physical boundaries inside the facility. The team may also define a single general hazard facility-section that includes common cause events that could involve more than one facility-section (e.g., facility fire and earthquake). The CSTF is divided into the following process locations for evaluation in the HA (list below includes inactive locations and closed waste tanks stated in Section 3.4.1.5.2):

- CSTF Evaporators
  - 242-F Evaporator
  - 242-16F Evaporator
  - 242-H Evaporator
  - 242-16H Evaporator
  - 242-25H Evaporator
- CSTF Waste Transfer Systems
  - F-Area Diversion Boxes (FDBs) FDB-1, FDB-2, FDB-3, FDB-4, FDB-5, FDB-6, H-Area Diversion Boxes (HDBs) HDB-1, HDB-2, HDB-3, HDB-4, HDB-5, HDB-6, HDB-7, HDB-8
  - F-Area Pump Pits (FPPs) FPP-1, FPP-2, FPP-3, H-Area Pump Pits (HPPs) HPP-1, HPP-2, HPP-3, HPP-4, HPP-5, HPP-6, HPP-7, HPP-8, HPP-9, HPP-10, High Point Flush Pit (HPFP)
  - H-Area Low Point Drain Tank (LPDT)

- Valve Boxes (VBs) 241-96H VB, VB-1, VB-2, VB-3, VB-4, VB-5, VB-15/16, VB LDB-17, Tank 21 VB, Tank 22 VB, VB-28a, VB-28b, Tank 40 VB, Tank 42 VB, Tank 49 VB, Tank 50 VB, and Tank 51 VB (includes Tank 40 Drain VB and Tank 51 Drain VB)
- LDB Drain Cell
- Transfer Lines and Jackets/Encasements [includes Leak Detection Boxes (LDBs)], Modified Leak Detection Boxes (MLDBs), Clean Out Ports (COPs), Leak Probe Sleeves (LPSs)
- F-Area Catch Tank, H-Area Catch Tank
- Pump Pit (PP)/Diversion Box (DB) Ventilation Systems (includes HDB-8 Building)

- CSTF Waste Tanks
  - Waste Tanks 1-51
  - Waste Tank Purge and Annulus Ventilation Systems
- Actinide Removal Process (ARP)
  - 241-96H
- Modular Caustic Side Solvent Extraction Unit (MCU)
  - 241-278H
- Chemical Storage Areas
  - HTF Cold Feed Area
  - Dilution Inhibited Water Facility
  - Inhibited Water (IW) System (includes Spray Wash Tanks, Bearing Water Tanks, and IW Tanks)
- Waste Management Maintenance Facility (299-H)
- Waste Boxes (e.g., B-25s, transport casks, Hanford containers)
- CSTF miscellaneous areas (e.g., internal transport area, chemical warehouse)

3.3.1.2 HAZOP Technique

Hazard Identification is performed utilizing the HAZOP technique. The HAZOP technique is selected in accordance with guidance found in *Guidelines for Hazard Evaluation Procedures* (Ref. 21) or the *CHAP Program & Methods Manual* (Ref. 211). In the HAZOP analysis, an interdisciplinary team uses a systematic approach to identify hazards and operability problems resulting from deviations from the system or process design intent that could lead to undesirable consequences. The HAZOP study focuses on specific points of the system called "study nodes" or process sections. The HAZOP Team examines each section for potentially hazardous process

deviations that are derived from a set of established guide words. These guide words are applied at each "study node" (process section) and are combined with process parameters relevant to the portion of the process that is being examined to identify the potential deviations from that nodes intended function. The following are examples of creating deviations using guide words and process parameters:

Guide Word		Parameter		Deviation
High	+	Pressure	=	High Pressure
Low	+	Flow	=	Low Flow
Other Than	+	Sequence	=	Operations performed out of order
No	+	Power	=	Failure of Power

The hazards were inherent in the deviations of the process intent. For example, "High Pressure" on a steam line may identify steam as being a hazardous energy source. Examples of other guide words are shown in Table 3.3-1.

3.3.1.3 Screening of Common Industrial Hazards

Hazards that are routinely encountered in general industry and construction, and for which national consensus codes and/or standards (e.g., OSHA and transportation safety) exist to guide safe design and operation are screened out as common industrial hazards. In accordance with DOE-STD-3009-94 (Ref. 4), HEs of industrial hazards and routinely accepted hazards are not included. SIHs and routinely accepted hazards are identified only to the degree that they are initiators and contributors to events that result in radiological and chemical hazards. The following characteristics are used to determine hazards that are SIHs and routinely accepted hazards:

- The hazard is routinely encountered first-hand by the general public in the home, home workshop, or public areas.
- Public consensus standards exist to control the hazard.
- No evidence exists that there are public or employee concerns about the hazard beyond normal prudence.
- The hazard is controlled by OSHA regulations or one or more national consensus standards (e.g., American Society of Mechanical Engineers [ASME], American National Standards Institute, National Fire Protection Association [NFPA], Institute of Electrical and Electronics Engineers, Inc., and National Electrical Code), where these standards are adequate to define special safety requirements, unless in quantities or situations that initiate events with serious impact to the public, workers, or environment.
- Hazards such as noise, electricity, flammable materials, welding operations, small quantities of chemicals that would likely be found in homes or general retail outlets,

and hazardous materials transported on the open road in Department of Transportation (DOT) specification containers are considered to be common hazards encountered in everyday life.

Examples of common hazards are those involving:

- Specific materials (e.g., lead and asbestos) that have their own control program,
- Thermal energy sources (potential for burns),
- Hazards typically found in machine shops,
- Fork lifts,
- Cranes,
- Fires not involving radioactive or hazardous materials,
- Gas cylinders transported and stored in DOT configuration and within design limits unless they are stored in large (hundreds) quantities at one location,
- Personnel pinches, trips, falls, slips, etc.,
- Confined space hazards,
- Hazards typically found in office areas,
- Mechanical presses.

If the identified hazard does not meet the appropriate screening criteria for identification as a common hazard, then the hazard is carried forward to the HE (Section 3.3.2). If the identified hazard meets the appropriate screening criteria, then the hazard is documented as common and no further consideration is given to it, except as a potential initiator/contributor to an event, which releases radiological or chemical material.

3.3.2 HAZARD EVALUATION

The HE constitutes the primary focal point of the HA. The purpose of the HE is to ensure a comprehensive assessment of facility hazards and focus attention on those events that pose the greatest risk to the public and Onsite workers. It provides the information that allows the development of specific events and scenarios associated with a hazardous release and the estimation of their frequencies and consequences and identifies potential mitigative and preventive features. The development of specific events and scenarios was achieved utilizing the HAZOP technique as described in the *Guidelines for Hazard Evaluation Procedures* (Ref. 21) or the *CHAP Program & Methods Manual* (Ref. 211). The HE is performed in accordance with the DSA guidance document (Ref. 4) and the *Hazard Analysis Methodology Manual* (Ref. 22) or the *CHAP Program & Methods Manual* (Ref. 211).

The scope of the HE includes:

- All aspects of the process and modes of operation

- Natural phenomena (e.g., earthquakes, tornadoes, straight-line winds), external events (e.g., aircraft and vehicular impact), and nuclear criticality (where applicable) are considered
- The entire spectrum of possible events for a given hazard in terms of both frequency and consequence levels
- Hazards addressed by other programs and regulations (e.g., Process Safety Management, OSHA, Resource Conservation and Recovery Act, DOT, and Environmental Protection Agency [EPA]) should be included only if loss of control of the hazard will result in a radiological or hazardous release

The scope of HE does not include:

- Willful acts, such as sabotage
- Hazards routinely accepted by the public (These are screened during the common hazard screening process prior to conducting the HE)

The HE process is divided into three steps: 1) Identification of Initial Conditions (ICs), 2) Unmitigated HE, and 3) Mitigated HE. Information related to the HE is collected and organized in HE Tables. These tables are a useful guide for performing the evaluation and provide an effective format for documenting the results. A separate HE Table is produced for each unique process location.

3.3.2.1 Identification of Initial Conditions

Prior to beginning the evaluation, the ICs for the facility are determined and documented. ICs are specific conditions that are a part of facility operations. ICs may include assumptions, inventory information and specific passive features (i.e., no mechanical or human involvement) such as the facility construction. Any ICs thus identified must have the specific information for which the IC is valid before it can be credited in the Unmitigated HE. Examples of ICs are:

- Building/Facility construction is capable of withstanding a surface vehicle impact without adverse affects on facility operations (Note: This does not cover vehicle impacts on support or process equipment located outside the main facility).
- Facility and process inventories are limited to that identified in the inventory document. [Note: The inventory document should give specifics such as design information relating to tank volumes and concentrations, location within the facility, etc.]
- Building construction is Performance Category (PC) -3. Frequencies for Tornado/High Winds and Seismic events impacting the building structure are as identified in DOE-STD-1020-2016 (Ref. 19).
- Worker's ability to react to obvious hazardous conditions and evacuate. This of course invokes the assumptions that the workers are physically able to evacuate, and

that an evacuation route is available during or immediately following the hazardous condition.

These ICs are part of the input to the Functional Classification process and may require protection as TSRs. Therefore, agreement between the facility representatives and the HA Team must be reached regarding the selection of ICs and the impacts the ICs will have on the HE.

3.3.2.2 Unmitigated Hazard Evaluation

Since the inception of the Consolidated Hazards Analysis Process (Ref. 211), guidance (e.g., risk schemes) has changed to reflect updated DOE requirements. The basic fundamentals and methodology of the HA process associated with References 1 and 242 are presented in this section. Subsequent CHAs (Ref. 265, 266, 274, 281, 290, 293, 295, 300, 307) contain the specific details of the methodology utilized. Information on consequence determinations presented in Section 3.3.2.2.9 is relevant to the subsequent CHAs.

The Unmitigated HE is performed to determine the risks involved with the facility and its associated operations without regard for any safety controls or programs. Unmitigated refers to the determination of the frequency and consequences without credit given for preventive or mitigative features other than the specified assumptions or ICs. It is essential to avoid taking credit for any types of active or passive barriers or controls, which must then be designated as a SC SSC or SS SSC depending upon which receptor (Offsite or Onsite) risk was reduced. During the unmitigated HA, the Material at Risk (MAR) will equal the available hazardous inventory that can be acted upon during the postulated event. No credit will be taken for any controls; however, the laws of physics will be obeyed. Details of the consequence determinations are presented in Section 3.3.2.2.9. The Unmitigated HE is presented in tabular form in References 1 and 242 and includes the following information:

- Event Number
- Event Category
- Event Description
- Causes
- Preventive Features/Controls
- Initiating Event Frequency Level
- Method of Detection (Ref. 1 only)
- Mitigative Features/Controls
- Unmitigated Consequence Level
- Risk Bin Number (Ref. 1)
- Risk Rank (Ref. 242)

Additional detail and pertinent methodology information regarding each of the HE Table categories are provided in the following sections.

3.3.2.2.1 EVENT NUMBER

Events are numbered to provide each with a sequential reference. The numbering system was chosen such that facility section is identified mnemonically. For example, consider a facility section identified as the PP. The mnemonic PP was chosen to represent this section, and events were numbered PP-1, PP-2, etc.

3.3.2.2.2 EVENT CATEGORY

Events identified from deviations are categorized according to the nature of the postulated release mechanism. A standard list of event categories is used. They are listed as follows, along with a general description of the consequence source:

- E-1 Fire – Consequences typically due to inhalation/ingestion of hazardous material released by a fire.
- E-2 Explosion – Consequences typically due to inhalation/ingestion of hazardous material released by an explosion.
- E-3 Loss of Containment/Confinement – Consequences typically due to inhalation/ingestion of hazardous material released by mechanical (e.g., impact, spill) or other means.
- E-4 Direct Radiological/Chemical Exposure – Consequences typically due to direct exposure (contact chemical exposure, radionuclide 'shine').
- E-5 Nuclear Criticality – Consequences typically due to direct exposure and release of fission products from a criticality.
- E-6 External Hazards – Consequences typically due to inhalation/ingestion of hazardous material released due to an external event. Depending on specific event, direct exposure consequences may also be applicable.
- E-7 Natural Phenomena – Consequences typically due to inhalation/ingestion of hazardous material released due to NPHs. Depending on specific event, direct exposure consequences may also be applicable.
- E-8 Other (Ref. 242 only) – Consequences typically due to loss of production (i.e., loss of primary program capabilities), monetary loss including cleanup, equipment damage, product value, etc., with no hazardous material release, or impact to existing structure, system, component (SSCs) or administrative controls credited for current hazardous events in the DSA.

These event categories are consistent with the postulated accidents to be considered in DSAs for waste processing facilities as provided in Appendix E of DOE/TIC-11603 (Ref. 23), except for event category E-8. Events should be categorized according to the initiating event.

3.3.2.2.3 EVENT DESCRIPTION

The development of specific events and scenarios was achieved utilizing the HAZOP technique. Using the HAZOP technique, the HAZOP Team develops deviations for each process section wherever a potential exists for a release of hazardous energy and/or material. By combining the deviation, derived from a set of established guide words, to the consequences from the deviation, postulated event scenarios are created for the HE Tables for the HA.

In addition to the hazards associated with normal and abnormal conditions that could be encountered during processing operations, the HAZOP Team evaluated the impact of external events. These included NPH events (earthquake, tornado, high winds, flood, etc.) and external impact (vehicle, crane, aircraft, etc.), which were evaluated using the "What-If" approach as outlined in *Guidelines for Hazard Evaluation Procedures* (Ref. 21).

The postulated event description clearly defines the nature of the event. It includes the type of event, hazard source (including MAR), affected system(s) or equipment, and any pertinent operating characteristics.

The scenarios cover the entire spectrum of possible events for a given hazard, from small consequence events, for which procedures or equipment is acknowledged to provide adequate protection, to reasonable worst-case conditions. Unlike "worst-case," "reasonable worst-case" does not necessarily consider every parameter in its most unfavorable state.

3.3.2.2.4 CAUSES

The HE Tables contain a description of the causes (initiating events) of a postulated event, which include postulated failures, errors, operational and limiting parameters, and environmental and operating conditions. The causes of a postulated event are identified to support the frequency estimation for the event. Causes are synonymous with initiating events, and therefore, need to be clearly identified to support frequency evaluation. The HAZOP Team members were knowledgeable regarding past operating events/experience, and this background was used as an input source for event initiators.

3.3.2.2.5 PREVENTIVE FEATURES/CONTROLS

The HE Tables include preventive features/controls associated with the facility, which are expected to reduce the frequency of a postulated event. These preventive design features (e.g., SSCs) and administrative controls (e.g., procedures, policies, and programs) were identified through a review of safety documentation and discussions with facility personnel. For the unmitigated HA, preventive features/controls were identified and applied for each process system (e.g., waste tanks, evaporators) as one whole system, unless specified otherwise. For example, all waste tanks were assumed to contain an active ventilation system. Preventive features/controls constitute a significant portion of DID and Worker Safety, and provide essential input to the functional classification task.

3.3.2.2.6 INITIATING EVENT FREQUENCY LEVEL

Initiating event frequency evaluation is a qualitative or semi-quantitative process that involves assigning a frequency level to each event in the HE Tables based on the event root cause(s). Frequency levels and descriptions are based on DOE-STD-3009-94 (Ref. 4). Failure rate data, historical accident data, and other sources of information are used to estimate the postulated event frequency. This process includes a review of existing safety documentation. The frequency evaluation levels that are used in the CSTF HE Tables are provided in Table 3.3-2.

Uncertainties in frequency levels are accommodated by erring in the conservative direction from best-estimate values. When evaluating event frequency, credit may be taken for items identified as Initial Conditions, e.g., inventory controls, which limit the amount of hazardous material in the facility or facility section. Crediting any other SSC or administrative control for its preventive properties is discouraged.

3.3.2.2.7 METHOD OF DETECTION (REF. 1 ONLY)

Method of detection includes operator interaction or features designed to detect initiating events or subsequent event progression. These include alarms, monitors, indicators, and an operator's ability to recognize the events by visual observation or sound.

3.3.2.2.8 MITIGATIVE FEATURES/CONTROLS

The HE Tables include mitigative features/controls associated with the facility that would reduce the consequences of a postulated event. These mitigative design features (e.g., SSCs) and administrative controls (e.g., procedures, policies, and programs) were identified through a review of safety documentation and discussions with facility personnel. The identification of such features/controls is made without regard to any possible pedigree of the feature/control such as procurement level or current classification. Mitigative features/controls must be capable of withstanding the environment of the event. Mitigative features/controls constitute a significant portion of DID and Worker Safety and they provide essential input to the functional classification task.

3.3.2.2.9 UNMITIGATED CONSEQUENCE LEVEL

For HA purposes, consequences are defined as the dose or exposure at specified receptor locations. Consequences are a function of the type and characteristics of the hazard, the quantity released, the release mechanism, relative location of the release, and any relevant transport characteristics. The consequence levels that are used in the CSTF HE Tables are provided in Tables 3.3-3 and 3.3-4.

When evaluating event consequences, credit may be taken (when justifiable for the event under consideration) for inventory controls limiting the amount of hazardous material in the facility or facility section consistent with the ICs discussed in Section 3.3.2.1. Credit may also be taken for the ability of workers to react to obvious hazardous conditions and evacuate. This of course

invokes the assumptions that the workers are physically able to evacuate, and that an evacuation route is available during or immediately following the hazardous condition. Crediting any other SSC or administrative control for its mitigative properties is discouraged.

The DSA guidance document (Ref. 4) does not require detailed consequence analysis for the HA. The evaluation requires a qualitative assessment based on the quantities of radionuclides and chemicals released as a result of each postulated event. In addition, these quantities are dependent on the Release Fractions (RF′) associated with each. The qualitative consequence evaluation initially evaluates the event without applying RF′.

3.3.2.2.9.1 Radiological Consequences

Radiological consequences are determined from (1) simple Source Term (ST) calculations, (2) existing safety documentation, and (3) qualitative assessment. Prior to determining the consequences of an airborne release of radionuclide, the ST for the radionuclide must be determined. The dose to each receptor was then determined using the Total Effective Dose (TED) factors per unit mass or volume along with the material released, or ST. The TED factors are further discussed in Section 3.4.1.1.1 and Section 3.4.1.3.1.

3.3.2.2.9.2 Source Term Derivation

In order to have conservative estimates of consequences from the accidental release of the radioactive inventory relating to the CSTF, ST estimates have been performed. For the types of inventory in the CSTF, the airborne pathway is of primary concern. The airborne ST is typically estimated by the following equation taken from DOE-HDBK-3010-94 (Ref. 14) and discussed in Section 3.4.1.1.1:

$$\text{Source Term (ST)} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

A conservative value of 1.0 was used for DR and LPF. The MAR was determined on an event-by-event basis. The ARF and RF are selected from DOE-HDBK-3010-94 (Ref. 14) based on conservative assumptions regarding the physical form of the material and the available energy during an event. These conservative assumptions are based on available descriptions of the processes involved and the results of the HE for the processes.

The release mechanism and material form categorizes the ARFs and RFs used for the consequence determination. The release mechanisms used are as follows:

- Fire – Events where the waste material is on fire or is impacted by the fire.
- Explosion – Explosion events caused by ignition of explosive gas, e.g., hydrogen. There are two types of explosions that can occur:
  - External – Blast occurs in an unconfined area and is external to the material.
  - Confined – Blast occurs within a confined area, (e.g., tank, evaporator) where the shock wave could reflect and impact more material.
- Loss of Containment/Confinement

- Ambient release – Loss of ventilation/exposed material events (e.g., entrainment, evaporation).
- External impact/fall – Mishandling and dropping events, impacts from external sources, plus spills and leaks.
- Energetic release – Overpressurization.

The material forms are:

- Liquid – Applicable to all solutions within the facility except for those considered slurries. Internal explosion releases are governed by the explosions' shock effects.
- Slurry – Thicker solutions. The only ARF and RF values are for External Impact/Fall events (specifically spills). Since the slurry is in a state between liquid and powder, the bounding ARFs and RFs shall be taken from the larger of the two values.
- Dry Sludge Solids or Aggregate – Comprised of insoluble solids from sludge in the form of a dry solid aggregate material (e.g., dried sludge). Applicable to dry sludge scenarios.
- Powder – Dry powder layer remaining from the evaporation of liquid waste (e.g., evaporated supernate). Applicable to dry sludge scenarios.
- HEPA Filter – Applicable to unenclosed High-Efficiency Particulate Air (HEPA) filters for bounding results.
- Packaged Waste – Applicable to waste contained in closed steel containers (e.g., B-25s).
- Surface Contamination – Applicable to residual contamination in pits, air ducts, cells, etc.

3.3.2.2.9.3 Consequence Derivation

For HA purposes, consequences are defined as the dose or exposure to specified receptors. Consequences are a function of the type and characteristics of the hazard, the quantity released, the release mechanism, relative location of the release, and any relevant transport characteristics. The HAs use qualitative engineering judgment to determine the consequences for each accident scenario. Values tabulated in the HAs are used solely as a basis in determining the consequence results. Consequences were determined as the dose or exposure at specified receptor locations based upon the release of hazardous material.

Consequences are evaluated at various receptor locations to assess the health effects of the postulated release. The HAs are concerned with the maximally exposed individual at each of the receptor locations. The receptors used in this analysis and their correlation to those used in the CSTF HA (Ref. 1) are as follows:

- Onsite 1 Worker – Facility Worker (FW) in the facility or vicinity of the facility or at the location where the accident occurs. For the CSTF HA, the Onsite 1 worker consequences were qualitatively determined.

- Onsite 2 Worker (100 meters) – Workers outside the CSTF process areas but within the site boundary. The consequence value was determined at distance of 100 meters from the process areas. These values were used to assess the consequence level (i.e., High, Moderate, Low, Negligible) based on the worst possible location.
- Offsite Population (9.4 km) – The Maximally Exposed Offsite Individual (MOI) located at the closest site boundary. These values were used to assess the consequence level (i.e., High, Moderate, Low, and Negligible).

Receptors (Ref. 242) are as follows:

- Facility Worker – Facility Workers (FW) are workers immediately adjacent or in the occupied area of the hazard. The occupied area of the hazard is 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.). Note: a physical barrier credited to protect workers outside the area or prevent entrance of workers into the area is to be identified as an IC.
- Co-Located Worker – Co-Located 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 meters to the hazard. For this analysis, CW consequences were qualitatively determined from the dose at 100 meters.
- Public – Public receptors are the public or everyone outside the site boundary at the time of the event. Public receptor consequences were qualitatively determined from the dose at 9.4 kilometers for FTF and 11.5 kilometers for HTF.

The dose for the Onsite 2 worker and the MOI are estimated by multiplying the ST (mass or volume) by the TED factors per unit mass or volume as given in Reference 1 or determined using RAD Screen (Ref. 24).

Consequences for events that did not result in a release of material (criticality and direct exposure events) were determined qualitatively, based on previous analyses or analyst judgment.

After the doses for the Onsite 2 (CW) and Offsite receptor were determined, the consequences were given qualitative descriptions of High, Moderate, Low, and Negligible according to the guidelines in Table 3.3-3 and in accordance to DOE-STD-3009-94 (Ref. 4). Consequence levels were assigned based on the dose or exposure received to each specified receptor location and physical injuries (e.g., shrapnel impacts) to the workers. The consequence determination should err in the conservative direction; thus, dose values that were considered relatively close to the guidelines were conservatively assigned the higher consequence value.

3.3.2.2.9.4 Chemical Consequences

Offsite and Onsite release concentrations were determined for those chemicals whose inventory exceeded the Reportable Quantity (RQ) of 40 CFR 302.4 (Ref. 8), the Threshold Planning Quantity (TPQ) of 40 CFR 355 (Ref. 9), or the Threshold Quantity (TQ) of 29 CFR 1910.119 (Ref. 7) and 40 CFR 68 (Ref. 36). Offsite and Onsite release concentrations were also

determined for those chemicals that do not have a RQ, TPQ, or TQ, but are considered hazardous based on engineering judgment. Based on these criteria, the chemicals that are considered materials of concern and evaluated are listed in Table 3.3-5.

The storage of chemicals in the locations listed in Table 3.3-5 support processes within the CSTF. It is not the intention of the DSA to provide analysis of SIH type of hazards (see Section 3.3.1.3). Rather, chemical hazards are evaluated to the extent that they act as initiators and contributors to accidents that result in a radiological or chemical release within the process.

The HAs evaluated the maximum local, Onsite, and Offsite release concentrations at 30 meters, 100 meters, and the site boundary, respectively, based on the release rates of chemicals given by the following equation:

$$\text{Release Rate} = \frac{\text{inventory (lb) x RF}' \text{ x 4.54E+05 milligrams (mg) per pound (lb)}}{\text{15 minutes (min) x 60 seconds (sec)/min}}$$

Where:

RF′ = Release Fraction. RF′ (Release Fraction) is different from the RF (Respirable Fraction) stated previously. RF′ values used to calculate the release rates for chemicals are taken from Reference 6.

Offsite and Onsite maximum chemical airborne concentrations were calculated by multiplying the release rate by the appropriate atmospheric dispersion factor (χ/Q) calculated from the MELCOR Accident Consequence Code System (MACCS) or MACCS2 computer code using 1987-1991 meteorological data or 1997-2001 meteorological data, respectively. The Onsite χ/Q values were determined for the 50th percentile consequence level without regard to sector while the MOI χ/Q values were determined for the 95th percentile consequence level without regard to sector for a ground level release. The chemical consequence analyses used χ/Q values with either 15-minute averaging time basis or 3-minute averaging time basis (the latter generally most appropriate for concentration-dependent chemicals and conservative for dose-dependent chemicals). The accident analyses results using MACCS2 are based conservatively on 3-minute averaging time. Specifically, the following χ/Q values were used in the various chemical consequence analyses: 5.4E-04 seconds per cubic meter (s/m^3) (MACCS) or 6.5E-04 s/m^3 (MACCS2) for Onsite 2 Worker (CW); 2.2E-06 s/m^3 for F-Area MOI; and 1.6E-06 s/m^3 for H-Area MOI.

The calculated maximum airborne concentrations were compared to the applicable criteria (Emergency Response Planning Guideline [ERPG] values or equivalent ERPG limits) to determine the appropriate consequence level. Source calculations which determine chemical consequences document the applicable chemical criteria limits (e.g., ERPG or equivalent limit) and provide the code of record for evaluation of requirements.

ERPGs are estimates of concentration ranges (dosage) for specific chemicals above which acute (< 1 hour) exposure would be expected to lead to adverse health effects of increasing severity for ERPG-1, ERPG-2, and ERPG-3. Permissible Exposure Limit - Time-Weighted Average

(PEL-TWA) values are developed by the OSHA for use in limiting worker exposures to airborne chemicals.

Workers exposed to concentrations in excess of ERPG-3 values could experience or develop life-threatening health effects (Ref. 17) and are ranked in the high consequence risk level. Also, individuals exposed to concentrations in excess of ERPG-2 values could experience irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action (e.g., Narcosis) (Ref. 17). According to the consequence threshold levels defined in Table 3.3-4, chemical events resulting in serious injury (assumed to be concentrations greater than ERPG-2) to Facility Workers are defined as moderate consequence events. Individuals exposed to concentrations in excess of ERPG-1 or PEL-TWA will have no appreciable risk of health effects and are ranked in the low or negligible consequence risk level, respectively.

Temporary Emergency Exposure Limits (TEELs) are used as equivalent chemical evaluation criteria for receptors in lieu of the ERPGs when no ERPGs currently exist for a specific chemical. TEELs are intended for use until such time as ERPGs are developed and approved for specific chemicals. Therefore, TEELs 1, 2, and 3 have the same definitions as the ERPGs 1, 2, and 3, respectively (Ref. 29). For this analysis, the TEEL-0 values are assumed to be the equivalent of the PEL-TWA values. ERPGs and TEELs, along with Acute Exposure Guideline Limits (AEGLs), are now collectively referred to as Protective Action Criteria (PAC) (Ref. 259). PACs can be used interchangeably with AEGLs, ERPGs or TEELs.

3.3.2.2.9.5 Hazardous Chemical Compatibility

A chemical compatibility study was performed to identify additional events (other than those identified in the HE Tables) that would exist if two hazardous chemicals were mixed. Chemical inventories at the CSTF were determined from References 30, 31, 242, 274, and 300. The first step of this analysis identified chemicals that could possibly be mixed in the event of a human error, inadequate procedures, NPH, or a process-related action. The possible mixing mechanisms identified include the following:

- Chemicals stored together that are mixed as a result of a container (e.g., storage tank, drum) rupture. Facility walkdown, facility drawings, and facility chemical inventory database determined the storage locations of the hazardous chemicals at the CSTF. These storage locations are documented in Table 3.3-5.
- Facility process and/or drain piping or interconnected piping that drains to a common vessel, resulting in chemical mixing. CSTF Piping and Instrumentation Drawings depicting flow paths and drain piping were reviewed to determine if mixing could occur, either by mixing in a common pipe or vessel or by a valve being out of position.
- Mixing caused by human error during process-related activities
- Equipment failure caused by malfunction, material failure, thermal stress, or corrosion that leads to mixing
- Inadequate procedures or an error in a process procedure step resulting in mixing

- Natural phenomena causing the rupture of storage containers/tanks of chemicals in close proximity

Based upon the analysts' knowledge of the chemicals, Material Safety Data Sheets, and results obtained from the National Oceanic and Atmospheric Administration/EPA Computer-Aided Management of Emergency Operations Chemical Reactivity Worksheet, Version 1.2, a variety of consequences may be expected to occur when two materials are combined. The mixing may produce the potential for any of the following: explosion, fire, flammable gases, heat, innocuous gases, or toxic gases.

A chemical compatibility study was performed for hazardous chemicals existing in the CSTF (except ARP and MCU facilities) and documented in Reference 1. In general, most of the compounds included in this work can be logistically mixed with others on the list. A hazardous chemical mixing matrix was developed to assess the likelihood of mixing any two of the chemicals listed in Table 3.3-5. Based upon this evaluation, an incompatibility table was constructed. Reference 1 provides the physical properties and chemical reactivities of each of the chemicals. Reference 1 also documents the incompatibility chart that describes the expected physical problems that will be encountered if there is an inadvertent mix of any two chemicals listed. Those chemicals that could initiate a hazard leading to a release of radiological or hazardous material are captured in the HE Tables.

Most of the expected reactions are of mass nature and are not expected to be catalytic, i.e., developing a continuous reaction when a small amount of one compound is mixed with large amounts of another. The chemical compatibility study was performed without regards to the stoichiometry of the reaction. Theoretically, the extent of reaction depends on the amount of material consumed.

The chemical compatibility study did not address interactions between material of construction and chemicals. The design of the process system is of importance since several of the chemicals are corrosive in nature and can cause corrosion of process SSCs.

For the ARP and MCU facilities, potential chemical interactions were evaluated in Reference 242, and no adverse impacts were identified.

3.3.2.2.9.6 <u>Chemical Reactivity During 242-16H Evaporator Acid Cleaning</u>

Acid cleaning of the 242-16H Evaporator requires the use of nitric acid (1.5 molar) and sodium hydroxide (50 weight percent [wt. %] or 19 molar). The nitric acid dissolves the evaporator scale and the sodium hydroxide adjusts the pH of the resulting solution prior to transfer to a waste tank. Several chemical reactions occur during this process. Although heat is evolved by some of these reactions, no strong energetic reactions will occur nor will energetic or explosive compounds form.

During dissolution in acid, scale components are converted to soluble species. None of the dissolved components pose a significant reactivity hazard under evaporator conditions. Acid dissolution will release physically trapped radon gas, decompose carbonate salts into carbon dioxide, and convert nitrite compounds in residual waste to NO_x gases (N_2O, NO and NO_2).

Radon, carbon dioxide, and N_2O are chemically inert under conditions in the evaporator and pose no chemical or reactivity hazard. NO will rapidly oxidize in the presence of air to NO_2. Strongly reducing compounds, such as elemental mercury, can react with the nitric acid to form small amounts of hydrogen gas, adding to hydrogen formed from radiolysis of the water.

Heating nitric acid with organic compounds can potentially result in energetic reactions. This will not occur during evaporator cleaning because (1) the scale does not contain significant amounts of organic compounds, (2) the nitric acid has a purchase specification limit on organic carbon, and (3) the dilute acid concentration reduces the potential reaction rate.

Neutralization of the acid solution will precipitate some components and change the form of others. All of the compounds formed from neutralization are typical of Savannah River Site (SRS) alkaline wastes and do not pose any reactivity hazards. No gas production (other than radiolytic) occurs during the neutralization process.

The heat of neutralization of the acid and dilution of the 50 wt. % sodium hydroxide cause the temperature of the solution to increase. A temperature increase of 25 to 60°C is expected in the 242-16H Evaporator. This change in temperature will not cause any additional reactions to occur.

3.3.2.2.9.7 Chemical Reactivity During Oxalic Acid Cleaning of Type I and Type II Waste Tanks

Waste Tank Chemical Cleaning will be performed in Type I and Type II Waste Tanks to remove the sludge remaining following bulk waste removal. Chemical cleaning will utilize oxalic acid (OA) to dissolve some of the residual sludge which will allow transfer to a designated receipt tank. The acidic waste will be neutralized in the receipt tank to restore pH to corrosion control requirements. Additionally, remaining acidic waste in the treatment tank may also be neutralized. Several chemical reactions will occur during this process. Although heat is evolved by some of these reactions, no strong energetic reactions will occur, nor will energetic or explosive compounds form (Ref. 274).

During sludge dissolution, a large majority of the sludge heel will be converted to soluble species. None of the dissolved components pose a significant reactivity hazard under waste tank conditions. Acid dissolution will decompose carbonate salts into carbon dioxide (CO_2), and convert nitrite compounds in residual waste to nitrous oxide (N_2O). Carbon dioxide and nitrous oxide are chemically inert under conditions in the waste tank and pose no reactivity hazard. The heat associated with the dissolution of sludge is not anticipated to cause a significant increase in solution temperature and therefore will not cause any additional reactions to occur.

Neutralization of the acid solution will precipitate some components and change the form of others. All of the compounds formed from neutralization are typical SRS alkaline wastes and do not pose any reactivity hazards. A large portion of the solids are attributed to the formation of sodium oxalate. No gas production (other than radiolytic) occurs during the neutralization process. The heat of neutralization of the acid is not anticipated to cause a significant increase in solution temperature and therefore will not cause any additional reactions to occur.

3.3.2.2.10 RISK BIN NUMBER (REF. 1)

Using event frequency and consequence levels, the HA Team "bins" events based on frequency and consequence to assess relative risk. The objective of risk binning is to focus attention on those events that pose the greatest risk to the public and Onsite receptors. Higher risk events are candidates for additional analysis and/or functional classification evaluation.

Tables 3.3-7, 3.3-8, and 3.3-9 define elements of the risk bin matrices for the three receptor locations considered in the CSTF HA (Ref. 1) (i.e., Offsite, Onsite 1, and Onsite 2). Each bin is uniquely numbered for identification purposes (i.e., risk severity is not proportional to the magnitude of the bin label).

Table 3.3-7 is the risk-binning matrix for the Offsite receptor. The darker shaded bins, (i.e., 1, 2, 3, 4, 5, and 7), represent risk that exceeds the Offsite radiological and/or chemical EGs for Functional Classification. Events falling into risk bins 1, 4, and 7, typically, require further evaluation as candidates for SC functions. Events falling into risk bins 2, 3, and 5, typically, require further evaluation as candidates for SS functions. In DOE-STD-3009-94 terminology, these events are considered "unique," or "situations of major concern," with sufficiently high risk that individual examination is needed by AA.

The three lighter shaded bins in Table 3.3-7, (i.e., 6, 8, and 9) fall below the Functional Classification EGs, yet per Reference 4, these events are considered "situations of concern" that yield a subset of "representative" events needing further examination. A review of the CSTF HA determined that all representative events in risk bin 6, 8, and 9 are bounded by at least one bounding event from each event category (fires, explosions, etc.).

Tables 3.3-8 and 3.3-9 are the risk-binning matrix for the Onsite 1 and Onsite 2 receptors. The darker shaded bins, (i.e., 1, 4, and 7), represent risk that exceeds the Onsite radiological and/or chemical EGs for Functional Classification. Events falling into these bins, typically, require further evaluation as candidates for SS functions.

The HE Tables provide a bin number, representing the risk bin at each receptor location, for each of the postulated events.

3.3.2.2.11 RISK RANK (REF. 242)

Using event frequency and consequence levels, events are "ranked" to assess relative risk. The objective of risk ranking is to focus attention on those events that pose the greatest risk to the Offsite, CW, FW, process, and support systems. Higher risk events might be candidates for additional controls, analysis, and/or specific functional classification evaluation.

For airborne radiological releases, once the unmitigated event frequency and consequence were estimated, events are located on the appropriate Risk Criteria Matrix for the Public, CW, or FW, as shown in Table 3.3-20:

- Region A1. Unmitigated events falling in Region "A1" due to radiological release require controls (SC for the public and SS for workers), and are highly recommended for additional Levels of Control for all receptors. Unmitigated events falling in Region "A1," due to chemical release or prompt fatality (etc.), require SS controls and highly are recommended for additional Levels of Control. The desired result is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.
- Region A2. Unmitigated events falling in Region "A2" due to radiological release require controls (SC for the public and SS for workers), and are recommended for additional Levels of Control for all receptors. Unmitigated events falling in Region "A2," due to chemical release or prompt fatality (etc.), require SS controls and are recommended for additional Levels of Control. The desired result is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.
- Region A3. Unmitigated events falling in Region "A3" due to radiological release require controls (SC for the public and SS for workers), and are considered for additional Levels of Control for CW or public. Unmitigated events falling in Region "A3," due to chemical release or prompt fatality (etc.), require SS controls and consideration for additional Levels of Control. The desired result is that the mitigated consequence is moved from "high" to "low" or "negligible."
- Region B. Events having moderate "B" consequences that challenge "A" region consequences require SC (public) or SS (worker) controls. Otherwise, events falling in Region "B" require Facility Controls. The desired result is that the mitigated combination of consequence and frequency is moved toward, and possibly into, the "C" region.
- Region C. Events falling in Region "C" are not considered for controls. However, there may be events in this region that require the addition of Facility Controls because the frequency is higher than desired, the occurrence of the uncontrolled event is unacceptable to management in any event, or the uncontrolled event is unacceptable for programmatic or political reasons.

3.3.2.3 Mitigated Hazard Evaluation

Events whose risk challenges the Offsite EGs (see Sections 3.3.2.2.10 and 3.3.2.2.11) are subjected to further AA. During the AA, the event consequences are reviewed to identify areas where the input parameters (MAR, DR, ARF, etc.) can be reduced, with the new consequence values documented. If the risk still challenges the Offsite EGs, SC functions and SS functions are identified to bring the risk sufficiently below the EGs for the Offsite receptor.

The *Hazard Analysis Methodology Manual* (Ref. 22) or the *CHAP Program & Methods Manual* (Ref. 211) requires that for events where the unmitigated consequences exceed the Onsite 2 (CW) EGs (see Tables 3.3-9, 3.3-20, and 3.3-21), additional analyses will be conducted and documented in the Mitigated Hazard Analyses (MHA). To ensure worker safety, events that exceed the Onsite 1 (FW) EGs (see Tables 3.3-8, 3.3-20, and 3.3-21) are also addressed in the MHA.

Various events from the HAs were not considered for further analysis based on assumption defense, low/negligible consequences, and further assessment of credibility. Table 3.3-11 provides the rationale for the events not considered for additional analysis, and, hence, controls selection. These events are not included in the MHA.

Certain events in the HAs were qualitatively determined to challenge the Offsite EGs or exceed the Onsite EGs and, thus, were analyzed as DBAs in Section 3.4.2. Based on analysis completed in Section 3.4, some of these events were shown not to require SC or SS controls. These DBA events are shown in Table 3.3-12, which provides reference to the DBA section that shows the event consequences do not challenge the Offsite EGs or exceed the Onsite EGs. These events are not included in the MHA.

Likewise, other HA events of the same DBA category (e.g., Evaporator Overpressure, Evaporator Overflows, Transfer Errors, 299-H Releases) were qualitatively determined in the HAs to not challenge the Offsite EGs, but exceed the Onsite EGs. Based on the results of the analyses in Section 3.4.2, these events were shown not to require SC or SS controls. These non-DBA HA events (i.e., those judged in the HAs to not challenge the Offsite EGs) are also shown in Table 3.3-12, which provides reference to the DBA section that shows the event consequences do not challenge the EGs. These events are not included in the MHA.

Therefore, the remaining events whose risks exceed the EGs for the Onsite receptors, but not challenge the EGs for the Offsite receptor, are analyzed in the MHA (Tables 3.3-13, 3.3-14, and 3.3-15). For an event that challenges the Offsite EGs, the AA typically analyzes the event for all receptors. The AA (including any specialized calculations such as structural analyses) and other applicable analyses are reviewed to capture the reductions in the frequency and the consequence input parameters (e.g., MAR, ARF/RF, DR, LPF). If the event still exceeds the Onsite 2 (Co-Located Worker) EGs, controls that have been identified as SC or SS are credited. The risks are then re-evaluated with the SC and SS controls credited. If the risk still exceeds the Onsite 2 (Co-Located Worker) EGs, additional controls are credited in an iterative manner until the risk is brought sufficiently below the Onsite 2 (Co-Located Worker) EGs.

The MHA for the Onsite 1 (FW) receptor is documented in Tables 3.3-13, 3.3-14, and 3.3-15. Controls that are required to limit any radiological or chemical consequences so that they do not exceed the EGs for the Onsite 1 (FW) receptor will also reduce the consequences so that they do not exceed the EGs for the Onsite 2 (Co-Located Worker) receptor. The Preventive Features and Mitigative Features credited to reduce the frequency and consequences, respectively, are listed along with their functional classification. These controls are identified for the bounding accidents postulated in the HAs, and the applicability of the controls for a given evolution is discussed in Section 3.4 and Chapter 5. Changes in event frequency, consequences and risk bin are documented, as discussed below.

3.3.2.3.1 PREVENTIVE FEATURES/CONTROLS

A preventive feature/control is any feature that is relied on to reduce the frequency of a hazardous event. Preventive features/controls that were credited for reducing the frequency during the MHA are listed in Tables 3.3-13, 3.3-14, and 3.3-15. Preventive features/controls are identified for the bounding accidents postulated in the HA, and the applicability of the features/controls for a given evolution is discussed in Section 3.4 and Chapter 5.

3.3.2.3.2 FREQUENCY LEVEL – PREVENTED

The events initiating frequency level (from the unmitigated hazard evaluation tables) is modified with the reductions due to credited preventive features/controls. The amount of frequency reduction is dependent on the feature/control(s) and may be defined during the AA. If the frequency reduction is not identified, then a qualitative evaluation of the reduction is made based on the failure rate of the feature/control and engineering judgment. An acronym representing the results of frequency evaluation is assigned according to the Table 3.3-2 lettering scheme.

3.3.2.3.3 MITIGATIVE FEATURES/CONTROLS

Mitigative features/controls are any features that are relied on to reduce the consequences associated with the release of hazardous material or energy. Mitigative features/controls must be capable of withstanding the environment of the event. Mitigative features/controls that are credited for reducing the consequences during the MHA are listed in Tables 3.3-13, 3.3-14, and 3.3-15. Mitigative features/controls are identified for the bounding accidents postulated in the HAs, and the applicability of the feature/control for a given evolution is discussed in Section 3.4 and Chapter 5.

3.3.2.3.4 MITIGATED CONSEQUENCE LEVEL

The unmitigated consequence levels for each event are modified with the reductions identified during the MHA. The credited feature/control is evaluated to determine what factors in determining the consequences will be affected by application of the feature. Factors that are evaluated include the MAR, DR, LPF, and the time at risk. If an event requires closer evaluation, the ARF and the RF used in the unmitigated evaluation can be evaluated to determine if they can be further reduced based on the results of the AA. The consequences are then re-evaluated in accordance with the methods for determining unmitigated consequences as presented in Section 3.3.2.2.9 to determine the appropriate consequence level.

3.3.2.3.5 MITIGATED RISK LEVEL

Based on the Prevented Frequency Levels and the Mitigated Consequence Levels, the events are binned/ranked in the same manner as during the Unmitigated Evaluation (Sections 3.3.2.2.10 and 3.3.2.2.11). The final risk level determined in this manner is used to demonstrate that the

prevention and mitigation features reduce the event risk so that the established EGs are not challenged/exceeded.

3.3.3 HAZARD ANALYSIS RESULTS

As discussed in Section 3.3, an HA consists of two basic analytical activities: Hazard Identification and HE. This section provides an in-depth discussion of the results from the performance of these activities. In addition, the HC determination was performed in accordance to DOE-STD-1027-92 (Ref. 6) and the results are discussed below.

3.3.3.1 Hazard Identification

As stated in Section 3.3, hazards associated with CSTF were systematically identified by utilizing the HAZOP technique. The hazards were inherent in the deviations of the process intent, which were documented during the HAZOP sessions. Screening was performed to eliminate material/energy types and quantities that are considered "common hazards." Hazard Identification was divided into three steps:

1) Division of the facility into "process locations,"
2) HAZOP process, and
3) Screening for common hazards.

3.3.3.1.1 DIVISION OF CSTF

The CSTF was divided into "process locations" to facilitate the hazard identification and evaluation as provided in Section 3.3.1.1. These process locations consisted of individual facility systems and functions located within the CSTF.

Using the HA methodology (Ref. 22, 211), hazardous energy sources and hazardous material sources were identified for the individual process locations. As part of the HAZOP approach, hazards identified from the HAZOP process were documented onto a hazard evaluation table in the CHA report.

The HE Tables were further organized by grouping functions within each facility or facility section. The grouping of similar functions within a section allows similar hazards to be grouped together. From these similar hazards, reasonable worst case frequencies and consequences can be developed to bound postulated accident conditions for a given section. For example, all the hazardous conditions identified for the VB could be treated as a single VB. Reasonable, worst case hazardous chemical and radioactive inventories are assumed present to bound the largest VB. Postulated scenarios for this bounding VB would thus bound all other VB operations.

3.3.3.1.2 SCREENING OF COMMON HAZARDS

The HE Tables generally do not include willful acts (e.g., sabotage) or hazards routinely accepted by the public. These were screened during the common hazard screening process prior to conducting the HE.

3.3.3.1.3 REVIEW OF PAST RELEVANT OPERATING HISTORY

A review of the Waste Management Fault Tree Data Bank Storage and Retrieval Database (Ref. 114) identified the hazardous situations that have occurred at the CSTF since the beginning of CSTF operation (early 1950s).

A safety analysis was issued in August 1988; however, preparation began in 1983 (Ref. 33). For the period prior to 1983, the safety analysis (Ref. 33) identified seventeen significant occurrences, of which nine were liquid releases to Four Mile Branch, six were assimilations and two were gaseous releases to the atmosphere. To determine the significant abnormal occurrences at these facilities from 1983 until January 1990, the Waste Management Fault Tree Data Bank Storage and Retrieval Database was searched for Waste Management Incident reports and Special Hazards Investigations. Significant occurrences were assumed to include personnel overexposures, assimilations, gaseous and liquid releases to the environment, and deaths. Based on this review, thirteen significant occurrences were identified, of which eight were overexposures, two were liquid releases to Four Mile Branch, one was a gaseous release to the atmosphere, and two were assimilations.

Personnel overexposure to ionizing radiation during this period consisted of workers exceeding whole body (600 mrem) and/or skin (3,000 mrem) maximum monthly radiation exposure guide limits. Both liquid releases exceeded the prorated monthly release guide as a result of pumping contaminated retention basin water to Four Mile Branch. Radioactivity released to Four Mile Branch during these two incidents was estimated to be 30 mCi and 36 mCi of Cs-137. The airborne release occurred when between 50 and 200 mCi of Cs-137 were released from the 242-H Evaporator cell, exceeding the 200-Area annual atmospheric release guide (6 mCi) for Cs-137.

The Site Item Reportability and Issue Management (SIRIM) Program was established in January 1991 to provide a system for reporting abnormal occurrences at SRS. This program ensures that the requirements of DOE Order 232.2 (Ref. 34) regarding occurrence reporting are followed. The significance determination criteria for this program are provided in the SIRIM Handbook. Information from the SIRIM Program database was utilized in HA preparation.

3.3.3.2 Hazard Categorization

The criteria for determining the radiological HC of facilities are provided in DOE-STD-1027-92 (Ref. 6), and the criteria for determining the chemical HC are provided in WSRC-MS-92-206 (Ref. 17).

Three HCs are defined by 10 CFR 830 (Ref. 3). A facility is designated as HC 1 if the analysis shows the potential for significant Offsite consequences, HC 2 if the analysis shows the potential for significant Onsite consequences, and HC 3 if the analysis shows the potential for significant localized consequences only. A facility that does not exceed the HC 3 threshold criteria but still possesses some amount of radioactive material is considered to be a Radiological Facility. The analysis conducted to determine the facility HC is performed without credit taken for engineered features or administrative controls. Examples of engineered features or administrative controls are those specific facility features (not including site location), such as building confinement, elevated exhaust ventilation stacks, equipment, systems, actions, or operating conditions, that are established to control risk. This approach allows credit to be taken for existing location and the physics of the dispersion of hazardous material releases, but not for containment, confinement, shielding, protection systems, administrative controls, or human activities.

The chemical evaluation for chemical HC compares each chemical to the RQ of 40 CFR 302.4 (Ref. 8), the TPQ of 40 CFR 355 (Ref. 9), or the TQ of 29 CFR 1910.119 (Ref. 7) and 40 CFR 68 (Ref. 36). Analysis is not required for any chemicals that do not exceed the RQs, TPQs, or TQs because chemicals in quantities less than those listed are generally accepted by the public. Following the initial screening process, the chemical HC is determined in accordance with the criteria of WSRC-MS-92-206 (Ref. 17).

Table 3.3-10 lists the Hazard Categories of the CSTF segments. As permitted by DOE-STD-1027-92, facility segmentation was applied to CSTF and four segments were classified as HC 2, and three as HC 3 (Ref. 97, 171, 174, 236, 242).

Based on the chemical constituents of the waste streams, the chemical HC of Moderate was conservatively assigned. The chemical feed areas were determined to be Low Hazard Facilities based on type and quantities of stored chemicals.

3.3.3.3 Hazard Evaluation

The HE results for CSTF are given in References 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, and 307. As discussed in Section 3.3.2.2, each event analyzed as a part of the HA process received a risk ranking. The specific accidents that require further analysis as a result of the HE are described in Section 3.3.3.3.5.

ARP and MCU Facilities

Reference 242 analyzed events for Actinide Removal in 241-96H. Since none of the radiological or chemical event consequences challenged/exceeded the EGs, no further evaluation is required. No SC or SS controls are required.

As evaluated in the CHA (Ref. 242), the consequences for 241-96H events are qualitatively estimated to be bounded by the calculated radiological release consequences of a deflagration in the 512-S Late Wash Precipitate Tank (LWPT) when containing concentrated monosodium titanate (MST)/sludge solids. The deflagration consequences for the LWPT reasonably bound

the consequences of a credible explosion event in 241-96H, with consequences of 1.04E-02 roentgen equivalent man (rem) (Offsite) and 6.10 rem (Onsite). An inhalation dose potential value of 1.8E+08 rem/gal was used to evaluate these consequences. This inhalation dose potential is conservative for 241-96H since the concentration process used to develop this inhalation dose potential value does not take place in 241-96H. To protect assumptions related to this consequence determination, the inhalation dose potential of the feed material to 241-96H shall be maintained less than or equal to 1.4E+06 rem/gal (Ref. 242). Tank capacities associated with consequence determinations for 241-96H ARP are stated in Table 3.3-19.

The hazardous chemical inventory that can be physically released from the facility was qualitatively compared against threshold values for chemicals evaluated in 512-S. Since the 241-96H process introduces no new hazards leading to a chemical release and/or personnel exposure, and no event consequences challenged Offsite or exceeded Onsite EGs in the immediate vicinity of 241-96H, no SC or SS controls are required.

In the MCU Facility, the radiological consequences for the aerosolization, full-facility fire, and seismic (spill plus fire) events do not challenge Offsite or exceed Onsite EGs. No SC or SS controls are required. The consequences for the 100 meter worker and the public are tabulated in Reference 242.

Nitric acid, boric acid, and sodium hydroxide quantities are such that they are screened from further evaluation. The quantities of solvent constituents are such that the maximum potential release could not result in chemical consequences that exceed Acute Exposure Guideline Limit-3, ERPG-3, or TEEL-3 limits. The TEEL-2 value could possibly be exceeded for the FW; however, no safety-related controls are required.

A comprehensive review of hazards associated with the MCU system was performed utilizing the HAZOP technique to identify possible process accident scenarios. The hazards review is documented in Reference 242. For the waste streams analyzed, consequences did not challenge Offsite EGs or exceed Onsite EGs. Administrative controls are in place to protect assumptions in the accident analyses, the HC 3 status of the facility, and downstream facility accident analyses.

As documented in the CHA (Ref. 242), since none of the radiological and chemical event consequences challenged/exceeded the EGs, no further evaluation is required. Various key inputs and assumptions utilized in Reference 242 are summarized in Tables 3.3-18 and 3.3-19.

3.3.3.3.1 PLANNED DESIGN AND OPERATIONAL SAFETY IMPROVEMENTS

The CSTF was constructed between the early 1950s and mid 1990s. As such, many of the systems were not built to the latest design standards and in some instances there are not sufficient controls to prevent or mitigate all the accidents discussed in Section 3.4. Table 3.3-16 discusses the modifications recommended for DOE approval to improve/achieve compliance with the design standards and ensure sufficient controls for each of the accidents. This DSA, including mitigated consequences, does not credit or account for any of these improvements. The consequences quoted in this chapter credit the currently installed equipment for preventing or

mitigating the given accident scenarios (i.e., no credit is given to the proposed improvements). Section 3.3.3.3.1 is not required to be evaluated against while performing Unreviewed Safety Question reviews, except for the "Currently Credited Control(s)" as presented in Table 3.3-16. These improvements are being pursued in accordance with DOE Order 413.3B (Ref. 35). When these modifications are installed, the DSA will be revised to account for the new equipment.

3.3.3.3.2 DEFENSE-IN-DEPTH

To compensate for potential facility failures, DID is based on several layers of protection with successive barriers to prevent the release of hazardous materials to the environment. This approach includes measures to protect the public, workers, and the environment from harm in case any of these barriers are not fully effective. Defining DID as it exists at a given facility is important for determining a safety basis; however, no requirement to demonstrate a particular number of layers of defense is imposed. Those events that had unmitigated consequences that did not challenge Offsite EGs or exceed Onsite EGs do not have specific DID identified, but DID is provided by the features described within the text of Section 3.4.2 (and subsections) corresponding to these events, the systems described in Chapter 2, the sitewide programs described below, as well as those worker protection controls specified in Tables 3.3-13, 3.3-14, and 3.3-15.

3.3.3.3.2.1 Defense-in-Depth Structures, Systems, and Components

Examination of the HE events results in identification of SSCs that provide DID for many of the events as shown in the HE Tables in References 1, 242, 274, 300, and 307 and Chapter 2 of this DSA.

Table 3.3-22 lists DID/Important-to-Safety (ITS) hazard controls. These were selected from the suite of controls in the supporting hazards analyses. No specific credit is given to these controls insofar as event frequency or consequence reduction, nor is any margin of safety assigned to these controls. However, by being listed in Table 3.3-22, the facility commits to ensuring that each additional DID hazard control is installed. Additionally, since these controls are not included in the TSR, facility operations may continue with these additional DID hazard controls temporarily out of service as permitted and managed by existing site procedures, facility procedures, and Safety Management Programs.

DID/ITS hazard controls are not required for inactive locations identified in Section 3.4.1.5.2 or Closure Waste Tanks (unless otherwise stated in Table 3.3-22). Additionally, in cases where redundancy is provided for an SSC listed in Table 3.3-22, elimination of one of the redundant SSCs does not constitute elimination of the DID/ITS hazard control or degradation of its safety function.

3.3.3.3.2.2 Defense-in-Depth Administrative Features

The primary method for providing DID through administrative controls is the development of facility procedures. These facility procedures are lower tiered documents that implement

site-wide requirements and the requirements of DOE Orders. These procedures also ensure safe facility operation and provide additional means of safety control.

Sitewide Programs

Administrative procedures are in place to govern the following:

- Authority and responsibility for facility safe operation and shutdown
- Equipment control (e.g., Lockout/Tagout)
- Procedure adherence
- Procedure review and control
- Conduct of Operations
- Control of modifications

Operating procedures are in place to govern the following:

- Startup, operation, and shutdown of the facility systems and equipment
- Surveillance requirements

Maintenance procedures are in place to govern the following:

- Control of routine maintenance, inspection, calibration, and test activities
- Preventive and Corrective Maintenance Programs

Other procedural activities govern implementation of the following:

- Safety-related alarm response and emergency response
- Measurement and Test Equipment Program
- Facility Fire Protection Program
- Facility specific annex to the Site Emergency Plan (SCD-7)
- Radiological Protection Program to limit materials released to the environment and to limit personnel exposure
- Industrial Hygiene Program
- Quality Assurance Program
- Critical Lift Program
- Combustible Control Program
- Configuration Management Program
- Industrial Safety Program
- Job HA Program

The implementation of these facility procedures provides the infrastructure for an outer layer of DID for potential events at CSTF. These programs, and the personnel training associated with development of a thorough understanding of hazards in the workplace, result in a work force that is capable of responding to any accident situation in a manner that mitigates the consequences to individuals at the facility and outside the facility. In addition, many potential accidents are prevented due to the implementation of these facility procedures and personnel training.

Although the HA may not address events from inactive locations, it is judged that the hazards associated with these locations will have insignificant consequences. The sitewide programs stated above are sufficient for the control of the hazards associated with the inactive locations identified in Section 3.4.1.5.2, and the analyses and control sets for DBAs in Section 3.4.2 do not apply to these locations. Activities that would introduce additional waste into inactive locations and waste transfers into or through inactive locations are prohibited.

Summary of Facility Specific Programs

- Programs for monitoring equipment condition
- Programs for monitoring tank and transfer systems conditions
- Programs for mobilization of wastes
- Programs for criticality

3.3.3.3.2.3 Safety Significant Structures, Systems, and Components

SSCs that are major contributors to DID or worker safety as determined in the MHA are considered for designation as SS SSCs. The designation of DID design features as SS SSCs is based on the qualitative assessment as discussed above. For the CSTF, the SS SSCs are designated based on them being DID for DBAs and/or their contributions to worker safety. Certain SSCs prevent the FW from being exposed to unnecessary hazards. Tables 3.3-13, 3.3-14, and 3.3-15 list SSCs and administrative controls that are designated as worker safety controls with its corresponding HA event (see Section 3.3.3.3.3). The applicability of the controls for a given evolution is discussed in Section 3.4 and Chapter 5. The CSTF SSCs that are designated as SS are presented in Chapter 4 of this DSA.

3.3.3.3.2.4 Technical Safety Requirements

DOE Standard DOE-STD-3009-94 (Ref. 4) provides basic screening criteria to identify DID features that may require TSR coverage. Items requiring TSR controls are listed in Tables 3.3-13, 3.3-14, and 3.3-15 with its corresponding HA event. The applicability of the controls for a given evolution is discussed in Section 3.4 and Chapter 5. Chapter 5 describes the basis for determining the TSRs for the CSTF.

3.3.3.3.3 WORKER SAFETY

A review of over 1,700 events in the HA (Ref. 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, 307), identified over 460 events in risk bins 1, 4, and 7 (Risk Regions A1, A2, B1, and B) for Onsite receptors. Events in these bins are defined as exceeding the site functional classification EGs for the Onsite receptor according to Tables 3.3-8, 3.3-9, 3.3-20, and 3.3-21.

Consequences for the Onsite 2 receptor (100 meters) for events in risk bins 1, 4, and 7 and for the CW receptor (100 meters) for events in Risk Regions A1, A2, B1, and B are analyzed by AA as DBAs. In conducting consequence assessments of these accidents, consequences to the Onsite 2 (CW) receptor are refined only to the degree necessary to demonstrate that the calculated consequences do not exceed the EGs.

Certain events in the HAs were qualitatively determined to challenge Offsite EGs or exceed Onsite EGs and, thus, are included in Table 3.3-17 as DBAs (see Section 3.3.3.3.5). Based on analysis completed in Section 3.4, some of these events were shown not to require SC or SS controls. These DBA events are shown in Table 3.3-12, which provides reference to the DBA section that shows the event consequences do not challenge the Offsite or exceed the Onsite EGs.

Likewise, other HA events of the same DBA category (e.g., Evaporator Overpressure, Evaporator Overflows, Transfer Errors, 299-H Releases) were qualitatively determined in the HAs to not challenge the Offsite EGs, but exceed the Onsite EGs. Based on the results of the analyses in Section 3.4.2, these events were shown not to require SC or SS controls. These non-DBA HA events (i.e., those judged in the HAs to not challenge the Offsite EGs) are also shown in Table 3.3-12, which provides reference to the DBA section that shows the event consequences do not challenge the Offsite or exceed the Onsite EGs.

Tables 3.3-13, 3.3-14, and 3.3-15 list the identified events requiring the use of SS SSCs or administrative controls to reduce the frequency or consequences of the events. These controls are identified for the bounding accidents postulated in the HAs, and the applicability of the controls for a given evolution is discussed in Section 3.4 and Chapter 5. Many of the features/controls protecting workers contribute to the DID of the facility and are discussed in the preceding section. Features identified as SC or SS SSCs that are protected through TSRs are identified in Chapter 4.

3.3.3.3.4 ENVIRONMENTAL PROTECTION

The process of developing LODs and identifying SC and SS SSCs not only provides protection for Onsite workers and Offsite public, but also provides levels of protection for the environment. It is the objective of the CSTF to handle liquid radioactive wastes in a manner that: 1) prevents release of any potentially harmful quantity of radionuclides or chemicals to the environment, and 2) minimizes exposure of Onsite workers and the public to radiation from these wastes. This applies to both normal and abnormal operation, and accidents.

Normal operation of the CSTF includes efforts to reduce personnel and environmental exposure to airborne and surface liquid releases. Releases due to normal operation are a small fraction of

an individual's typical 300-mrem/year background dose. The 2000 estimated dose for all of 200-Area operation (including CSTF) was 0.04 mrem/year for airborne radionuclides and 0.14 mrem/year for releases directly to surface streams for a maximally exposed individual located at the site boundary (Ref. 5). Likewise, the impact upon the environment is small due to normal operation releases. The design and operation features that protect the public and worker also protect the environment. The objective is to prevent releases that cause unacceptable harm to the Onsite worker, Offsite public, and the environment. Controls include:

- Process areas that normally contain liquid waste (Waste Tanks, Pump Tanks/PPs, Evaporator Cells, some DBs) or contamination are typically equipped with a forced purge exhaust system. The forced ventilation exhaust system is capable of providing a slightly negative air pressure in the process area for environmental protection by ensuring that any air leakage is into the process area. Purge air during ventilation system operation is exhausted through HEPA filters to minimize the release of radioactive nuclides from these process areas.
- Prevention and control of radioactive liquid releases (Ref. 44). The plan includes stormwater runoff control. The stormwater from the CSTF is diverted to retention basins with a minimum capacity of 4 million gallons each.
- A testing program is in place to determine the integrity of the majority of the waste line secondary containments.

Abnormal operations of the CSTF center on preventing and minimizing the consequences of leaks or spills during transfers. Key to protecting the Offsite public and the environment from large surface releases is prevention of leaks and timely detection of a leak so that mitigation can begin. Controls include:

- Components that handle the High Level Waste (HLW) (excluding Type IV Waste Tanks and some transfer line segments) were designed to have secondary containment.
- Waste tanks are set in underground reinforced concrete vaults. This maintains tank leaks as subsurface leaks thereby allowing time for interdiction and mitigation.
- The evaporators are installed in stainless steel lined concrete cells that also provide shielding.
- All transfer lines constructed since 1970 are double-wall pipe with leak detection provided between the inner and outer pipes. Currently, most transfers are conducted through double-wall piping. The typically double contained, self-draining piping system is designed to utilize gravity-assisted flow to the extent practical. The system uses leak detection features and sumps equipped with conductivity probes for leak detection, collection and routing of leaked wastes back to waste tanks. Most of the transfer system pipelines, DBs, and PPs are located below grade. Core pipe not fitting one of these types (e.g., flexible hose) may be used as a temporary transfer line.

- Because of the possibility of leakage at the gasketed joints, some DBs have sumps to collect free liquid and facilitate the detection of leaks using installed conductivity probes.
- Area Radiation Monitors (ARMs) are distributed across the Tank Farms with some overlapping coverage to ensure that any significant surface releases are detected. Adequacy of radiation monitoring coverage is periodically assessed (Ref. 41).

Environmental evaluation is qualitative in nature. Environmental damage from accidental releases is addressed by the following:

- Limits on releases external to the SSCs inherent in the EGs for protection of the public and workers
  - Risk of injury or accident, as measured by the frequency of occurrence and severity of the consequence, meet goals and standards
  - Exposure to radioactivity is below DOE administrative control levels
  - Exposure to toxic materials is sufficiently low that medical effects, including carcinogenic and genetic effects, are insignificant
  - The occupational radiation dose of employees is reduced to as far below the federal exposure limits as is reasonably achievable
- Numerous legally enforceable restrictions on normal operation releases
- Numerous legally enforceable notification and response requirements for releases of hazardous or radioactive materials
- Engineering good practices

Environmental monitoring is used to assess pollutants released from SRS operations and demonstrate that CSTF operations are not adversely affecting the environment or Offsite populations. This information is documented in an Annual Environmental Report.

3.3.3.3.5 ACCIDENT SELECTION

Accident analysis entails the formal quantification of a subset of accidents, known as DBAs that define the safety envelope for the facility. These DBAs are to represent a complete set of bounding conditions. DBAs are defined as those credible accidents with the potential for consequences that require SC SSCs and/or TSR controls. The identification of accidents needing additional quantitative evaluation is accomplished in this section.

A review of over 1,700 events in the HA (Ref. 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) identified over 460 events in risk bins 1, 4, and 7 for the Onsite 2 receptor (100 meters) and in risk bins 1, 2, 3, 4, 5, and 7 for the Offsite receptor (Risk Regions A1, A2, B1, and B for CW and Offsite receptor, Ref. 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) as shown in Table 3.3-17. Events in these bins are defined as “unique” events requiring individual examination according to Tables 3.3-7, 3.3-20, and 3.3-21. Table 3.3-17 lists accidents requiring

analysis in Section 3.4. Various events from the HAs were not considered for analysis based on assumption defense, low/negligible consequences, and further assessment of credibility. Table 3.3-11 provides the rationale for the events not considered for additional analysis, and, hence, controls selection. The remaining events from the HA with potentially significant risks to the Onsite 2 (CW) worker and Offsite public are considered to be DBAs and are analyzed in Section 3.4.2.

Some of the HA events that were judged to challenge the Offsite EG (and thus are included in Table 3.3-17 and analyzed in Section 3.4.2) have similar events in the same class (e.g., Evaporator Overpressure, Evaporator Overflow) that the HAs qualitatively judged would not challenge the Offsite EG. For completeness, some of the supporting consequence calculations and Section 3.4.2 write-ups include discussion and evaluation of these similar HA events that were judged to not challenge the Offsite EG. This was done to quantitatively support the HA judgments and Table 3.3-12 (see Section 3.3.3.3.3).

The Accident Selection identifies events associated with NPHs (i.e., Seismic, Tornado/High Winds, and Wildland Fire). Since the NPH events potentially involve multiple process areas (i.e., has a cumulative effect), additional events (including some that the HA determined to have negligible consequences) have been identified on Table 3.3-17 and included for consideration (as illustrated in the accident progressions). Additionally, although the HA did not address events from inactive locations, it is judged that events involving these locations will have insignificant consequence impact and need not be considered for cumulative NPH effect due to conservatisms in the overall NPH analysis.

In addition, events involving pure chemical releases that were not screened out in the HAs (Ref. 1, 242, 265, 266, 274, 281, 290, 293, 295, 300, 307) have been determined to be SIHs and are not covered in the DSA, with the exception of mercury vapor produced by the Waste Evaporators (see Section 3.4.2.21) and mercury vapor releases from operations involved with Type I/II Acidic Chemical Cleaning Waste Tanks and Chemical Cleaning Transfers. For operations involved with Type I/II Acidic Chemical Cleaning Waste Tanks and Chemical Cleaning Transfers, Reference 274 qualitatively determined that mercury exposure to personnel could exceed the applicable Onsite EGs only for the FW in the immediate vicinity of the event. Therefore, these HA events are not analyzed as a DBA and not included in Section 3.4.2.21. SS SSCs and controls for these mercury exposure related events are identified in Tables 3.3-14 and 3.3-15 to reduce the chemical consequences so that they do not exceed the chemical EGs. Common industrial hazards are covered by national consensus codes and/or standards (e.g., OSHA regulations), which define and regulate appropriate practices without the need for special analysis. The CSTF is designed to handle Standard Industrial Chemical Hazards as described under Procedure Manual 4Q (Ref. 82), WSRC-IM-95-58 (Ref. 81), and Engineering Standards Manual WSRC-TM-95-1 (Ref. 83), which specifies various consensus standards for chemical hazards, storage tanks, chemical process components, etc. regardless of functional classification (i.e., a non-SC or non-SS chemical storage tank would still have to meet these code requirements).

3.4 ACCIDENT ANALYSIS

Section 3.3 discusses the process by which potential accidents are identified for further quantitative analysis. This section describes the methodology used to analyze these accidents. The CSTF was analyzed for potential radiological and chemical hazards, beginning with the development of initiating events and continuing with ST development and consequence evaluation for postulated accidents. The principal purpose of the AA is to identify any SC and SS SSCs and TSRs needed to meet appropriate acceptance criteria to demonstrate protection of the public.

This DSA section is also based on the following general guidance documents:

- Title 10 Energy, CFR, Part 830 (Ref. 3)
- The Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses, DOE Standard DOE-STD-3009-94 (Ref. 4)
- The methodology, guidance, and examples section of the DOE handbook on Airborne Release Rates (ARRs) for RFs, DOE-HDBK-3010-94 (Ref. 14)
- The Safety Strategy for Preparation of the Consolidated CSTF Safety Basis Documents to meet 10 CFR 830 (Ref. 112)
- The Safety Basis Strategy for Updated Total Effective Dose Factors (Ref. 302)

Table 3.4-7 lists radiological and chemical consequence summary results for effective dose equivalents to the Offsite receptor for events quantitatively assessed. The results in Table 3.4-7 include mitigation for those cases where mitigation is needed for the calculated dose to not challenge the EGs.

The calculated doses in Table 3.4-7 also include Onsite receptor (100 meter) doses.

3.4.1 METHODOLOGY

Analysis of a DBA or Beyond Design Basis Analysis (BDBA) involves the calculation of consequences of the accident and the expected frequency of occurrence for the accident. This section describes the methods used to develop the scenario and ST, quantify the frequency and consequences of operational accidents, NPH events, and external events analyzed in Sections 3.4.2 and 3.4.3.

3.4.1.1 Source Term Analysis

Airborne consequences are a result of a mass of material escaping the confines of the primary containment. A number of release scenarios are possible; the specific details of the modeling are provided in Sections 3.4.2 and 3.4.3.

3.4.1.1.1 AIRBORNE RELEASES

The basic methodology used for determining the amount of radioactive or other hazardous material released from a facility to the atmosphere is based on techniques described in the DOE handbook on airborne releases (Ref. 14). This DOE handbook:

- 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 that has the same units as those used to express the amount of MAR (in kilograms [kg] or Curies [Ci]) is determined from the multiplication of the ST parameters, as follows:

Source Term = MAR x DR x ARF x RF x LPF

Where:

MAR = 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 = Damage Ratio. The fraction of MAR actually impacted by accident generated conditions.

ARF = Airborne Release Fraction (or ARR x time [t]). The fraction of MAR that is suspended in air as an aerosol, and thus, is available for airborne transport due to the physical stresses from a given accident. The ARR is the coefficient used to estimate the amount of a radioactive or hazardous material that can be suspended in air by continuously acting mechanisms such as aerodynamic entrainment/resuspension.

RF = Respirable Fraction. The fraction of airborne radionuclides or hazardous material (as particles) that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particles 10-µm Aerodynamic Equivalent Diameter (AED) and less.

LPF = Leak Path Factor. The fraction of radionuclides or hazardous material (in air) transported through some confinement, deposition, or filtration mechanism.

The selection of one of the release terms (i.e., ARF or ARR) for the ST analysis of a specific event is based on the type of event and the nature on the release data available to characterize it. Events where the release occurs suddenly (such as an evaporator explosion) generally employ the “ARF” equation. Events where the release occurs over an extended time, such as an

evaporative release from an open pool of volatile liquid resulting from a spill, generally employ the "ARR x t" equation.

The ST values are generally adjusted during the consequence analysis by dividing them by a time interval (the time of the release or the time over which the dose is received by the receptor) in order to produce "standard" units, such as Ci/sec (for radionuclides) or kg/sec (for hazardous chemicals). With these adjusted units, the ST can be multiplied by the quantity χ/Q (χ/Q is a measure of dispersion during atmospheric transport and normally has units sec/m^3) in the consequence assessment phase.

This product quantity can then be used to determine the inhalation dose (radiological) or concentration (chemical) to a receptor at the dose evaluation point. The conversion of a ST to a receptor dose employs industry-standard computer programs that take other phenomena (such as deposition) into account. The consequence analyses are described further in Section 3.4.1.3.

The most important factors in the above ST equation are the combination of ARF x RF (or ARR x t x RF). The ARF, ARR, and RF values are generally based on the experimental and test data summarized in Reference 14.

Much of the hazardous material in the CSTF can be characterized as having an extremely heterogeneous nature. Radioactive material exists within CSTF in mostly a liquid form, and to a lesser degree in a solid form, in slurries, and powder. The chemicals have a wide range of volatility and physical form. Because of the heterogeneous nature of the material, selection of appropriate MAR and ARF x RF values is generally based on direct use of test data or theoretical calculations and sometimes based (at least in part) on qualitative and/or logical arguments.

The next several sections, below, describe how the values of the factors in the ST equation are determined for the CSTF. The TED factor, which is used to determine the radiological dose to the receptor of interest, is also discussed.

3.4.1.1.1.1 <u>Material at Risk</u>

In AA, the MAR defines the inventory (amount and type of radiological and/or chemical material) present in conjunction with a dispersive energy source. Radiological MAR is usually expressed in terms of curies of activity for the various isotopes that are present in sufficient quantity to contribute to an inhalation dose if a portion of material is dispersed into the atmosphere. Sometimes the MAR is further characterized into components of isotopic activity concentrations per unit volume (C_i) and total volume (V) or equivalently on a mass basis of isotopic activity concentration per unit mass and total mass. The summation of the product of the isotopic Inhalation Dose Conversion Factor ($IDCF_i$) and C_i terms is used to define a radiological dose potential concentration (in units of rem per unit volume) for the inventory. Chemical MAR is usually expressed in terms of total mass of a given chemical constituent.

3.4.1.1.1.2 <u>Airborne Release Fraction</u>

The ARF is the coefficient used to estimate the amount of a radioactive and/or chemical material suspended in air as an aerosol and thus available for transport due to physical stresses from a

specific accident. For discrete events, the ARF is a fraction of the material affected. For mechanisms that continuously act to suspend radionuclides (e.g., aerodynamic entrainment/resuspension), a release rate is required to estimate the potential airborne release from postulated accident conditions. Generally, ARRs are based upon measurements over some extended period to encompass most release situations for a particular mechanism. The rates are average rates for the broad spectrum of situations and, as such, the most typically meaningful time unit to reflect average conditions is 1 hour. There is evidence that in some situations (e.g., aerodynamic entrainment of sparse powder deposits on a heterogeneous surface), the rate of release is not uniform with time. Even in situations where the rates are relatively uniform, the source is depleted by the removal of particles from the surface by aerodynamic forces and the amount of material airborne decreases with time unless the source is continuously replenished.

DOE-HDBK-3010-94 (Ref. 14) provides guidance on acceptable bounding ARFs for various phenomena and is used where applicable. The key elements associated with determining respirable ARFs include:

- The general nature of the material (e.g., solid, liquid, powder, or waste) affected by the event;
- The physical processes involved in the event (e.g., mechanical shock, vibration, fire, explosion); and,
- When applicable, the approximate quantity of kinetic and thermal energy involved in the physical process.

As previously noted, waste in CSTF is mostly in liquid form and will primarily be released as such. For this liquid to become airborne, the waste must be subdivided into particles or droplets small enough to be entrained in the local air flow. The mechanisms by which aqueous waste solutions may become airborne are thermal stress, a free-fall spill, the aerodynamic entrainment/resuspension of the liquid waste, and the venting of pressurized liquid waste.

Most events are treated as having at least two general phases:

- A short-duration phase, where the direct effects of the event cause material to become airborne; and
- A long-duration “resuspension” phase, where material spilled (or otherwise affected), but not made airborne, during the immediate release phase, is made airborne by natural air currents, or by event recovery actions.

STs are calculated for both of these general phases. In complex scenarios, the short-duration phase can be divided into several sub-phases; this is discussed in more detail in each accident section as applicable. The ST analysis results include the time duration of the releases and the elevation of the release.

Several different ARF models and methodologies are used in the HA and AA calculations. The following sections describe these techniques.

Thermal Stress

The temperature of the liquid waste is somewhat greater than ambient temperature because of internal heating. The temperature of the waste may be significantly above ambient temperatures, depending upon its age and content. Under these conditions, if there is a release of waste from the CSTF, the slightly elevated temperature results in some material becoming airborne. The ARFs recommended in DOE-HDBK-3010-94 (Ref. 14) are based on observations at 100°C.

Free-Fall Spill

Aqueous solutions (e.g., waste from a ruptured transfer pipe) that spill onto a hard, unyielding surface can be subdivided into drops by the instability/shear stress at the surface of the liquid during the fall and by impact upon the striking surface (splashing). This action causes some part of the falling liquid to become airborne. Experiments have been performed to establish bounding estimates of the fraction of the falling liquid that can become airborne.

Aerodynamic Entrainment/Resuspension

Liquid can become airborne by the passage of air over its surface through either air flow parallel to the surface or air flow directed onto the surface. As the released liquid waste collects in pools after an accident, some waste may become airborne because of this effect.

Venting of Pressurized Liquid

As waste is pumped through the CSTF Waste Transfer System piping, it is under pressure from the pumps. If the transfer piping is damaged, it is possible that cracks could develop, leading to spraying of the liquid waste. This spraying of the waste could cause the waste to become airborne.

3.4.1.1.1.3 Respirable Fraction

The RF is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particles 10-µm AED and less. Measured experimental data for RFs are much more limited but are from the same general sources used for the ARFs. To keep RFs at a reasonable bounding rather than an ultraconservative level, the RF associated with the measured bounding ARF is generally selected rather than the highest RF value measured. The highest RF values are often associated with the smallest ARFs, and when used in conjunction with the bounding ARF, result in ultraconservative estimates of the RF released. When no measured RF is associated with the maximum measured ARF, but other measured RFs are available for the experimental set, the greatest RFs are generally used. In some cases where significant uncertainty may exist, RFs are arbitrarily set to a value of 1.0 for conservatism. Bounding estimates of RF are developed in this report. DOE-HDBK-3010-94 (Ref. 14) provides guidance on acceptable bounding RFs for various phenomena.

3.4.1.1.1.4 Damage Ratio

The DR is the fraction of the MAR actually impacted by the accident-generated conditions. A degree of interdependence exists between the definitions of MAR and DR. If it is predetermined that certain types of material would not be affected by a given accident, some analysts will exclude this material from the MAR.

The DR is estimated based upon engineering analysis of the response of structural materials and materials-of-construction for containment to the type and level of stress/force generated by the event. Standard engineering approximations are typically used. These approximations often include a degree of conservatism due to simplification of phenomena to obtain a useable model, but the purpose of the approximation is to obtain, to the degree possible, a realistic understanding of potential effects. DOE-HDBK-3010-94 (Ref. 14) provides guidance on acceptable DRs for various phenomena.

3.4.1.1.1.5 Leak Path Factor

The LPF is the fraction of the radionuclides in the aerosol transported through some confinement, deposition, or filtration mechanism. There can be many LPFs for some accident conditions (e.g., the fraction transported from the package, such as a shipping container, to the cell or enclosure; the fraction leaked from the enclosure, cell, or glovebox to the operating area around the enclosure or room; and the fraction leaked from the room to the building-atmosphere interface). Where multiple leak paths are involved, their cumulative effect is often expressed as one value that is the product of all leak path multiples. The LPF is a calculated or standard value based upon (1) established relationships between size of the particulate material, airborne transport mechanisms, and losses by deposition mechanisms, or (2) specified filtration efficiencies. DOE-HDBK-3010-94 (Ref. 14) provides guidance on acceptable LPFs for various phenomena.

A simplified model for estimating the amount of particulate removed due to deposition is provided in Reference 159. The model determines the LPF as a function of the deposition velocity of the aerosol, the air exchange rate of the area into which the aerosol is released, and the volume and surface area of the area into which the aerosol is released. The formula from Reference 159 for the LPF due to deposition is:

$$LPF = \frac{R}{R + V_d \frac{A}{V}}$$

Where:

R = air exchange rate (the ventilation volumetric flowrate divided by the total internal volume of the structure),

V_d = deposition velocity of aerosol,

A = internal surface area of the structure, and

V = internal volume of the structure.

3.4.1.1.1.6 Total Effective Dose Factor

The Total Effective Dose Equivalent (TEDE) value is the historical term for the calculated dose to determine radiological consequences for the receptor of interest from the amount of material that goes airborne at the site of the event. Based on the guidance provided in Reference 302, the TEDE term has been replaced with TED. Similarly, the term Committed Effective Dose (CED) replaces the Committed Effective Dose Equivalent (CEDE) term for internal inhalation dose. The newer terminology is used throughout the DSA even when results are cited from references that use the historic terminology (i.e., TEDE, CEDE). The receptors of interest are the Onsite 2 receptor at 100 meters and the Offsite receptor at the site boundary. The TED factors used in this DSA are discussed in Section 3.4.1.3.1.

3.4.1.1.2 MECHANISTIC MODELS AND METHODOLOGIES

The following sections detail the models and methodologies used in determining terms for the standard ST equation given in Section 3.4.1.1.1.

3.4.1.1.2.1 Explosive Stress

This section summarizes the methods used to calculate the ST resulting from explosions. Included in this section are determination of flammability and explosive limits, flammable vapor generation and concentration, and explosion STs.

Temperature Corrected LFL for Hydrogen

The Lower Flammability Limit (LFL) for hydrogen is 4.0% by volume or 0.04-volume fraction. The stated LFL is for room temperature conditions (i.e., 25°C). Since the LFL is temperature dependent, the LFL is adjusted for the various temperature conditions found in the CSTF using the Burgess-Wheeler Law (Ref. 94). The Burgess-Wheeler Law provides an empirical correlation to correct the LFL to account for temperature variations. This correlation is:

$$LFL_T = LFL_{25C} * (1 - A(T - 25))$$

Where:

LFL_T = LFL at temperature T (in °C)

LFL_{25C} = LFL at 25°C

A = empirical coefficient (Zabetakis attenuation factor), and

T = temperature at which LFL is to be evaluated in °C.

From References 151 and 162, the value of A for hydrogen is 0.0011.

Temperature Corrected LFL for Isopar® L

The LFL for Isopar® L is 0.60% by volume or 0.006-volume fraction. The stated LFL is for room temperature conditions (i.e., 25°C). Since the LFL is temperature dependent, the LFL is adjusted for the various temperature conditions found in the CSTF using the modified Burgess-Wheeler Law (Ref. 224). The modified Burgess-Wheeler Law provides an empirical correlation to correct the LFL to account for temperature variations. This correlation is:

$$LFL_T = LFL_{25^oC} - \frac{0.75}{\Delta H_{c,\,average}}\left(T - 25^oC\right)$$

Where:

LFL_T = LFL at temperature T (in °C)

LFL_{25C} = LFL at 25°C

$\Delta H_{c,average}$ = heat of combustion, and

T = temperature at which LFL is to be evaluated in °C.

From Reference 224, the value of $\Delta H_{c,average}$ for Isopar® L is 1734.1 kcal/mol. The 0.75 is a correlation coefficient derived by Zabetakis.

Flammable Vapor Concentration Determination

Radiolytic Hydrogen Generation Model

The methodology used to calculate the radiolytic hydrogen generation rate is taken from Reference 54. The hydrogen generation rate for a given waste depends on the radiation dose to the waste and the concentration of any hydrogen scavengers that may be present. Free ions of nitrate (NO_3) and nitrite (NO_2) are scavengers that serve to decrease the overall production of hydrogen. To account for the scavenging effect of both of these ions, the NO_{eff}, equal to the nitrate concentration plus one-half the nitrite concentration, is introduced.

The hydrogen generation rate, x_{RAD}, is calculated from the radioactive decay heat using the equation:

$$x_{RAD} = \frac{R_{\beta/\gamma}H_{\beta/\gamma} + R_{\alpha}H_{\alpha}}{10^6}$$

Where:

$R_{\beta/\gamma}$ = volume (ft^3) of hydrogen generated per Million British Thermal Units (MBTU) of heat added from beta or gamma decay

$H_{\beta/\gamma}$ = heat generated by beta and gamma decay (BTU)

R_α = volume (ft^3) of hydrogen generated per MBTU of heat added from alpha decay, and

H_α = heat generated by alpha decay (BTU).

The values of R_α and $R_{\beta/\gamma}$ are dependent on the concentration of nitrate and nitrite in the waste and are given by the equations:

$$R_\alpha = 134.7 - 82.3 * (NO_{eff})^{1/3} - 13.6 * (NO_{eff})^{2/3} + 11.8 * (NO_{eff})$$

$$R_{\beta/\gamma} = 48.36 - 52.78 * (NO_{eff})^{1/3} + 14.1 * (NO_{eff})^{2/3} + 0.572 * (NO_{eff})$$

Where:

NO_{eff} = the nitrate concentration plus one-half the nitrite concentration (where concentrations are in units of mol/L).

The heat generated by alpha and beta/gamma decay is determined by the equations:

$$H_\alpha = \sum_i Q_i * A_i$$

$$H_{\beta/\gamma} = \sum_j Q_j * A_j$$

Where:

H_α = total heat generated by alpha decay

Q_i = heat generated per curie for each isotope that decays by alpha

A_i = total activity of each isotope that decays by alpha

$H_{\beta/\gamma}$ = total heat generated by beta or gamma decay

Q_j = heat generated per curie for each isotope that decays by beta or gamma, and

A_j = total activity of each isotope that decays by beta or gamma.

Corrosion Induced Hydrogen Generation Model

The methodology used to calculate the corrosion induced hydrogen generation rate for OA is based on the area of contact with carbon steel. The rate is specified in Section 3.4.1.5.5. Hydrogen generation rate due to corrosion is:

$$x_{CORR} = \text{Area Contacted x Rate}$$

Total Generation Rate of Hydrogen

The total hydrogen generation rate is the sum of the contribution from radiolytic hydrogen generation and corrosion induced hydrogen generation. This total generation rate is:

$$x_{H_2} = x_{RAD} + x_{CORR}$$

Where:

x_{H_2} = total generation rate of hydrogen

If corrosion induced hydrogen generation is not a contributor, x_{CORR} is zero and the equation becomes:

$$x_{H_2} = x_{RAD}$$

Temperature Corrected Hydrogen Generation Rate

The hydrogen generation rate calculated or assumed is for Standard Pressure at an initial temperature (T_i) (e.g., 25°C). Many of the accidents are assumed to occur at elevated temperatures. Therefore, the hydrogen generation rate must be corrected for the higher temperatures.

From the ideal gas law (and assuming constant pressure):

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Therefore, the hydrogen generation rate (x_{H_2}) of the waste at Standard Pressure and the initial temperature must be corrected by the ratio of the temperatures (temperature in degrees absolute):

$$Q_{H2} = x_{H2} * \frac{(T + 273)}{(T_i + 273)}$$

Hydrogen Concentration

The hydrogen vapor space concentration at any given time depends on the initial hydrogen concentration, the hydrogen generation rate, and the flow rate of air or ventilation flow rate. Given a volumetric flow rate (ventilation) of Q into the cell, the mole fraction (concentration) of hydrogen gas [y(t)] is:

$$y(t) = \left(y_0 - \frac{Q_{H_2}}{Q_{H_2} + Q} \right) e^{-\left(\frac{Q_{H_2} + Q}{V_v}\right)t} + \frac{Q_{H_2}}{Q_{H_2} + Q}$$

Where:

$y(t)$	=	mole fraction of hydrogen at time (t)
y_0	=	initial hydrogen mole fraction
Q	=	volumetric flow rate of air into the tank vapor space
Q_{H_2}	=	total evolution rate of hydrogen into the vapor space
V_V	=	volume of the vapor space

This formula is used to determine hydrogen concentration in the vapor volume at any given time. If the evolution rate of hydrogen is zero, the formula reduces to:

$$y(t) = (y_0)e^{-\left(\frac{Q}{V_v}\right)t}$$

For any given box after the spill of waste, there is hydrogen buildup due to the radiolytic decomposition of water. This spill and hydrogen buildup will not increase pressure in the box because the process is relatively slow and there are leak paths through cell covers and ventilation piping. These leak paths are at the top of the boxes, which would more likely vent off hydrogen than other gases in the hydrogen-air mixture. Assuming uniform mixing of the hydrogen with the air is, therefore, conservative.

Well-Mixed Vapor Space without Ventilation

The hydrogen concentration reached due to a specified evolution rate for a given time period can be expressed, using the ideal gas law and assuming a well-mixed vapor space, as:

$$y_{H2} = \frac{R_{H2} \cdot t}{R_{H2} \cdot t + n_v} \approx \frac{R_{H2} \cdot t}{n_v} = \frac{Q_{H2} \cdot t}{V_v}$$

Where:

y_{H_2}	=	concentration in the vapor space (mole fraction, unitless)
Q_{H_2}	=	total hydrogen volumetric evolution rate (ft^3/hour)
V_v	=	vapor space volume (ft^3)
R_{H_2}	=	molar hydrogen evolution rate, and (mole/second [s])
n_v	=	number of moles of gas in the tank vapor space (mole)
t	=	time (s)

The approximation made in the preceding equation implicitly assumes that the amount of hydrogen in the vapor space is small relative to the total amount of gas, which is a valid assumption for all cases of interest (i.e., hydrogen concentrations not greatly in excess of the LFL). This expression also implicitly assumes that hydrogen does not escape from the vapor space; this is a simplifying assumption that does not introduce significant error for small hydrogen concentrations. Hence, the time required to reach the LFL (t_{LFL}) at the specified evolution rate is:

$$t_{LFL} = y_{LFL} \cdot (1 - f_i) \cdot \left(\frac{V_v}{Q_{H2}} \right)$$

Where:

t_{LFL} = time required to reach the LFL (hr)

f_i = initial concentration as a fraction of the LFL

y_{LFL} = hydrogen concentration at LFL (mole fraction, 0.04)

V_v = vapor space volume (ft^3)

Q_{H_2} = total hydrogen volumetric evolution rate (ft^3/hour)

Vapor Space Hydrogen Concentration Due to Dissolved Hydrogen

If it is assumed that the hydrogen concentration in a vapor space due to dissolved hydrogen is in equilibrium conditions, then the solubility and the dissolved hydrogen concentration can be used to determine the change in the vapor space hydrogen concentration during heatup of the liquid. As the liquid heats up, if the solubility in the liquid decreases, the amount of hydrogen released to the vapor space is equal to the difference in the solubilities at the initial temperature and the final temperature. Note that another determining factor in the amount of hydrogen that can be released is the liquid waste volume. The larger the liquid volume, the more dissolved hydrogen is present in the waste to be released.

The amount of hydrogen released can then be used to determine the volume of hydrogen released to the vapor space using the equation:

$$Volume_{H2} = \frac{\Delta c \text{ mg/L} * V_L * 22.4 \text{ L/gmole} * (\text{T} + 273) \text{ K}}{1000 \text{ mg/g} * 2.016 \text{ g/gmole} * 273 \text{ K}}$$

Where:

Δc = change in dissolved hydrogen concentration (mg/L),

V_L = liquid waste volume (gal),

22.4 = molar volume at Standard Temperature and Pressure (STP: 0°C and 1 atmosphere) (L/g-mole),

T = temperature of interest (°C),

2.016 = molecular weight of H_2 (g/g-mole), and

273 = 0°C in degrees Kelvin (temperature at which molar volume is 22.4 L/g-mole).

This equation will give the volume of dissolved hydrogen released to the vapor space in units of gallons. Since at a given liquid level the vapor space has a constant volume, the volume fraction and volume percent hydrogen concentration in the vapor space as a function of temperature during heatup can be determined.

Adiabatic Combustion Pressure Model

A conservative constant-volume adiabatic combustion model can be used to calculate the pressure as a result of combustion. The governing equation of this model is the First Law of Thermodynamics for a closed system (Ref. 111):

$$Q - W = \Delta U = U_1 - U_0$$

Where Q is the heat released by the hydrogen deflagration; W is the work; U is the internal energy, and the subscripts 0 and 1 designate initial and final states, respectively. If no work is assumed (i.e., constant volume), the preceding equation becomes:

$$Q = m\,(u_1 - u_0) = m\,\overline{C}_V\,(T_1 - T_0)$$

Where $\overline{C}_V$ is the specific heat of the gas mixture; m is the mass of the gas mixture, and T is the temperature. Upon rearranging, this equation can be written as:

$$T_1 = T_0 + \frac{Q}{m\,\overline{C}_V}$$

For a mixture of air (hydrogen and air), the constant volume specific heat C_V can be calculated by the mass-weighted average of the individual gases; i.e.,

$$\overline{C}_V = \frac{m_a}{m} C_{Va} + \frac{m_H}{m} C_{VH}$$

Where the m is total gas mass, which is the sum of the mass of hydrogen (m_H) and the mass of the air (m_a). The gas masses can be calculated by the Ideal Gas Law, i.e.,

$$m_H = [H_2]\frac{M_H\,P_0\,V_V}{\overline{R}\,T_0}$$

$$m_a = \{1 - [H_2]\}\frac{M_a P_0 \; V_V}{\overline{R}\, T_0}$$

Where:

P_0 = Pressure before ignition,

T_0 = Temperature before ignition,

$\overline{R}$ = Universal Gas Constant,

M_H = Molecular weight of hydrogen,

M_a = Molecular weight of air, and

V_V = Vapor Space volume.

For a constant volume process, the combustion pressure is proportional to the final temperature. Expressing in gauge, the adiabatic combustion pressure is:

$$P = \frac{P_0\left(\frac{T_1}{T_0}\right)}{6895(\text{Pa/psi})} - P_{atm}$$

The adiabatic pressure calculated by this model should be viewed as very conservative because of the following reasons:

- No heat loss to the surroundings is assumed
- The present analysis assumes the air is dry and moisture effect (in the form of humidity or combustion product) is not accounted for
- The entire combustion energy is used to calculate the pressure. The energy used to vaporize the liquid is not deducted
- Sufficient oxygen is assumed to be always available for complete combustion
- The reduction of the total number of moles of gases resulting from the combustion (i.e., it takes two hydrogen molecules and one oxygen molecule to form two water molecules) is not accounted for

Energy of Combustion

The energy of combustion for a hydrogen explosion is calculated by the product of the number of moles of hydrogen and its molar combustion energy:

$$E_T = (n_H + n_H^*)\varepsilon_H$$

Where ε_H is the molar combustion energy of hydrogen (57.8 x 10^3 cal/mole x 4.187 J/cal) and n_H is the total number of moles of hydrogen, which is given by:

$$n_H = \frac{[H_2]\, V_v}{\frac{(T+273)}{273} 22.4\,(\text{L/mole})}$$

And n_H^* is the total number of moles of "equivalent" hydrogen due to the presence of organics. Therefore, number of moles of equivalent hydrogen is:

$$n_H^* = \frac{\left(\frac{E_{org}}{100}\right) V_v}{\frac{(T+273)}{273} 22.4(\text{L/mole})}$$

Where E_{org} is the hydrogen energy equivalency (in vol. %) of any organics present.

Deflagration Model

A deflagration is assumed to occur if the hydrogen concentration is between LFL (4%) and Lower Explosive Limit (LEL) (12%). Two potential STs could contribute to the consequences of a deflagration:

- Vaporization from the liquid surface
- Entrainment from the liquid surface

The consequences resulting from a deflagration would be much less severe than those of a detonation because of the lower pressures involved.

Vaporization from the Liquid Surface

During a deflagration, thermal radiation is emitted from the hot product gas and deposited in the waste solution, resulting in vaporization at the liquid surface. A portion of the energy from the heat of combustion would go into boiling the top layer of waste. If the top layer is supernate, the underlying sludge will be protected from the heat and airborne radioactivity will be less hazardous.

The energy available in the vapor space is calculated based on the combustible gas density and heat of combustion for the combustible gas mixture. Hydrogen is the main combustible in the waste tanks with trace amounts of organics and non-organic gases. Effects of organics on explosion have been accounted for, as discussed in Sections 3.4.1.5.3 and 3.4.1.5.4.

The fraction of this energy that is deposited into the liquid surface is taken to be equal to the fraction of the total surface area represented by the liquid; this assumes that no energy is lost by venting and that the heat flux from the product gas volume is uniform:

$$F = E_T (A_F / [A_W + A_C + A_F])$$

Where:

F	=	energy deposited into the liquid surface
E_T	=	total energy from the combustion of hydrogen gas
A_F	=	footprint area (typically the liquid surface area)
A_W	=	area of exposed walls
A_C	=	ceiling area

The deposited heat is assumed to evaporate the uppermost layer of the liquid (i.e., no conduction away from the liquid surface). An ARF value of 0.1 and an RF value of 1.0 are employed for source generation via rapid liquid vaporization based on the discussion given in Reference 147. This ARF is different from the standard definition in that it applies only to the fluid that is evaporated.

The MAR is calculated as follows:

$$MAR = \frac{MW * V_{vap} * E_H * F}{v * (C_p \Delta T + H)}$$

Where:

MW	=	Molecular weight of hydrogen
V_{vap}	=	Volume of hydrogen
E_H	=	Heat of combustion of hydrogen + applicable organic energy correction factor (per unit mass)
F	=	Ratio of Heat Transfer Surface Area/Total Vapor Surface Area
v	=	Specific volume of gas at STP (temperature-corrected as applicable)
C_p	=	Specific heat of liquid
ΔT	=	Temperature differential to raise the temperature to boiling

H = Latent heat of vaporization of liquid

Using this approach, the DR is set equal to one, since the amount of the MAR actually impacted by the accident-generated conditions has been implicitly considered.

Entrainment from the Liquid Surface – Specified Velocity

During a deflagration, liquid could be entrained from the waste solution surface by high-velocity gas moving across the surface and up to the vent holes (e.g., risers) at the top of the enclosed space. Reference 110 evaluated this mechanism using a model developed by Fauske and Associates along with relevant experimental data. Reference 110 concludes that there would be no entrainment if the liquid surface were more than 2 to 4 vent diameters away from the vents. The 2-vent diameter is based upon a correlation of experimental data. The 4-vent diameter is calculated from an analytical model.

For those cases where the liquid surface is not more than 2 to 4 vent diameters away from the vents, a semi-mechanistic model is provided to describe liquid entrainment during high pressure blowdown through a containment vent or breach to the environment. This model requires a specified velocity for the deflagration (for the cases where a velocity is not specified an alternate model follows).

In general, during a deflagration blowdown, an effective mass discharge rate ($\dot{m}_g$) through a containment vent or breach may be approximately determined using the following equation:

$$\dot{m}_g = C_D \cdot A \cdot \sqrt{\gamma \cdot p \cdot \rho_g \cdot g \cdot \left(\frac{2}{\gamma+1}\right)^{\left(\frac{\gamma+1}{\gamma-1}\right)}} \qquad p > p_{crit} = p_{atm} \cdot \left(\frac{\gamma+1}{2}\right)^{\left(\frac{\gamma}{\gamma-1}\right)}$$

$$\dot{m}_g = C_D \cdot A \cdot \sqrt{2 \cdot p \cdot \rho_g \cdot g \cdot \left(\frac{\gamma}{\gamma-1}\right) \cdot \left[\left(\frac{p_{atm}}{p}\right)^{\left(\frac{2}{\gamma}\right)} - \left(\frac{p_{atm}}{p}\right)^{\left(\frac{\gamma+1}{\gamma}\right)}\right]} \qquad p < p_{crit}$$

Where:

C_D = Discharge coefficient (modeled as 0.7, based on a sharp edged orifice)

A = Vent or breach area

p = Gas pressure in the vapor space

ρ_g = Gas density (at vapor space conditions)

γ = Specific heat ratio ($=c_p/c_v$)

g = Gravitational constant

p_{atm} = Atmospheric pressure

p_{crit} = Critical pressure

Assuming a constant volumetric flow, may also be written as:

$$\dot{m}_g = \rho_g VA$$

Where:

ρ_g = Gas density (at vapor space conditions)

V = Flow velocity at the vent or breach

A = Vent or breach area

Corresponding to the velocity at the vent or breach, a minimum gas velocity (V_{ent}) required for entrainment at the liquid surface away from the breach may be also defined as:

$$V_{ent} = 3.1 \cdot \left(\frac{\sigma \cdot g \cdot \rho_f}{\rho_g^2} \right)^{0\ 25}$$

Where:

g = Gravitational constant

σ = Surface tension

ρ_f = Waste liquid density

The entrainment rate is now calculated by integrating the local entrainment rate at the liquid surface over the affected surface area, wherever the gas velocity exceeds the minimum entrainment velocity. This is expressed as:

$$\dot{m}_e = \int_{r_0}^{r_{ent}} E_0 \cdot \sqrt{\rho_f \cdot \rho_g} \cdot V(r) \cdot 2\pi\pi \cdot dr$$

Where:

$\dot{m}_e$ = Entrainment rate (entrained liquid mass flow rate)

E_o = Entrainment coefficient (assumed to = 0.1 based on data for single phase jets)

V(r) = $V_v \cdot r_o^2 / 2 \cdot H \cdot r$ = Gas velocity distribution modeled as radial near the vapor space vent, (i.e., by continuity, $V_v\ \pi r_0^2 = V(r) \cdot 2\pi r \cdot H$)

V_v = Gas velocity in the entrance to the vent

r = Radial distance from the vapor space vent radius at $r = r_0$ (where $V(0) = V_v$) to the point where the velocity drops below the entrainment velocity

r = $r_{ent} = V_v \cdot r_o^2 / 2 \cdot H \cdot V_{ent}$, and

H = Freeboard (vertical distance between the vapor space vent plane and liquid surface).

Substituting the relationship for V(r) and integrating the equation over radial distance (r) from r_0 to r_{ent}, keeping V_v, ρ_f and ρ_g constant, yields the following relationship for entrainment rate:

$$\dot{m}_e = E_0 \cdot \sqrt{\rho_g \cdot \rho_f} \cdot V_v \cdot \left(\pi r_0^2\right) \cdot \left(\frac{r_0}{H}\right) \cdot \left[\frac{1}{2} \cdot \frac{V_v}{V_{ent}} \cdot \left(\frac{r_0}{H}\right) - 1\right]$$

Substituting $V_v = \dfrac{\dot{m}_g}{\rho_g A_v}$ for the vapor space vent velocity (V_v), (πr_0^2) for the vapor space vent area (A_v), and rearranging, the fraction of waste liquid entrained per unit of mass blowdown is:

$$\left(\frac{\dot{m}_e}{\dot{m}_g}\right) = E_0 \cdot \sqrt{\frac{\rho_f}{\rho_g}} \cdot \left(\frac{r_0}{H}\right) \cdot \left[\frac{1}{2} \cdot \left(\frac{V_v}{V_{ent}}\right) \cdot \left(\frac{r_0}{H}\right) - 1\right]$$

The total entrainment rate can be estimated by using the initial value of this mass rate ratio (i.e., for the initial values of ρ_f, V, and V_{ent}) along with the total gas mass that must be vented. Assuming an isentropic blowdown to atmospheric pressure (where p/ρ^γ = constant), the total gas mass vented is:

$$m_g = m_{initial} \cdot \left[1 - \left(\frac{14.7}{p}\right)^{1/\gamma}\right]$$

Where:

$m_{initial}$ = The initial amount of gas in the vapor space = $\rho_g V_{vs}$

Finally, the amount of liquid entrained may be bounded by:

$$m_e = m_g \cdot \left(\frac{\dot{m}_e}{\dot{m}_g}\right)_{initial}$$
$$= m_{initial} \cdot \left[1 - \left(\frac{14.7}{p}\right)^{1/\gamma}\right] \cdot \left(\frac{\dot{m}_e}{\dot{m}_g}\right)_{initial}$$

Where:

γ = The specific heat ratio (c_p/c_v)

Entrainment from the Liquid Surface – No Specified Velocity

In the case that the combustion product gases travel parallel to the liquid surface, it is possible that some liquid can be entrained (by shear force) by the gases to the environment through a break. Examples for this kind of release are deflagration in the tank vapor space with liquid level very close to the exit pipe and deflagration in a partially filled pipe. It is possible to evaluate the entrainment ST by postulating that the RF is controlled by the kinetic energy of the gas and the liquid surface tension. However, this is applicable only if a characteristic velocity parallel to the liquid surface can be specified. In some cases (e.g., an annulus explosion), it is difficult to define such a characteristic velocity because the liquid surface is well below the over-fill pipe line where the gas velocity is parallel to the liquid surface. As a result, an alternate Pressure Release ST model can be used for a given waste volume (V); i.e.,

$$ST_{PR} = V * ARF * RF$$

From Reference 14, it is known that for pressures up to 50 pounds per square inch gauge (psig), the bounding ARF and RF are 5E-05 and 0.8, respectively. In the present analysis, it is postulated that the ARF has a pressure dependence; i.e.,

$$ARF * RF = 4 \times 10^{-5}\left(\frac{P}{50}\right)$$

Where P is the adiabatic deflagration pressure expressed in psig.

Detonation Model

Detonations are assumed to be possible if the hydrogen concentration is greater than LEL. For detonations, the Trinitrotoluene (TNT) equivalent model (conservatively using the TNT heat of combustion rather than the heat of detonation) outlined in Reference 14 is used in a modified form (modifications are due only to conversion factors). In this model, M, the mass of liquid made airborne by the detonation is set equal to the mass of TNT that would give the same total energy release as that due to the gas-phase combustion of hydrogen, calculated by:

$$M = \frac{MW * V * E}{v * E_{TNT}}$$

Where:

MW	=	Molecular Weight of the Combustible Gas
	=	2.016 g/g-mole for H_2
V	=	Volume of Combustible Gas
	=	Volume % of Combustible Gas x Vapor Space Volume
E	=	Heat of Combustion
	=	28.7 kilocalorie/g H_2
ν	=	Specific Volume of Combustible Gas (l/g-mole)
	=	24.45 l/g-mole at STP (25°C and 1 atmosphere)
E_{TNT}	=	Specific Energy of TNT
	=	4,520 kilojoule/kg

The detonation MAR is taken to be the amount of radionuclides present in this amount of liquid. DR, ARF, and RF are set equal to one.

3.4.1.1.3 LIQUID RELEASES

The consequence results stated in the DBAs are for airborne releases. The consequences do include a contribution due to shine for the Onsite receptor. The consequence results for the Offsite receptor do not include a contribution due to ingestion or waterway release due to the relatively long time it takes for potential liquid pathway releases from CSTF events to reach the dose receptors and the ability of credited controls (e.g., PPs, DBs) and the Emergency Preparedness Program to mitigate any ingestion or waterway release prior it to contributing significantly to the overall DBA consequence (Ref. 39). Radionuclides undergoing retarded flow (in which the waste interacts with immobile soil particles) reach the surface water in times

ranging from thousands to tens of thousands of years (Ref. 93). Radionuclides subject to unretarded flow (in which the waste interacts with the mobile soil particles thereby undergoing facilitated transport) reach the surface water in a matter of years. However, only a small fraction of the soil particles (approximately 0.1-0.01%) flow through soil pores with the groundwater.

3.4.1.2 Frequency Methodology

HE Tables bin hazards qualitatively into two-order-of-magnitude frequency categories as defined in Reference 4. This qualitative binning of frequencies is sufficient for the HA phase; however, frequencies for accidents selected for further analysis may be evaluated quantitatively to verify they have been categorized appropriately. A graded approach is used in the quantitative assessments to apply effort commensurate with the consequences of the hazard. For example, if an event is shown to be in the unlikely frequency category using conservatively bounding assumptions and the consequences are acceptable compared with the evaluation criteria, no attempt is made to refine the analysis to bring the frequency of that event into a lower frequency category. The following section describes the methods used to quantify frequencies of occurrence for various types of hazards listed in Section 3.3.

Frequencies of events may be determined in a variety of ways depending on the amount of data available and the significance of the event being analyzed. For process-related events for which an abundance of data exist, the frequency and other statistical parameters can be determined using the STATPAC computer code or an equivalent code (Ref. 113). An arithmetic average is used when only a limited amount of data is available. Fault tree or event tree analysis techniques may be used to quantify events where there is no direct data available.

3.4.1.2.1 WASTE MANAGEMENT FAULT TREE DATA BANK

The Waste Management Fault Tree Data Bank is a compilation of incidents that have occurred in the Waste Management facilities (Ref. 114). It contains more than 35,000 entries ranging from minor equipment malfunctions to incidents with significant potential for injury or contamination of personnel. Data entries have been abstracted from 53 types of sources (47 site publications and 6 site unpublished sources such as logbooks).

For the CSTF, the data bank was used as the initial reference with the following limitations:

- Prior to January 1979, the data bank is used only to determine the occurrence of specific incidents, since log book entries were not included.
- Between January 1979 and January 1990, the data bank can be treated as complete.
- From January 1990 onwards, the data bank cannot be used since it is incomplete.

3.4.1.2.2 GENERIC COMPONENT FAILURE DATABASE

A number of generic databases for component failure rates exist. These generic databases include databases that include limited SRS-specific component failure rates and failure modes as well as chemical and nuclear industry failure rate databases (Ref. 45, 115, 116).

3.4.1.2.3 STATPAC - FREQUENCY DETERMINATION FOR ABUNDANT-DATA CASES

The primary objective of STATPAC is to determine the "best-fit" density function given a set of time-between-occurrence data (Ref. 113). Five types of distribution are considered: normal, lognormal, exponential, Weibull, and log uniform. To accomplish this objective, statistical procedures for estimating parameters and selecting "best-fit" distributions are required.

Parameters associated with a distribution can be estimated using statistical procedures such as Maximum Likelihood (ML), moment estimation, and least squares methods. Selection procedures such as the chi-square test, Kolmogorov-Smirnov statistic, and Atkinson's method could be used to determine the "best-fit" distribution function (Ref. 46). The method used in STATPAC involves the estimates of the distributions parameters and the selection of the best among the five estimated distributions. The most commonly used parameter estimation procedure in statistical literature is the ML method. This method chooses the estimator functions of the sample such that the likelihood function is maximized. The main advantage of using the ML method is that the estimator is consistent and asymptotically unbiased and has an asymptotic normal distribution. The ML estimation is only asymptotically unbiased and may not produce an unbiased estimate elsewhere. Therefore, some modifications to the ML method have been made for four of the distributions (all except the Weibull distribution) to ensure that the estimators are unbiased. Additional details regarding STATPAC and the ML method are presented in Reference 113.

3.4.1.2.4 ARITHMETIC AVERAGE - FREQUENCY DETERMINATION FOR LIMITED-DATA CASES

For process-related events in which less than 10 occurrences are recorded, STATPAC calculations lose their validity. In such cases, an arithmetic average is used over the historical lifetime of the facility. The data are also examined for validity over the specific time frame in question.

3.4.1.2.5 DELETED

3.4.1.2.6 HUMAN RELIABILITY ANALYSIS

The purpose of Human Reliability Analysis (HRA) is to provide an estimate of the probability of human error in the formulation of fault and event trees.

A human error is an action that fails to meet some limit as defined for the required operation of a system. These actions may involve manipulations of a system (i.e., closing a valve) or a cognitive action (fault diagnosis or decision making).

HRA includes the identification of environments that could lead to human error as well as an estimation of the probability of that error.

The techniques for performing an HRA have the following steps:

- Identification of relevant tasks performed by operators
- Representation of each task by some method, such as decomposition of the task into its principal components to identify the following:
  - Opportunities for error
  - Points of interaction with the plant
- Use of data derived from historical records or judgment; some techniques have their own database as well
- Identification of the existence of conditions that affect error rates. These conditions are termed performance-shaping factors that take into account stress, training, and the quality of displays and controls used by operators

The results of the HRA are expressed in the form of Human Error Probabilities (HEPs) or Rates:

$$\text{Human Error Probability} = \frac{\text{Number of errors}}{\text{Number of opportunities for error}}$$

$$\text{Human Error Rate} = \frac{\text{Number of errors}}{\text{Total task duration}}$$

There are two major techniques for obtaining human error quantification:

3.4.1.2.6.1 <u>Technique for Human Error Rate Prediction</u>

Technique for Human Error Rate Prediction (THERP) involves reducing a procedure or overall tasks into unit tasks and combining this information in the form of event trees. Conditional probabilities of success or failure for each branch of the tree are estimated. The event tree calculations are then performed (Ref. 119).

3.4.1.2.6.2 <u>Accident Sequence Evaluation Program</u>

The Accident Sequence Evaluation Program is a shorter and more conservative method for HRA than THERP (Ref. 120). This method is used only for initial screening of the importance of human error. The short method estimates the HEP for two states in an accident sequence:

- Pre-accident

- Post-accident

To complete any HRA, a detailed description of the process system, procedure, and overall task must first be developed. Application requires expert judgment, comprehensive data, or direct estimates of HEP data, depending on the technique used. The most common HEP data can be derived from nuclear power plants but can be applied with judgment to chemical plants (Ref. 121).

3.4.1.2.7 FREQUENCY DETERMINATION FOR NATURAL PHENOMENA

DSAs require consideration of the risks of incidents caused by natural events. Natural events of interest to SRS safety analysts include high-velocity straight winds, tornadoes, earthquakes, hurricane, flood, precipitation, lightning strike, or extreme cold or heat. The NPH standard provides criteria for the design of new SSCs and for evaluation, modification, or upgrade of existing SSCs so that DOE facilities safely withstand the effects of the previously listed NPHs. DOE-STD-1020-2016 (Ref. 19) provides consistent criteria for all NPHs and for all DOE sites across the United States.

3.4.1.3 Consequence Analysis

The highlights and conclusions of standard environmental transport/dosimetry methodology and codes used at SRS are provided in the following section.

3.4.1.3.1 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR ACCIDENTS

Consequences of releases of radionuclides under postulated accident conditions were estimated with Version 1.5.11.1 of MACCS and Version 1.13.1 of MACCS2 code (Ref. 125, 126, 229, 230, 231). MACCS/MACCS2 models the dispersion of radioactivity in the atmosphere from the nuclear facility and computes plume depletion effects. MACCS/MACCS2 then calculates the effects of this radioactivity to downwind receptors and to the environment. During plume passage, doses and associated health effects are computed for inhalation from the plume, immersion or cloudshine, groundshine, deposition on the skin, and inhalation of resuspended ground contamination. Long-term effects such as ground contamination and economic impacts, and ingestion of contaminated water and foodstuffs, inhalation of resuspended material, and groundshine to the individual may also be calculated.

MACCS/MACCS2 predicts dispersion of radionuclides by the use of multiple, straight-line Gaussian plumes (with Tadmor-Gur set of dispersion coefficients). Although each plume treats the released material as a neutrally buoyant gas, the direction, duration, sensible heat, and initial radionuclide concentration may be varied from plume to plume. Cross-wind dispersion is treated by a multi-step function and both wet and dry depositions features can be modeled as independent processes. Meteorological variability is treated with a stratified random sampling algorithm. Based on this sampling and dose and health effects models, a Complementary

Cumulative Distribution Function is calculated for the consequence of interest. The average, median, peak, 90th, 95th, 99th, and 99.5th quantile doses are output in a tabular format.

The regulatory basis for obtaining meteorological data and performing dispersion analyses is cited in DOE-STD-3009-94 (Ref. 4). DOE-STD-3009-94 invokes Regulatory Guide 1.145, Position 1.2 and Position 3 (Ref. 269), and Regulatory Guide 1.23 (Ref. 270). The CSTF demonstrates compliance with applicable sections of Regulatory Guide 1.145 (Ref. 269) and Regulatory Guide 1.23 (Ref. 270) in Reference 271.

The results of the MACCS/MACCS2 calculations are given in the tables of maximum resultant TED over various user-specified release periods (e.g., 3-minute, 20-minute, 1-hr, 2-hr, 8-hr, and 10-hr). Unit TED factors (e.g., rem/gal, rem/g, rem/Ci) are typically calculated and used with ST values (units of gallons, grams, or radionuclide curies) to determine the TED incurred by the receptor of interest that is released into the atmosphere at the location of the event. The receptors of interest are the Onsite 2 receptor at 100 meters and the Offsite receptor at the site boundary. The Onsite TED values are reported at the 50th quantile dose level (see further discussion below) and the Offsite TED values are reported at the 95th quantile dose level (see further discussion below) according to References 165 and 4, respectively. The unit TED factors used for various release mechanisms and durations are taken from the following references:

- S-CLC-G-00266: Radiological Consequence Analysis of Concentration, Storage, and Transfer (CST) Airborne Unit STs (Ref. 109)
- S-CLC-F-00593: F-Area and H-Area Tank Farm Radiological Consequence Analysis for Unit Curie Releases (Ref. 232)
- S-CLC-G-00267: Radiological Consequence Analysis of CST Unit STs Released During a Postulated Tornado (Ref. 108)
- S-CLC-G-00268: Radiological Dose Potential for Unit CST STs (Ref. 106)
- S-CLC-G-00269: CST Surface Water Unit Material Radiological Consequence Analysis (Ref. 105)
- S-CLC-G-00379: Total Effective Dose Factors for CSTF Waste Streams (Ref. 303)

The set of unit TED factors used in each of the individual accidents is specified in each accident consequence calculation.

The cloudshine and groundshine Dose Conversion Factors (DCFs) used are based on Federal Guidance Report 12 (Ref. 10). The inhalation 50-year CED DCFs were based on Publication 68 and 72 of the International Commission on Radiological Protection (ICRP) (Ref. 50, 51) as taken from the ICRP Dose Coefficient Database Compact Disc (Ref. 53). The receptor individual will be an adult worker and an adult member of the general public.

ICRP Publications 68 and 72 (Ref. 50, 51) give inhalation DCFs for the worker and general public. These values are based on the ICRPs 1990 recommendations on radiation protection standards in Publication 60 (Ref. 11), as well as the revised kinetic and dosimetric model of the respiratory tract in Publication 66 (Ref. 49). Since the issuance of ICRP Publications 68 and 72 (Ref. 50, 51), the ICRP has issued a compact disc with a dose coefficient database (Ref. 53)

using the same models. The database gives both organ and effective dose coefficients. Additionally, the database gives the user greater flexibility by including dose coefficients for ten particle sizes and ten commitment time periods as well as six ages at exposure.

For a workplace population, ICRP Publication 68 (Ref. 50) recommends a particle size of 1 µm or 5 µm (default value) Activity Median Aerodynamic Diameter (AMAD). For members of the general public, ICRP Publication 71 (Ref. 52) recommends a particle size of 1 µm AMAD as a default value. However, a particle size of 1 µm or 5 µm AMAD would not be characteristic of the release passing through a filtration system since a HEPA filter would remove all particles greater than 0.3 µm in aerodynamic diameter. Therefore, for the filtered release, a particle size of 0.1 µm AMAD will be used for the Onsite worker population and adult members of the general public.

The DOE- Environmental Management (EM) issued a memorandum in July 2006 specifying the methodology for calculations of Onsite (100 meter) worker radiological consequences from radiological releases postulated in a facility's accident analysis. This methodology is referred to as DOE-EM Interim Guidance and differs from initial CSTF methodology (described above) in two parameters: 1) Meteorological conditions used in the MACCS/MACCS2 calculations (95th percentile consequence level vs. 50th percentile consequence level), and 2) Surface roughness factor (3 cm vs. 100 cm). The adjustment of these parameters results in an Onsite consequence factor increase of approximately 10 above that which historically has been used in the CSTF consequence calculations. In March 2009, the CSTF DBAs that have Onsite mitigated consequences were re-evaluated based on the DOE-EM Interim Guidance (Ref. 255). The re-evaluation of Onsite mitigated consequences did not include events in the Hazards Analysis that did not carry forward into the Safety Analysis. Events with an increase in mitigated Onsite consequence have been categorized as follows:

- Conservatism sufficient to offset the difference in methodologies
- Events requiring controls which have been credited in other events that used the existing CSTF methodology
- Events requiring new controls

DBAs with increased mitigated consequences for the Onsite worker have controls specified to reduce the consequence to below the EGs. In some events conservatisms have been included in the consequence values. For the engineering calculations were not revised utilizing DOE-EM Interim Guidance, the engineering calculation conclusions were modified by Reference 255 and are contained in the analysis.

Additionally, the DOE-EM Interim Guidance establishes an Onsite EG of 100 rem TED as a definitive value to be used for safety-related controls criteria. "Challenging" the radiological EGs is no longer applicable for the Onsite worker. As per Reference 255, changes to NPH roll-up events are not included in the evaluation (i.e. utilizes initial methodology [50th percentile consequence level and 100 cm surface roughness]).

The SRS engaged in a Dispersion Modeling Project to revise the site methodology for calculations of Onsite (100 meter) and Offsite consequences from radiological releases

postulated in a facility's accident analysis. This methodology differs from the DOE-EM Interim Guidance methodology for calculations of Onsite consequences and initial CSTF methodology for Offsite consequences (described above). The next several paragraphs, below, describe the differences in methodology and utilization of the new methodology in radiological consequence analysis for accidents.

For calculations of Onsite consequences, the unit TED factor for the Onsite (100 meter) receptor is calculated using the DOE-STD-1189, Appendix A (Ref. 304) atmospheric dispersion (χ/Q) value of 3.5E-03 s/m^3 for all accident release periods. This differs from DOE-EM Interim Guidance methodology, which determines a time based (e.g., 3-minute, 20-minute, 1-hr, 2-hr, 8-hr, and 10-hr) χ/Q value using 95th percentile meteorological conditions and a 3 cm surface roughness factor. Use of DOE-STD-1189 χ/Q value as a basis for consequence calculations serves the dual functions of protecting worker safety and standardizing the hazard index so that SS controls are based on inventory and MAR rather than special analysis techniques, facility features, or unique physical plant conditions.

Assessment of accident doses using Gaussian dispersion (computed with the DOE-STD-1189 χ/Q) requires use of inhalation DCFs for the Onsite receptor. As previously discussed, for a workplace population, ICRP Publication 68 (Ref. 50) recommends a particle size of 1 µm or 5 µm AMAD (latter judged to be more representative of workplace aerosols). In all unfiltered cases for the Onsite receptor, the 5 µm AMAD particle distribution is considered the default value and is used for selecting an inhalation DCF for the Onsite receptor, which historically has been used in the CSTF consequence calculations.

For calculations of Offsite consequences, this methodology differs from initial CSTF methodology in two parameters: 1) Surface roughness factor (160 cm vs. 100 cm), and 2) deposition velocity (0.6 to 0.7 cm/s vs. 1.0 cm/s). Additionally, the MACCS2 95th percentile calculations are based on 2002 through 2006 meteorological data that has been processed using updated methodology. Use of this updated methodology is primarily responsible for Offsite consequences increasing by a factor of approximately 3 above that which historically has been used in the CSTF consequence calculations.

Utilization of the new methodology in radiological consequence analysis for accidents will be on a forward fit basis in accordance with Reference 302. All new or revised accident calculations performed after December 2014 will utilize the TED factors from Reference 305.

3.4.1.3.2 MODEL FOR DISPERSION OF HAZARDOUS CHEMICAL VAPORS

The chemical consequences are limited to airborne releases because, in an accident scenario, this release typically represents the most immediately significant route of public exposure (Ref. 17). Air dispersion modeling uses the Areal Locations of Hazardous Atmospheres (ALOHA) computer code, Gaussian finite release model, or MACCS/MACCS2 (Ref. 125, 128, 129, 229).

There are two separate dispersion models in ALOHA: Gaussian and heavy gas. ALOHA uses a Gaussian dispersion model to describe the movement and spreading of a gas that is neutrally buoyant. The heavy gas dispersion calculations in ALOHA are those used in the Dense Gas

Dispersion (DEGADIS) model (Ref. 130). The DEGADIS model was selected because of its general acceptance and the extensive testing that was carried out by the authors. ALOHA uses the friction Richardson Number as the criterion for Gaussian or heavy gas modeling. For release scenarios in which Gaussian dispersion is applicable based upon the Richardson Number criterion, a Gaussian finite release model (hand calculation) or MACCS/MACCS2 have also been used.

Concentrations for comparison with guidelines are calculated as the peak 15-minute time-weighted average concentrations using χ/Q values based on either the 3-minute or 15-minute averaging time as appropriate (Ref. 17).

3.4.1.4 Comparison to Guidelines

Offsite EGs deal with the protection of the public and are numerical dose/dosage EGs. Onsite EGs are established for defined areas Onsite to protect workers at functionally independent facilities Onsite. Onsite doses are calculated at the Onsite Evaluation Point (OEP). The OEP is the facility area exclusion zone, which is located at 100 meters from the facility area. For elevated or buoyant releases that do not land within the exclusion zone, the OEP is the point beyond the exclusion zone where the release reaches ground level.

Official ERPG values are used for Onsite chemical consequence evaluation when available. When ERPG values are not available, TEEL values are used. The TEEL values are equivalent to the ERPG values and are used where no official ERPG values have been developed (Ref. 29).

3.4.1.4.1 ACCIDENT ANALYSIS EVALUATION GUIDELINES

For internal and external manmade accidents, the consequence resulting from individual DBAs/evaluation basis accidents over the frequency spectrum shall be compared against dose/dosage EGs (Ref. 4). The following EGs are based on Reference 16 with guidance provided by Reference 255.

3.4.1.4.1.1 Offsite Radiological Evaluation Guidelines

DBAs shall not cause doses to the MOI that challenge 25 rem.

3.4.1.4.1.2 Offsite Toxicological Evaluation Guidelines

DBAs shall not cause dosages to the MOI that exceed ERPG-2 / TEEL-2.

3.4.1.4.1.3 Onsite Radiological Evaluation Guidelines

DBAs shall not cause dosages at the OEP that exceed 100 rem.

3.4.1.4.1.4 Onsite Toxicological Evaluation Guidelines

DBAs shall not cause dosages at the OEP that exceed ERPG-3 / TEEL-3.

3.4.1.4.1.5 Onsite Evaluation Guidelines within the OEP

Based on a qualitative evaluation, DBAs shall not result in significant radiological or chemical exposure, a prompt fatality, or serious injury that would result in medical treatment for immediately life-threatening or permanently disabling injuries (e.g., loss of eye, loss of limb) from hazards other than those routinely encountered in general industry and construction, and for which national consensus codes or standards (e.g., OSHA, transportation safety) exist to guide safe design and operation. Worker safety (including HE) is discussed in Section 3.3.3.3.3.

3.4.1.5 General CSTF Inputs and Assumptions

3.4.1.5.1 SOURCE TERM INPUTS AND ASSUMPTIONS

3.4.1.5.1.1 Material at Risk

The waste streams handled at the CSTF are widely varied in composition and characteristics. The wastes can differ from tank to tank and by source of waste generation. The wastes are not segregated by specific elemental curie distributions. Therefore, for the purpose of developing bounding MAR quantities for specific accidents, radiological constituent concentrations were determined for reference sludge-solid and supernate waste quantities using the CST Waste Characterization Database. These reference concentrations are documented in References 58, 233, 248, and 263, and are listed in Table 3.4-8.

For convenience, several waste streams are used throughout the DSA to signify the MAR on a per unit volume basis. The inhalation dose potentials for the public (ICRP 72 values) are used to define these waste streams. Use of the inhalation dose potentials for the public is conservative since these are larger than those used for the worker (ICRP 68 values). These waste streams include:

- Bounding Sludge Slurry: A waste stream with an inhalation dose potential of up to 1.5E+09 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 16.7 wt. % sludge-solids, a sludge-solids density of 5 g/centimeter (cm)^3, a supernate density of 1.4 g/cm^3, maximum radiological constituent concentrations in the High-Activity Supernate, and maximum radiological constituent concentrations in the High-Activity Sludge.
- 242-25H Evaporator Bottoms: A waste stream with an inhalation dose potential of up to 3.7E+07 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 1.0 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, a supernate density of 1.8 g/cm^3, maximum radiological constituent concentrations in the High-Activity Supernate, and the radiological constituent concentrations in the Tank 32 High-Activity Sludge (Waste Tank 32 is the 242-25H Evaporator Feed Tank).

- 242-16H Evaporator Bottoms: A waste stream with an inhalation dose potential of up to 3.3E+07 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 1.0 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, a supernate density of 1.6 g/cm^3, maximum radiological constituent concentrations in the High-Activity Supernate, and the radiological constituent concentrations in the Tank 32 High-Activity Sludge. The waste stream generated during chemical cleaning operations is bounded by the 242-16H Evaporator Bottoms (Ref. 221).
- Bounding Supernate: A waste stream with an inhalation dose potential of up to 9.8E+07 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 1.0 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, a supernate density of 1.6 g/cm^3, maximum radiological constituent concentrations in the High-Activity Supernate, and maximum radiological constituent concentrations in the High-Activity Sludge.
- Static Tank Supernate: A waste stream with an inhalation dose potential of up to 6.0E+06 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 0.0 wt. % sludge-solids, a supernate density of 1.6 g/cm^3, and maximum radiological constituent concentrations in the High-Activity Supernate.
- Slurried Type IV Tank Waste: A waste stream with an inhalation dose potential of up to 1.0E+07 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 104). This waste stream dose potential is based on a stream with 7.0 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, a supernate density of 1.2 g/cm^3, maximum radiological constituent concentrations in the Low-Activity Supernate, and maximum radiological constituent concentrations in the Low-Activity Sludge.
- Tank 50 Supernate: A waste stream with an inhalation dose potential of up to 2.09E+05 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 233). This waste stream dose potential is based on a stream with the maximum radiological constituent concentrations in the Tank 50 Low-Activity Supernate.
- Type I/II Waste Tank Chemical Cleaning Slurry: A waste stream with an inhalation dose potential of up to 3.98E+08 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 248, 249, 275). This waste stream dose potential is based on a stream with the maximum radiological constituent concentrations in the Tanks 1-15 sludge solids.
- Type I/II Tank Sludge Solids: A waste stream with an inhalation dose potential of up to 6.1E+09 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs, per Reference 262). This waste stream dose potential is based on a stream with 100 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, and maximum radiological constituent concentrations in the Type I/II Tank High-Activity Sludge.
- Type IV Tank Sludge Solids: A waste stream with an inhalation dose potential of up to 5.6E+08 rem/gal (determined using ICRP Publication 72 Inhalation CED DCFs,

per Reference 263). This waste stream dose potential is based on a stream with 100 wt. % sludge-solids, a sludge-solids density of 5 g/cm^3, and maximum radiological constituent concentrations in the Low-Activity Sludge.

In addition to the above, waste transfers may be categorized as "High-Rem" or "Low-Rem." High-Rem waste transfers have an inhalation dose potential of greater than 2.0E+08 rem/gal while Low-Rem waste transfers have an inhalation dose potential of less than or equal to 2.0E+08 rem/gal. The following may be categorized as Low-Rem transfers (Ref. 79, 80, 107, 256):

- Transfers from other facilities that have been shown to be less than or equal to 2.0E+08 rem/gal by their Waste Compliance Plan
- Transfers out of H-Area waste tanks that meet the Sludge Carryover Minimization Program
- Transfers of evaporator bottoms
- F-Area transfers (restricted to less than or equal to 16.7 wt. % sludge-solids or have an inhalation dose potential that meets the Low-Rem Waste Transfer criteria [as determined by engineering evaluation]). Sludge slurry transfers out of Waste Tanks 33 and 34 when the suction of the transfer device (pump or jet) is below the sludge layer shall be verified by sampling to have an inhalation dose potential of less than or equal to 2.0E+08 rem/gal prior to the transfer.
- Transfers (including Waste Tanks 33 and 34) that do not meet the Sludge Carryover Minimization Program but the suction of the transfer device (pump or jet) is at or above the sludge layer

  Based on transfer device zone of influence modeling, Reference 256 evaluated the inhalation dose potential impacts of a transfer with 0 to 24 inches of separation between the pump/jet suction and sludge layer. Based on this evaluation, the resulting MAR would not impact events analyzed in the DSA and the total dose potential would be within the Low-Rem values assumed for the applicable accidents. Therefore these types of sludge slurry transfers may be categorized as Low-Rem transfers.
- CSTF initiated transfers that have been verified by sampling to have an inhalation dose potential of less than or equal to 2.0E+08 rem/gal

Additionally, a Chemical Cleaning Transfer is a waste transfer containing OA (as part of the Type I/II Waste Tank chemical cleaning process). Chemical Cleaning transfers are considered waste transfers but are categorized separately from "High-Rem" or "Low-Rem" waste transfers. Chemical Cleaning Transfers have an inhalation dose potential of less than or equal to 9.8E+07 rem/gal.

The radiological content of a particular waste stream is represented by the dose potential concentration (in rem/gal). The same dose potential concentration can be achieved from a multitude of isotopic distributions, which are equivalent from a consequence perspective in the case of an airborne release. Though specific isotopic elements are identified as assumed

conditions to establish the dose potential of the waste streams defined, the streams are controlled by dose potential and not by the isotopic distribution assumed. The computer codes used for the AA require elemental isotopic distributions for calculating resulting doses. In those cases, the isotopic distributions were supplied. Because the airborne release models do not assume elemental separation, it can readily be determined from the use of the five-factor ST approach (see Section 3.4.1.1) for airborne releases, that the results are valid for the waste stream controlled to the dose potential.

Further discussion of the MAR and related bases (e.g., sludge-solids density, supernate density, wt. %- sludge-solids, sludge-solids carryover percent) is provided in the CSTF input data document (Ref. 58).

Certain activities are not considered to be waste transfers. These activities include, but are not limited to, removal of contaminated rainwater in-leakage from inactive locations. Transfers may be treated as non-waste transfers (i.e., do not have to be considered waste transfers) if the transfer stream can be demonstrated to meet the following:

- Transfer stream has a sufficiently low inhalation dose potential (≤ 2.5E+05 rem/gal) such that hazards (e.g., spills, explosions) posed by the stream could not challenge the EGs.
- Hazards (e.g., spills, explosions) posed by the transfer stream will not release an amount of material that could challenge the chemical EGs, as defined in Reference 73. The amount of material released is determined from the use of the five-factor ST approach (see Section 3.4.1.1).

Transfers to or from the CSTF have been evaluated against the receiving facility Waste Acceptance Criteria (WAC) or Safety Basis restrictions (Ref. 213, 314). Some waste streams have been shown to meet the above criteria and, therefore, need not be considered waste transfers nor require transfer controls (see exceptions for Tank 50 below). These waste streams include, but are not limited to, transfers from CSTF to the Saltstone Facility (2.09E+05 rem/gal), transfers from Effluent Treatment Project (ETP) to Tank 50 (1.5E+03 rem/gal), transfers to Tank 50 with an inhalation dose potential less than or equal to Tank 50 Supernate (2.09E+05 rem/gal), and transfers of Evaporator Overheads to ETP (33.1 rem/gal).

For transfers from Tank 50 to the Saltstone Facility and transfers into Tank 50 (e.g., MCU to Tank 50), three DBAs (Transfer Error/SMP Waste Release [Waste Tank Overflow], Waste Tank Annulus Explosion, and Seismic event) associated with transfer controls were qualitatively judged to exceed the FW criteria in the immediate vicinity of the event (see Sections 3.4.2.9, 3.4.2.12, and 3.4.2.18). For the Transfer Error/SMP Waste Release DBA (Waste Tank Overflow), equipment to stop transfers is credited. For the Waste Tank Annulus Explosion and Seismic event DBAs, portions of the core pipe that traverse the Tank 50 annulus and controls that support the core pipe integrity are credited. Additionally, the Transfer Facility Explosion and Seismic event DBAs (see Sections 3.4.2.7 and 3.4.2.18) credit the core pipe for preventing leakage into transfer facilities (LDB Drain Cell). However, for the remaining DBAs associated with transfer errors or transfer related explosions, no transfer controls were credited for transfers into and out of Tank 50 to the Saltstone Facility or transfers into Tank 50. Therefore, only those portions of the Transfer Control Program specified in Sections 3.4.1.5.6, 3.4.2.7, 3.4.2.9,

3.4.2.12, and 3.4.2.18 apply to transfers from Tank 50 to the Saltstone Facility and transfers into Tank 50, and those transfers need not be considered waste transfers.

For the purpose of this DSA, a distinction is made between containment and confinement:

- The safety function for containment provides a barrier to contain released material (liquid) or provides a barrier that enables the channeling of the material (liquid) to an appropriate leak detection location.
- The safety function for confinement provides mitigation for airborne releases.

3.4.1.5.1.2 Sludge Carryover

Several waste streams include 1.0 wt. % maximum sludge content. The 1.0 wt. % maximum sludge is considered to be conservative based upon the nature of the processes. For evaporator operation, sludge content is a function of the proximity of the feed pump to the sludge, agitation of the tank, as well as the concentration effect of multiple passes through the Evaporator System. The historical process of ensuring sufficient settling times and separation of the feed pump from the sludge has resulted in minimal sludge carryover or accumulation in the evaporator. Several indicators of this are listed below:

- Numerous camera inspections over the years show that the salt precipitated from evaporator bottoms is typically white indicating minimal sludge content, even after concentration of the material through several passes of evaporation.
- Numerous core saltcake samples from tanks have been analyzed over the years, without report of significant sludge content.
- A core saltcake sample from Waste Tank 38 (an evaporator drop tank) was analyzed for solids content (Ref. 101). The analysis of the solids showed that the insoluble solids, in total, comprised 0.8 wt. % of the core sample material. The sample showed two types of solid material, small white pebbles (indicating salt) and a black sludgy material. The two solids species were separated and characterized separately. The sample analysis showed that the black sludgy material was mostly salt with slightly higher concentrations of Al, Fe, and Mn which indicated that it may have contained a small amount of HLW sludge. This indicates that the sludge content of Tank 38 was a small fraction of 0.8 wt. %.
- Other saltcake samples from Waste Tank 41 (Ref. 100) have also been characterized to have insoluble solids contents near 1.0 wt. %. However, these solids did not show any sludge content. Small quantities of dark solids were observed in the Waste Tank 41 saltcake samples, but analysis showed the material to be sodium aluminum silicate and not sludge materials.
- Sludge loss in large quantities from evaporator feed tanks and during supernate transfers has not occurred over the years of facility operation. If 1.0 wt. % carryover was actually occurring, this would have resulted in the complete de-inventory of evaporator feed tanks in just a short period of time.

- During sludge washing activities in Extended Sludge Processing (ESP) tanks, sludge loss has not been observed following multiple decants.

Computational Fluid Dynamics (CFD) studies (Ref. 99, 103) support the observations listed above. Evaporator feed pumps are typically located significantly higher than the sludge level in the feed tanks and are either located above the inlet downcomer outlet elevation or are physically separated on the opposite side of the tank from the downcomer. Controls are established to ensure other mixing devices will not disturb sludge.

Sludge carryover in supernate transfers other than evaporators is a function of the proximity of the jet/pump suction to the sludge layer, as well as the prior agitation of the tank contents. While the proximity to the sludge can be lower for non-evaporator supernate transfers, the settling time and jet/pump separation of 24 inches have prevented any significant mobilization of sludge. This is evidenced by the lack of inadvertent sludge movement noted following the many supernate transfers accomplished over the past 50 years. This is also supported by analysis of sludge entrainment from jets and pumps:

- CFD studies have shown that a transfer jet placed 11 inches above the sludge layer and a feed pump placed 9 inches above the sludge layer would result in entraining 1% of the flow from the hindered settling region (Ref. 103). In the same calculation, it was shown that less than 0.5% of total flow would come from depths greater than 12 inches below the evaporator feed pump suction.
- A separate CFD calculation for Waste Tank 40 was issued addressing the carryover of silicon particles during decant transfers into Waste Tank 30 (Ref. 102). The calculation concluded that less than 1% of flow through the jet comes from 21 inches below the jet suction. Based on sample histories related to Waste Tank 30 after the decant transfer, 21 inches was adequate to prevent excess carryover of silica. Since sludge is denser than the silica, it is reasonably conservative to apply this analysis to sludge carryover.

In order to assess the degree to which the operating experience to date has been masked by historical controls, a qualitative assessment of the impact of these controls was conducted. In the event a transfer jet or pump were submerged in the current deepest layer of sludge, the limited zone of influence of the jet or pump would limit the amount of sludge that could be mobilized in a transfer. The quantity of sludge mobilized, in comparison to a typical transfer volume, would not challenge the 1.0 wt. % value when the total quantities of sludge and supernate are compared. This represents a reasonably bounding estimation of the impact of an unmitigated transfer of supernate. Given the historical lack of evidence of any significant sludge carryover, and a reasonably bounding estimate of mobilization in an inadvertent transfer, the use of 1.0 wt. % sludge carryover is considered to be reasonably conservative.

3.4.1.5.2 FACILITY CONFIGURATION AND DESIGN INPUTS

Many of the inputs and assumptions included in this section are described further in References 58 and 292. Parenthetical references to DBA sections listed after inputs are provided

as a guide to indicate which DBAs use the input/assumption. Some inputs/assumptions are considered inherent to all of the analyses and no particular DBA is listed.

3.4.1.5.2.1 General Configuration and Design Inputs

- The Building 299-H radiological inventory is within HC 3 limits.
- Fuel powered equipment/vehicles (other than diesel powered) within Building 299-H are prohibited.
- Closure Waste Tanks may become a dry sludge tank. No other waste tank will be permitted to become a dry sludge tank. Only Type I, II, and IV waste tanks are permitted to be a Closure Waste Tank. Peaks or mounds of sludge/salt that are above the liquid surface and sludge/salt that are exposed during waste removal operations are acceptable and shall not result in a waste tank being considered a "dry sludge tank."
- Addition of waste into or waste transfers through (non-waste transfers out are permitted) the following inactive locations are prohibited. Waste transfers for which these inactive locations are receipt vessels or leak detection locations are also prohibited: FDB-1, FDB-5, FDB-6, HDB-1, HDB-3, HPP-1, VB-15/16, F-Area Catch Tank, 242-F Evaporator, 242-16F Evaporator, 242-H Evaporator, F--Area Concentrate Transfer System (CTS), and H-Area CTS.
- Sludge slurry transfers into Waste Tank 49 are prohibited.
- Waste additions/transfers to or from Waste Tank 48 are prohibited.
- High-Rem waste transfers through a diaphragm pump are prohibited.
- Only Waste Tanks 40 and 51 may be an ESP Sludge Slurry Waste Tank. An ESP Sludge Slurry Waste Tank has a total radiolytic hydrogen generation rate greater than 19.6 ft^3/hr and less than or equal to 65.3 ft^3/hr (Ref. 251). Classification of a waste tank as an ESP Sludge Slurry Waste Tank is independent of the transfer material being classified as ESP Sludge Slurry during transfer.
- ESP Sludge Slurry may only be transferred along the leak-checked transfer paths identified in Figure 3.7-1. ESP Sludge Slurry is defined as a sludge slurry transfer that has a hydrogen generation rate greater than 1.5E-05 ft^3/gal-hr and less than or equal to 5.0E-05 ft^3/gal-hr. Waste that is transferred with a radiolytic hydrogen generation rate greater than 1.5E-05 ft^3/gal-hr must be classified as ESP Sludge Slurry. Classification of material as ESP Sludge Slurry is independent of the inhalation dose potential of the material and is independent of the waste tank containing the material being classified as an ESP Sludge Slurry Waste Tank.
- Simultaneous sludge slurry transfers through two or more core pipes contained within the same core pipe jacket/encasements are prohibited.
- High-Rem waste transfers through transfer lines for which COPs are credited leak detection locations are prohibited.

- Waste transfers through 242-16H Evaporator Cell transfer jumpers shall have an inhalation dose potential less than or equal to 9.8E+07 rem/gal.
- Contingency Transfer System transfers shall have an inhalation dose potential less than or equal to 9.8E+07 rem/gal.
- An installed blank will prevent inadvertent waste transfer from the LDB Drain Cell to the 242-16H Evaporator overheads receiver tanks.
- High-Rem waste transfers into the FTF are prohibited (the HPFP is not considered part of the FTF in determining compliance with this restriction).
- High-Rem waste transfers through the 241-96H VB are prohibited. The 241-96H VB may not be a leak detection location for High-Rem waste transfers.
- High-Rem waste transfers through HDB-2 are prohibited. HDB-2 may not be a leak detection location for High-Rem waste transfers.
- Transfers through the Tank 50 VB and through receipt transfer lines into Tank 50 shall have an inhalation dose potential less than or equal to 2.09E+05 rem/gal.
- Steam jet transfers into an ESP Sludge Slurry Waste Tank are prohibited.
- Steam jet transfers into Tank 50 are prohibited.
- Steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through transfer lines for which DBs or PPs are credited leak detection locations are prohibited.
- Steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through 242-16H Evaporator Cell transfer jumpers are prohibited.
- Sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal activities in Tank 50 that could exceed the Tank 50 Gas Release Criteria (as described in Section 3.4.2.11) are prohibited.
- Chemical Cleaning operations in Tank 1 are prohibited.
- During transfers through a pump tank, the inhalation dose potential of the waste stream leaving the pump tanks is assumed to be the same as the inhalation dose potential of the material entering the pump tank (i.e., a Low-Rem transfer to a pump tank would be considered a Low-Rem transfer after leaving the pump tank). This assumption is based on the fact that pump tanks are not used for long term waste storage and the heel left behind after transfers through the pump tank typically contain a limited (less than 1,260 gallons) amount of waste due to drainback and solids accumulation (solids accumulation is a concern principally in pump tanks without agitation available). This assumption is reasonably conservative since the material with the inhalation dose potential of most concern (solids heel in unagitated pump tanks) is immobile and transfers through the pump tank are not expected to mobilize significant solids. In pump tanks with agitation available, a significant mobile heel will not develop. This judgment is based on the limited amount of High-Rem material that could be disturbed in the pump tank sludge heel (the amount

would be less than 1,260 gallons total with only a portion of the 1,260 gallons disturbed per individual transfer).

There are two exceptions to the above assumption:

1) If a pump tank is used for temporary storage of High-Rem material, transfers through the pump tank shall be considered a High-Rem transfer after leaving the pump tank regardless of the inhalation dose potential of the waste stream entering the pump tank, until such time as the temporary stored waste is removed (i.e., the High-Rem material is pumped out) and only the typical residual heel (drainback and immobile solids accumulation) is left in the pump tank.

2) If actions are taken to mobilize the solids heel in a pump tank (installation of a new pump tank agitator or other pump tank equipment does not necessarily result in mechanical agitation of the solids in the heel), the initial transfer through the pump tank shall be considered a High-Rem transfer after leaving the pump tank regardless of the inhalation dose potential of the waste stream entering the pump tank, due to the presence of newly mobilized solids (unless the waste stream is confirmed not to be High-Rem via sampling).

- Unless otherwise stated, the Onsite exposure duration for DBAs is the duration of the event plus 2 hours.
- Unless otherwise stated, the Offsite exposure duration for DBAs is 8 hours. The 8 hour duration is justified based on the Emergency Preparedness Program (see Chapter 15 of this DSA) in place and site emergency training.
- Unless otherwise stated, the operator response to event notification is 30 minutes.
- The maximum response time to a pressurized leak in a box (or 242-16H Evaporator Cell from a transfer jumper) is 360 minutes. This maximum response time is based on the number of different instruments used in the field (e.g., ARMs, dip tubes, conductivity probes, reel tapes), personnel present in the facility, and the fact that evolutions in the facility are closely watched, such that an event would be noticed and acted upon within 360 minutes. The response time to a spray event is longer than the response to a large flowing break due to the reduced flow of the small leak. However, this longer time frame would allow operators to perform material balances as an additional means to detect the leak (Ref. 58).
- The unmitigated maximum missing waste volume is 15,000 gallons (Ref. 292), except for slow leaks inside the evaporator cell from the Evaporator System (as discussed in Sections 3.4.1.5.2.7 and 3.4.2.3), SMP waste release events (as discussed in Section 3.4.2.9), and Tank 50 to the Saltstone Facility transfer error events (as discussed in Section 3.4.2.9). The unmitigated maximum missing waste volume is a function of the detection time, the leak mitigation time, and the pump flow rates. The mitigation time is small due to the multiple, simple means with which a transfer can be shut down (e.g., breakers in adjacent Motor Control Centers, the Distributed Control System (DCS), various panel board switches, push buttons or pistol grips in the control rooms). The remaining two parameters were assessed in tandem, since the

leak rate affects the detection time (i.e., the larger the leak, the quicker it would be detected and vice versa). A discussion of detection and response times is provided in Section 13.5.3 of this DSA.

During transfers, leaks or spills can be detected by several means in the facility, including periodic material balances, personnel in the field, and numerous instruments in the facilities. Available instruments include reel tapes, tank level instrumentation using radar, ARMs, Continuous Air Monitors, dip tubes, and conductivity probes (not all of these features are present to detect waste in each location). Under normal conditions, these indications will inform the operator that an upset is in progress well before 3,000 gallons have been released. The unmitigated maximum missing waste volume of 15,000 gallons represents approximately 4 inches of level in a waste tank, and would be readily detected either by material balance inputs or by detection of the actual leakage. The 15,000 gallon volume also includes the volume associated with the drain back of the various transfer lines into the pump tanks/ waste tanks. This volume can vary from a couple hundred gallons for the shorter lines to a couple thousand for the Inter-Area Line (IAL).

For pump flow rates, 360 gallons per minute (gpm) represents the highest allowable flow rate in an above-ground (or excavated) transfer line (Ref. 292). The maximum speed for transfer pumps, calculated at the first above-ground leak location (the point of lowest system resistance that results in leakage outside the tank, assuming a guillotine break of the piping) prevents exceeding this flow rate. For pumps with Variable Frequency Drives (VFDs), the maximum pump speed relies on limiting the speed on the VFD and verifying the speed setting is correct and functional prior to initiating the transfer. Single speed pumps that have no VFD, must meet the 360 gpm criteria at the pump operating speed. The transfer pump speed setting check is performed as part of the Transfer Control Program. The 360 gpm is calculated based on the transfer pump location, such that the elevation difference from the pump to the break location is considered. The 360 gpm flow rate is protected at the first above-ground break location.

For leaks inside transfer facilities (including 242-16H Evaporator Cell from a transfer jumper), non-seismic pump tank overflow, spills into the annulus, and Waste Tank Overflows, the maximum flow rate of 250 gpm was selected (Ref. 292). This maximum flow rate bounds the highest flow rate observed for any transfer previously conducted (including transfers from the high head transfer pump on Tank 40). A maximum VFD speed (or operating speed for single speed pumps) shall be calculated to maintain a flow rate of 250 gpm or less for the intended transfer, to ensure this flow rate is not exceeded. For pumps with VFDs, the maximum pump speed relies on limiting the speed on the VFD and verifying the speed setting is correct and functional prior to initiating the transfer. Single speed pumps that have no VFD, must meet the 250 gpm criteria at the pump operating speed. The transfer pump speed setting check is performed as part of the Transfer Control Program. Operating experience has shown that transfers conducted at a speed calculated to maintain 250 gpm will typically have at a flow rate of approximately 100 to 200 gpm. This leads to the establishment of a reasonably conservative maximum volume that could

leak before detection and mitigation of 15,000 gallons. For transfers which are at a lower flow rate (250 gpm or less), the transfers are monitored periodically for indications of transfer events often enough such that a leak of 15,000 gallons (e.g., 250 gpm for 1 hour, 100 gpm for 2.5 hours, 50 gpm for 5 hours) would be detected. The timing of monitoring (including material balances) is commensurate with transfer rate and type of transfer (batch vs. continuous) such that 15,000 gallons would be detected.

A flow rate of 125 gpm will be used for seismic pump tank overflow (Ref. 292). As discussed above, transfers calculated not to exceed 250 gpm are observed to typically have a flow rate in the 100 to 200 gpm range. Therefore, 125 gpm is considered a reasonable transfer rate to use during and following a seismic event.

Many of the underlying facility processes that protect the unmitigated maximum missing waste volume input are controlled programmatically. The following controls have been identified as necessary in defending this initial assumption and have been carried forward into Section 3.4.1.5.6:

- Controls governing waste transfers shall be established addressing determination of transfer path. This evaluation shall identify the necessary process area(s) and leak detection locations needed to support the transfer. This evaluation will also ensure that the transfer line segments associated with the transfer path and piping downstream of the isolation point has acceptable integrity (required by the Structural Integrity Program) prior to initiating the transfer.
- Controls governing waste transfers shall be established addressing independent verification of correct transfer path alignment. Use of correct motive force shall be independently verified after initiating the transfer.
- Controls governing waste transfers shall be established addressing determination of equipment needed to stop transfers and siphons.
- Controls governing waste transfers shall be established addressing determination of methods/equipment needed to prevent exceeding transfer path flow rate limitations (transfer pump speed evaluations).
- As part of the Radiological Protection Program, procedures for personnel radiological protection shall be approved, maintained, and adhered to for all operations involving personnel radiation exposure in order to ensure radioactive releases are minimized and detected such that personnel are protected from radiation exposure.
- Waste transfers shall be monitored periodically for indications of transfer events (i.e., Transfer Error, siphoning, leakage). Monitoring shall extend beyond the transfer path to locations (e.g., pump tanks, waste tanks) determined by evaluation. The evaluation to determine the monitoring locations beyond the transfer path shall consider the isolation method used to define the transfer path (e.g., non-leak tested valve versus leak-tested valve, double valve isolated, blanked). The frequency and method (e.g., level/leak monitoring) of transfer

monitoring and material balances shall be determined on an individual basis. Waste transfers with the potential to transfer material in amounts greater than 15,000 gallons require material balances. In general, increased monitoring frequency is appropriate during the initial stages of the transfer, with a lesser frequency required once a transfer has been established. Material balances are not required for Contingency Transfer System transfers or waste transfers involved with feed to and receipt from an evaporator. Contingency Transfer System transfers are transfers of waste from the annulus of a leaking waste tank back to the primary side of the same waste tank using the Contingency Transfer System. Material balances are required for evaporator recycle transfers.

Other non-credited features exist to support the adequacy of the above credited controls in detecting ≤ 15,000 gallons of leaked waste:

- As part of the Environmental Compliance Program, secondary containment and leak detection provisions are in place in accordance with the CSTF Federal Facilities Agreement.
- As part of the Radiological Protection Program, ARMs are strategically located throughout the CSTF.

- Since some DBAs rely upon a release rate in calculating consequences, rather than a total volume, specific flow rates (and therefore response times) must be provided. For DBAs that rely upon a release rate, the following values will be used (Ref. 292):
  - A flow rate of 360 gpm (with a response time of 15,000 gal/360 gpm = 41 min) will be used for an above-ground leak.
  - A flow rate of 250 gpm (with a response time of 15,000 gal/250 gpm = 60 min) will be used for pump tank overflow (non-seismic), spills into the annulus, and Waste Tank Overflows, as well as Transfer Errors into a box (VB, DB, PP, etc.) or 242-16H Evaporator Cell from a transfer jumper.
  - A flow rate of 125 gpm (with a response time of 15,000 gal/125 gpm = 120 min) will be used for seismic pump tank overflow.
- For Waste Tank Explosion analysis, 250 gpm will be used as the maximum transfer flow rate due to free supernate removal over solids (Ref. 292).
- The unmitigated event duration is a maximum of 10 days for the following events: Evaporator Pot Explosion, Evaporator Cell Explosion, Waste Tank Annulus Explosion, Transfer Facility Explosions, and PP and Pump Tank Explosion. The types of actions required in 10 days include (but are not limited to) restoration or addition of ventilation, removal of spilled material, investigation of actual time to LFL, and removal of evaporator contents. For operational events, these actions are expected to take on the order of two to three days with time for troubleshooting and repairing equipment or replacing damaged equipment. To reflect the size and number of facilities in the CSTF, as well as, the expected outside support if a significant NPH event was to occur at SRS, this duration was adjusted to 10 days (Ref. 292).

- For a Waste Tank Annulus Explosion for Type I/II Acidic Chemical Cleaning Waste Tanks, the unmitigated event duration is a maximum of seven days following a seismic event.
- The assumed HEPA filter efficiency varies for different accidents. A minimum HEPA filter efficiency of 99.5% bounds the various values used in the analyses (this assumption is not applicable to Closure Waste Tanks) (Sections 3.4.2.9, 3.4.2.10, 3.4.2.14).
- Maximum steam jet waste transfer rate ≤ 110 gpm (Sections 3.4.2.7, 3.4.2.8) (Ref. 58).
- The temperature increase due to a steam jet transfer of waste material ≤ 20°C (Sections 3.4.2.7, 3.4.2.8, 3.4.2.11, and 3.4.2.12) (Ref. 58).
- The aerosolization design inputs are given in Table 3.4-6 (Section 3.4.2.10).
- The solvent carryover concentrations present in the Decontaminated Salt Solution (DSS) from the MCU process to Tank 50 are limited to the following (Ref. 292) (Section 3.1.2):

Total Solvent Carryover Concentration	150 ppm (185 mg/L)
Isopar® L (diluent)	105 ppm (128 mg/L)
Cs-7SB (modifier)	44.6 ppm (54.4 mg/L)
BOBCalix (extractant)	1.4 ppm (1.7 mg/L)
Trioctylamine (TOA)	0.2 ppm (0.24 mg/L)

Requirements associated with the MCU process for protecting the Saltstone Facility Isopar® L limits (see Section 5.5.4.2.15) provide assurance that the Tank 50 limits stated above will not be exceeded.

The above concentrations are based on the BOBCalix-based solvent. The NGS includes the following components and their carryover concentrations (Ref. 292):

Isopar® L (diluent)	111 ppm (137 mg/L)
Cs-7SB (modifier)	30.3 ppm (36.9 mg/L)
MaxCalix (extractant)	8.5 ppm (10.43 mg/L)
TiDG (suppressor)	0.3 ppm (0.3 mg/L)

The blended solvent is bounded by the BOBCalix-based solvent and NGS component concentrations. The BOBCalix-based solvent component concentration limits are considered bounding of or equivalent to the NGS component concentrations; thus, the chemical analysis performed for BOBCalix-based solvent remains valid for NGS (Ref. 311).

3.4.1.5.2.2 Transfer Facility Configuration and Design Inputs

- The design configuration inputs for the various transfer facilities are given in Table 3.4-1 (Sections 3.4.2.7, 3.4.2.8, 3.4.2.9).
- Transfer line jumpers and connectors along a transfer path may have "drip-wise" leakage and still be considered functional primary containment. "Drip-wise" leakage shall not be a continuous flow of material or spray. "Drip-wise" leakage shall not exceed the initial (i.e., residual) waste volumes presented in Table 3.4-1 within a 30-day period.
- The maximum volume of waste in a pump tank is 945 ft^3 (Sections 3.4.2.8, 3.4.2.13).
- PP and DB Internal Equipment Volume Percentage = 10% (Section 3.4.2.9).
- The HDB-8 connection to the Tank 50 VB (via the ETP DB) is a passive inlet line into the vapor space of H-Area Pump Tank (HPT) HPT-10. This connection is not connected to other waste transfer piping in HDB-8. Additionally, this connection is not connected to a motive force which could move waste through the line to the Tank 50 VB nor configured such that a siphon of waste could occur back to the Tank 50 VB.
- The pump tank cooling coils are isolated from the Chromate Cooling Water (CRW) System. Isolation of these lines may be performed through installation of blanks/dummy connectors or jumper removal.
- An installed blank in the steam/air line to the HPT-3 recirculation jet will prevent jet impingement aerosolization events or pump tank overheating from the recirculation jet. The HPT-4 recirculation jet is configured such that steam/air cannot be supplied to the recirculation jet.

3.4.1.5.2.3 Waste Tank and Waste Tank Annulus Configuration and Design Inputs

- For the purpose of this DSA, the term "waste tank mixing device(s)" is used to describe any of the following: slurry pumps (any type), SMPs, or CSMPs.
- An installed blank in the steam/air line to the Tank 42 steam spargers will prevent jet impingement aerosolization events or waste tank overheating from the spargers.
- Waste Tanks 5, 6, 12, 16, 17, 18, 19, and 20 have been closed and backfilled with grout and are not considered hazard locations.
- The design configuration inputs for the various waste tank designs are given in Table 3.4-2 (Sections 3.4.2.10, 3.4.2.11, 3.4.2.12, 3.4.2.13).
- The design configuration inputs for the various waste tank annulus designs are given in Table 3.4-3 (Sections 3.4.2.9, 3.4.2.12).
- The design configuration of the Sealant Deployment System (when connected for use on the CRW System) prevents the potential for a siphon/pump-out on the affected waste tank. The Sealant Deployment System equipment (e.g. tank, pump, piping) is located above the affected waste tank thus preventing the potential for a siphon. The return for the Sealant Deployment System discharges into a tank which is vented to

atmosphere thus preventing the potential for a pump-out. The Sealant Deployment System and affected waste tank cooling coil are isolated from the CRW System when the Sealant Deployment System is connected (3.4.2.15). The Sealant Deployment System may be used on Tanks 1, 2, 3, 4, 7, 8, 9, 10, 11, 13, 14, 15, and 30.

- Type IV Waste Tank Internal Radius = 42.5 feet (Sections 3.4.2.10, 3.4.2.13).
- Operation of SMPs is prohibited in Waste Tanks 48 and 50, and Type IV Waste Tanks.
- Operation of waste tank mixing devices in Waste Tank 39 is prohibited.
- Operation of Flygt Mixers is prohibited.
- Installation of CSMPs is prohibited in Waste Tank 40, Waste Tank 48, Waste Tank 49, Waste Tank 50, Type I/II Acidic Chemical Cleaning Tanks, Type I/II Non-Acidic Chemical Cleaning Tanks, and evaporator feed tanks.
- Sludge slurry transfers out of Waste Tanks 32 and 35 are prohibited.
- The Type III/IIIA Waste Tank annulus ventilation inlet dampers/valves (outer annulus only) are open or throttled open to prevent flammable vapor accumulation in the annulus air duct. A physical barrier (e.g., locking/blocking device) shall be installed on the dampers/valves to ensure there is free air exchange between the annulus air duct and atmosphere. Damper/valve position which is sufficiently open to ensure airflow from the inlet duct into the outer annulus when the annulus exhaust fan is operating will also ensure free air exchange between the annulus air duct and the atmosphere when the exhaust fan is not operating (or the circular air inlet duct is submerged in waste) (Section 3.4.2.12).
- Grout formulation shall be designed to not heat the waste to boiling (Section 3.4.2.13).
- Operation of the following pumps, which require bearing water for operation, is prohibited in a waste tank containing saltcake (Section 3.4.2.11):
  - Slurry pump
  - Telescoping transfer pump when operated for the purpose of waste tank recirculation

  Recirculation with a transfer pump is defined as the planned movement of waste tank contents through a flow path (which may or may not be exclusively internal to the waste tank) that concludes with the bulk of the material being returned to the same waste tank. Flow that returns to the waste tank through an engineering feature (such as a siphon break in the transfer line) or minor leakage from valves, fittings, etc. is not considered recirculation, as long as the bulk of the material is being removed from the waste tank.

3.4.1.5.2.4 Type I and Type II Waste Tank Chemical Cleaning Configuration and Design Inputs

During the waste tank chemical cleaning process of Type I/II Waste Tanks, the conditions of the waste tank and related transfers from the waste tank can vary based on whether the contents contain OA (that has not been neutralized). Additionally, assumptions in the DSA (e.g., waste tank wall integrity) also vary based on whether a waste tank has undergone chemical cleaning (even if the contents are neutralized). For this reason, the following terms are used throughout the DSA to define applicability of related discussion and controls. These terms define the assumed conditions within the waste tank, waste tank annulus, and transfers related to waste tank chemical cleaning operations.

Type I/II Chemical Cleaning Waste Tank: Waste storage tank that is undergoing or has undergone the waste tank chemical cleaning process with OA. The waste tank contents may contain OA or be neutralized. DSA discussion and related controls for a Type I/II Chemical Cleaning Waste Tank is applicable to Type I/II Acidic Chemical Cleaning Waste Tanks and Type I/II Non-Acidic Chemical Cleaning Waste Tanks. Waste tank wall integrity (see Sections 3.4.2.12 and 3.4.2.14) is not assumed for these tanks.

Type I/II Acidic Chemical Cleaning Waste Tank: Waste storage tank that is undergoing or has undergone the waste tank chemical cleaning process with OA. The waste tank contents may contain OA and the pH may be less than 7. For waste tank flammability control aspects, these waste tanks have a flammability classification of a Chemical Cleaning Tank (see Section 3.4.2.11). Additionally, acidic material may be contained in the annulus.

Type I/II Non-Acidic Chemical Cleaning Waste Tank: Waste storage tank that has undergone the waste tank chemical cleaning process with OA. The waste tank contents have a pH greater than or equal to 7 (e.g., waste from previous chemical cleaning operations has been neutralized). For waste tank flammability control aspects, these waste tanks have a flammability classification of a Rapid Generation Tank, Slow Generation Tank, or Very Slow Generation Tank (see Section 3.4.2.11). Additionally, acidic material is not contained in the annulus.

Chemical Cleaning Transfer: A transfer containing oxalic acid (as part of the waste tank chemical cleaning process). Once a transfer line has been flushed, subsequent transfers need not be considered a Chemical Cleaning Transfer.

For Type I/II Non-Acidic Chemical Cleaning Waste Tanks (that had previously undergone chemical cleaning), neutralization of the acidic tank contents will stop the OA corrosion of the primary waste tank carbon steel. After the primary tank is neutralized, any annulus contents (if leakage occurred during the chemical cleaning process), will also be verified neutralized. After completion of waste tank neutralization, verification will be performed to ensure that the annulus level is not increasing. No increase in annulus level will demonstrate that significant leak sites have not occurred due to OA corrosion. These requirements shall be performed to transition a Type I/II Acidic Chemical Cleaning Waste Tank to a Type I/II Non-Acidic Chemical Cleaning Waste Tank.

- The radiological material in Type I/II Chemical Cleaning Waste Tanks shall have an inhalation dose potential of less than or equal to 3.98E+08 rem/gallon and the residual sludge volume shall be less than or equal to 10,000 gallons.
- Waste Transfers into Type I/II Chemical Cleaning Waste Tanks from other waste tanks are prohibited.
- Waste Transfers and Chemical Cleaning Transfers into Type I/II Acidic Chemical Cleaning Waste Tanks from the annulus back to the primary side of the same waste tank are allowed with the exception of steam jetted transfers. Steam jetted transfers into and out of Type I/II Chemical Cleaning Waste Tanks (primary and annulus) are prohibited.
- Waste Transfers into Type I/II Non-Acidic Chemical Cleaning Waste Tanks from the annulus back to the primary side of the same waste tank are allowed with the exception of steam jetted transfers. Steam jetted transfers into and out of Type I/II Chemical Cleaning Waste Tanks (primary and annulus) are prohibited.
- Direct receipt of OA is only permitted in Type I/II Acidic Chemical Cleaning Waste Tanks. Maximum ratio of nominal 8 wt. % OA to sludge is a 20:1 ratio.
- Receipt waste tanks for Chemical Cleaning Transfers are required to be preconditioned with sufficient inhibitors to neutralize the acidic waste being added to it. Operation of one waste tank mixing device is required in the receipt tank during Chemical Cleaning Transfers.
- Prior to initiation of a Chemical Cleaning Transfer, isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic waste from entering waste tanks other than sending or receiving tank.
- Waste transfers that traverse the annulus of a Type I/II Chemical Cleaning Waste Tank are prohibited. Vent and drain operations associated with Chemical Cleaning Transfers are permitted in the transfer line that traverses the Tank 51 annulus.
- Chemical Cleaning Transfers are only permitted through the following secondary containments: FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, Tank 51 Drain VB, FPP-1, FPP-2, and HPP-3. Chemical Cleaning waste that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell have also been analyzed (transfer paths associated with these locations are permitted to have Chemical Cleaning Transfers).
- Air and steam to any waste tank primary or annulus transfer jet shall be isolated for Type I/II Chemical Cleaning Waste Tanks (Sections 3.4.2.10, 3.4.2.13).
- Bulk saltcake dissolution and saltcake interstitial liquid removal activities in Type I/II Chemical Cleaning Waste Tanks are prohibited.
- Sludge agitation activities in Type I/II Acidic Chemical Cleaning Waste Tanks are allowed. Trapped gas release from sludge for Type I/II Acidic Chemical Cleaning Waste Tanks has been accounted for in the flammability analysis (as described in Section 3.4.2.11).

- Sludge agitation activities in Type I/II Non-Acidic Chemical Cleaning Waste Tanks that could exceed the Gas Release Criteria (as described in Section 3.4.2.11) are prohibited.

3.4.1.5.2.5 Type I, II, IV Closure Waste Tank Configuration and Design Inputs

- The radiological material in a Closure Waste Tank shall have a total effective inhalation dose potential of less than or equal to 1.0E+12 rem.

  The total effective inhalation dose potential applies only to the primary side of a Closure Waste Tank due to the accident analysis progressions associated with these waste tanks. The Closure Waste Tank annuli do not use a total effective inhalation dose potential limit for their accident progressions (e.g., Annulus Explosion); therefore, this limit does not apply to waste tank annuli.
- Waste additions/transfers to or from a Closure Waste Tank are prohibited.
- The radiolytic hydrogen generation rate shall be less than or equal to 0.5 ft^3/hr evaluated at 25°C with an NO_{eff} equal to zero.
- The following transfer line segments associated with Closure Waste Tanks shall be isolated from the waste tank using a single leak-tested valve, double valve isolation, blanks, plugs, cutting and capping, or providing physical separation (air gap) of the line or shall be rendered incapable of a transfer by isolating the motive force (e.g., closed valve for steam/air, open disconnect for electrical power) and ensuring no siphon potential:
  - Transfer line segments into and out of the waste tank and annulus (excluding the installed annulus to primary transfer).
  - Transfer line segments for which secondary containment overflows/drains to the tank.
- Air and steam to any waste tank primary or annulus transfer jet shall be isolated for Closure Waste Tanks (Sections 3.4.2.10, 3.4.2.13).
- Liquid additions to a Closure Waste Tank are limited to those necessary to (Sections 3.4.2.9, 3.4.2.10):
  - Flush equipment (e.g., pumps, jets, cooling coils)
  - Maintain tank chemistry
  - Rewet dry solids on the floor of the waste tank
  - Prevent exposed solids on the floor of the waste tank from drying to the point that they pose special airborne release concerns
  - Achieve waste immobilization for permanent closure (e.g., grouting, flushing of grouting equipment, grout line clearing).

  The above list is meant to document those additions that are permitted and is not meant to imply that the above additions are required (e.g., additions to maintain tank chemistry are dictated by the Corrosion Control Program).

- Liquid addition due to rainwater intrusion is allowed.
- Cooling coil flushing/grouting system configuration shall not create the potential for a siphon/pump-out event from the Closure Waste Tank (Section 3.4.2.15).
- Operation of waste tank mixing devices is prohibited in a Closure Waste Tank (Section 3.4.2.10). Additionally, pressurization sources to any pump/mixer column shall be isolated.
- Waste tanks are isolated from the CRW System (cooling coils and purge exhaust condenser) and bearing water supply prior to being declared a Closure Waste Tank (Sections 3.4.2.9, 3.4.2.15).
- Direct receipt of OA in a Closure Waste Tank is prohibited.

3.4.1.5.2.6 Dissolution Water Skid Configuration and Design Inputs

- A siphon potential from the waste tank to the DWS system does not exist due to the DWS system design and location.
- Liquid additions to the waste tank from the DWS are less than the total calculated volume that causes the vapor space to exceed the Gas Release Criteria (as described in Section 3.4.2.11) and do not have continuous makeup capability. The liquid source system for the DWS contains solenoid actuated valves, controlled by a Programmable Logic Controller (PLC) that mechanically isolate the system from the continuous water source. The solenoid actuated valves and PLC controller have been shown to be extremely robust in flow isolation capabilities. A failure of the PLC causing continuous makeup flow is considered not to exist.
- Suck back of waste material from the waste tank into the above-ground DWS components does not exist due to the DWS system being vented to atmosphere.
- The Mixing Eductors are designed to entrain four gallons of surrounding waste tank liquid for every one gallon of water supplied through the eductor nozzle. This entrainment ratio is used for development of the Liquid to Saltcake Dissolution Ratio input (Ref. 292) for Mixing Eductors (see Section 3.4.1.5.3).

3.4.1.5.2.7 Evaporator Configuration and Design Inputs

- The evaporator input data is given in Table 3.4-4 and Table 3.4-5 (Sections 3.4.2.1, 3.4.2.2, 3.4.2.3, 3.4.2.4).
- The term “Evaporator System jumpers” refers to the jumpers that transfer waste to/from the evaporator vessel. The term “transfer jumpers” refers to the jumpers that transfer waste through the 242-16H Evaporator Cell.
- The 242-16H Evaporator contains ≤ 300 gallons of scale. The 242-25H Evaporator does not contain significant uranium bearing/hydrogen producing scale.
- The maximum undetected waste volumes in the evaporator cells following a non-seismic Evaporator System slow leak are 36,803 gallons (242-16H) and 32,861 gallons (242-25H) (Section 3.4.2.2) (Ref. 58).

- The maximum undetected waste volumes in the evaporator cells following a non-seismic Evaporator System fast leak are 4,875 gallons (242-16H) and 8,500 gallons (242-25H) (Sections 3.4.2.2, 3.4.2.3) (Ref. 58).

  These values were chosen based on a maximum applicable lift rate over a 4-hour period. The concentrate receipt tank level is periodically measured and recorded. It is conservatively judged that action would be taken to shutdown the evaporator after observing no change in the concentrate receipt tank for 4 hours. The expected increase in the tank level after 4 hours would have been 2.4 inches for 242-25H and 1.4 inches for 242-16H. The feed flow was not chosen for this leak because the leak would be found much sooner (less than 1 hour) due to abnormal evaporator operation (i.e., evaporator pot level would begin to decrease).

- The maximum waste volumes to leak undetected from the Evaporator System into the evaporator cells following a seismic event are 5,190 gallons (242-16H) and 14,647 gallons (242-25H) (Sections 3.4.2.2, 3.4.2.3) (Ref. 58).

  The seismic leak volume values chosen assume the pot fails and empties its entire contents into cell. Since the control room is not seismically qualified, it can be assumed it fails. Collapse of the control room will cause failure of the control equipment (e.g., VFDs, DCS, power, and control wiring). Sixty minutes is allowed to de-energize the pump in the field.

  Using the above leak volume bounds an overflow or leak/spill event in volume spilled into the cell. The pot as well as the cell has multiple indications to detect an abnormality such as overflow or an increase in level in the cell. It is unreasonable to assume that all of these instruments are not functional during evaporator operation. Therefore, the volume spilled would be significantly less than the above scenario involving of pot failure.

- During chemical cleaning operations of the 242-16H Evaporator (i.e., upon introducing acid to the evaporator vessel and through completion of water rinse with measured level in the evaporator vessel less than or equal to 73 inches), transfers through 242-16H Evaporator Cell transfer jumpers are prohibited.

- During chemical cleaning operations of the 242-16H Evaporator (i.e., prior to adding acid to the evaporator vessel and while the vessel contains acidic material), the following shall be performed:

  - Lines from the Overheads System to Tank 43 are isolated
  - Feed line from Tank 43 to the Evaporator is isolated
  - Mercury Removal Tank (MRT) is drained of elemental mercury and isolated from the evaporator feed tank

  Isolation of these lines may be performed through installation of blanks/dummy connectors or jumper removal.

3.4.1.5.3 FLAMMABLE VAPOR RELEASE METHODOLOGY

3.4.1.5.3.1 Explosions (Deflagrations/Detonations)

Due to the potential for flammable vapor accumulation in various CSTF process areas, various explosion events have been addressed in the accident analyses. For an explosion to occur, all of the following conditions must exist:

- Sufficient oxygen
- Ignition source
- Presence of flammable vapors in explosive concentrations

Because most CSTF process areas have air atmospheres, quantities of oxygen sufficient to allow an explosion are typically assumed available. The number and type of ignition sources present to cause an explosion vary dependent on the process area involved. For the purpose of the accident scenarios, no ignition source controls were credited.

3.4.1.5.3.2 Flammable Vapor Sources

The primary flammable vapor of concern in the CSTF is hydrogen. The primary source of hydrogen is the radiolytic decomposition of water except during Chemical Cleaning of Type I/II Waste Tanks where hydrogen generation from corrosion of carbon steel is an additional source. The hydrogen can be released directly to an adjacent vapor space or can be retained in the waste. The retained hydrogen is either captured in the tank supernate (i.e., dissolved hydrogen) or tank saltcake/sludge (i.e., trapped hydrogen). The dissolved hydrogen is continuously released from the supernate, with the release rate being dependent on the supernate characteristics (e.g., temperature, salt content). Trapped hydrogen is assumed to be released from saltcake when the saltcake is dissolved, during seismically initiated agitation (due to mobilization from liquid sloshing), during saltcake interstitial liquid removal, or from the reduction in static pressure (e.g., free supernate removal). Trapped hydrogen is assumed to be released from sludge when the sludge is agitated (e.g., seismic event, waste tank mixing device operation), from the reduction in static pressure (e.g., free supernate removal), or the spontaneous liberation of gas bubbles from the slurried sludge layer (Ref. 253). The trapped hydrogen release rates are dependent on the characteristics of the saltcake/sludge and the cause of the release.

For the purpose of this DSA related to trapped hydrogen retention/release, the terms “settled sludge” and “slurried sludge” are used to distinguish the different sludge layers potentially in waste tanks (to determine use of flammability related inputs). An individual waste tank may contain both types of sludge layers (as long as the layer meets the criteria); however, a slurried sludge layer cannot exist beneath a settled sludge layer (Ref. 292). When the term “sludge” is used independently, this indicates that the DSA text is applicable to both settled sludge and slurried sludge. Each sludge layer is defined below (Ref. 292).

Settled Sludge

Sludge meeting the following shall be considered settled sludge:

- Sludge that has not been mixed (see discussion below) for greater than or equal to 15 years.
- Sludge receipts into a waste tank received greater than or equal to 15 years ago (see discussion below).

Slurried Sludge

Sludge meeting the following shall be considered slurried sludge:

- Sludge that has been mixed (see discussion below) less than 15 years ago.
- Sludge receipts into a waste tank received less than 15 years ago, except as described below.

Sludge received into a waste tank during DWPF Recycle transfers, Canyon transfers, or transfers from settled sludge waste tanks with the transfer device suction at or above the sludge layer can be considered to be settled sludge immediately (due to limited quantities), provided both of the following criteria apply:

- No waste tank mixing device operation (which created slurried sludge) occurred in the waste tank in the 15 years prior to the date the sludge was received, or after the date of receipt.
- No sludge was received into the waste tank in the previous 15 years that did not meet the criteria above.

Additionally, supernate transfers (transfers that meet the Sludge Carryover Minimization Program) from one waste tank into another waste tank do not contain sludge for the purpose of determining sludge receipts (slurried sludge).

Operating a mixing device in a waste tank is considered to create slurried sludge from any settled sludge within the zone of influence of the mixing device, after the mixing device has operated for a cumulative total of 10 days with turntable rotating and indication of sludge mixing. Additionally, sludge that has been within the zone of influence of an operating waste tank mixing device (i.e., based on tank cross sectional area and sludge disturbance depth as defined in Section 3.4.1.5.3.6 for settled sludge agitation) will be considered slurried sludge, irrespective of the requirements previously stated, if any mixing device in the waste tank is lowered. Sludge that does not fully meet one of these criteria may continue to be considered settled sludge. Additional information pertaining to settled sludge and slurried sludge consideration (for waste tanks that are undergoing initial sludge agitation) is provided in Section 3.4.2.11 (Waste Tank Quiescent Time Program subsection).

For waste tanks that are undergoing initial sludge agitation, multiple waste tank mixing devices will typically be used to ensure a sludge layer within a waste tank (or entire sludge inventory) has been slurried (and thus be considered slurried sludge). However, a process upset under certain waste tank conditions (e.g., failure of slurry pumps / CSMPs during slurrying with a remaining single slurry pump / CSMP operated for cumulative total of 10 days), could result in only a portion of the sludge layer to become slurried sludge. Although this scenario is unlikely to occur based on typical sludge agitation processing plans, the DSA refers to slurried sludge "layers" or "levels". Evaluations associated with DSA programs are able to account for this abnormal situation for amounts of slurried sludge. Additionally, this situation is addressed for slurried sludge hydrogen depletion considerations provided in Section 3.4.2.11 (Waste Tank Quiescent Time Program subsection).

In addition to hydrogen, some waste streams may contain small quantities of volatile organics (e.g., butanol, n-paraffin, toluene, benzene, Isopar® L) or other flammable vapors (e.g., ammonia). Isopar® L is an organic solvent used in the treatment of radioactive waste in the MCU and may be present in Tank 50 due to potential carryover from MCU transfers. Isopar® L is an isoparaffin diluent which is a mixture of branched chain hydrocarbons, designated Isopar® L by the vendor. Although the solvent used in the MCU contains other organics, Isopar® L is the only MCU organic of analytical concern on flammable vapor generation and energy contribution to an explosion. The masses and vapor pressures of the other MCU solvent organic components are small enough to discount (Ref. 224, 286).

For the purpose of this DSA, the term "organics" is used to describe any flammable vapor other than hydrogen that may contribute to the LFL (Composite Lower Flammability Limit [CLFL] for Tank 50). See Section 3.4.1.5.3.8 below for further information on organics.

3.4.1.5.3.3 <u>Hydrogen Generation Due to Radiolytic Decomposition</u>

The irradiation of water forms free radicals that can combine into such species as H_2 and H_2O_2. The production of hydrogen from the recombination of the noted free radicals is negatively influenced by the presence of nitrates and nitrites. The production rate of hydrogen is proportional to the radiolytic heat load of the waste in the tank. The species that are major contributors to the radiolytic heat load are Sr-90, Cs-137, Ce-144, Pu-238, Cm-244, Pu-239, and Am-241 (Ref. 89).

Time to LFL calculations are required to account for the major radiolytic contributors to the production of hydrogen. The flammable hydrogen concentration is temperature dependent and is temperature corrected as applicable. Because hydrogen is naturally buoyant in air and diffuses readily, hydrogen released to vapor spaces from radiolytic decomposition is well-mixed (i.e., no hydrogen layering) and only bulk hydrogen concentrations are considered, unless otherwise noted. The methodology and equations for determining the radiolytic hydrogen generation rate are described in Section 3.4.1.1.

3.4.1.5.3.4 <u>Hydrogen Generation Due to Corrosion</u>

The hydrogen generation rates associated with corrosion of carbon steel waste tank components are insignificant in comparison to the other hydrogen generation sources (except for Chemical

Cleaning as described below), based on corrosion controls in place for primary containments and the slow corrosion rate in alkaline media (Ref. 37). Hydrogen generation rates associated with corrosion of other metals, which could enter the waste from postulated evolutions, have not been analyzed in this DSA.

During chemical cleaning activities with OA, the hydrogen generation rate due to corrosion of carbon steel components is significant. The hydrogen generation rate for Type I/II Acidic Chemical Cleaning Waste Tanks (waste tanks and annuli) is based upon experimental results from process demonstrations performed by SRNL (Ref. 247, 277). For Type I/II Acidic Chemical Cleaning Waste Tanks, it is recognized that operation of the waste tank mixing devices may result in OA contact with the waste tank wall and internal components (e.g., cooling coils, columns) from the discharge of the SMP cooling ports and the agitation of the waste. This is addressed by having the ventilation flow rate conservatively based on the maximum fill limit of the waste tank which bounds the surface area that would be contacted by this spray. The process demonstrations used both simulated (HM and PUREX wastes) and actual waste (PUREX waste) and were designed to simulate tank chemical cleaning operations including acid concentration and acid to sludge volume ratio at expected operating temperatures. Metal coupons were used to approximate the exposed carbon steel surface area of the tank in contact with the acid. Electrochemical tests (e.g., open circuit potential tests) were also completed to determine whether hydrogen evolution was thermodynamically or kinetically favored during the dissolution of sludge with OA. The experiments documented in Reference 247 also monitored metal test coupons located in the demonstration vessel vapor space in order to assess potential impacts to the tank vapor space from chemical cleaning operations. Test results indicated minor general area corrosion due to condensate formation. However, analysis of the corrosion products did not indicate that the OA was a contributor to the corrosion reaction. The corrosion induced hydrogen generation rate for Type I/II Acidic Chemical Cleaning Waste Tanks (waste tanks and annuli) is specified in Section 3.4.1.5.5. Time to LFL calculations for Type I/II Acidic Chemical Cleaning Waste Tanks (waste tanks and annuli) are required to account for the corrosion induced hydrogen associated with the chemical cleaning process.

3.4.1.5.3.5 <u>Hydrogen Retention and Release (Trapped Hydrogen and Dissolved Hydrogen)</u>

Hydrogen is produced in each different layer of aqueous waste: supernate layer, settled sludge layer, slurried sludge layer, and saltcake layer. Each layer is capable of retaining a portion of the hydrogen produced within it. The supernate retains hydrogen up to the solubility limit. The sludge (settled sludge or slurried sludge) retains hydrogen based on the rheological properties and geometry of the sludge material (all insoluble solids are considered to be sludge for the purposes of trapped gas retention). The saltcake layer retains hydrogen based on the size of the voids and the associated equilibrium with the liquid also in the void spaces. Hydrogen release from saltcake and sludge is only a concern for waste tanks because these are the only process areas with significant quantities of static saltcake or sludge.

The release rate of the hydrogen increases as the layer becomes saturated, eventually matching the generation rate (when the associated layers are fully saturated). Typically, release rates are stable until the waste is disturbed, with the exception of the periodic spontaneous liberation of

trapped hydrogen within the slurried sludge layer (described further below). The release rate can be increased if the waste becomes disturbed in one of the following ways:

- Temperature increase (changes hydrogen solubility in liquid waste)
- Agitation of sludge
- Seismic activity
- Saltcake dissolution
- Waste transfers out of a tank (reduces the hydrostatic head pressure over waste layers containing trapped hydrogen, eventually resulting in its release as the retained hydrogen becomes buoyant)

Spontaneous liberation can occur from slurried sludge. Slurried sludge retains radiolytic hydrogen and can collect this hydrogen into bubbles. These bubbles enlarge by absorbing additional radiolytic hydrogen. The buoyancy of the bubbles is held in check by the hydrostatic head of the material above it as well as the rheological properties of the sludge. If the buoyancy of a bubble is sufficient to overcome the vertical forces acting on it, the bubble rises. This can occur when the force holding the bubble in place is reduced (such as during free supernate removal) or if the bubble becomes sufficiently large for its buoyancy to overcome the existing forces acting on it. As the hydrogen bubbles rise through the sludge layer, an interaction can occur with other hydrogen bubbles in close proximity. The release of a few bubbles can induce fluid motion, which can lead to a slow cascade release of additional hydrogen bubbles without influence from other agitation sources (e.g., waste tank mixing device operation) (Ref. 253).

Controls are established to address flammable gas retention and release including, as applicable, seismic and pump induced release mechanisms. Testing has shown that the addition of OA during Chemical Cleaning does not increase the retention of hydrogen, although it does increase the generation of hydrogen (Ref. 247).

3.4.1.5.3.6 <u>Trapped Gas Release</u>

As previously discussed, hydrogen bubbles can become trapped in the saltcake and/or sludge layers and released. The amount of trapped hydrogen released (e.g., percent released, global release vs. localized release) is dependent upon the release initiator. The amount of trapped gas released varies depending on the agitation source (e.g., seismic event, waste tank mixing device operation) and the agitator height (for waste tank mixing devices). The amount of trapped gas released also varies depending on the solids layers (saltcake, settled sludge, and slurried sludge) within the waste tank that are affected by the activity. Evaluations that use the inputs stated in the subsections below shall consider the combined contents of the waste tank (e.g., saltcake, settled sludge, and slurried sludge) and apply the inputs to each of the applicable solids layers.

Investigations into the nature and extent of trapped hydrogen release from sludge and saltcake have been performed at SRS and the conclusions are summarized below (Ref. 292).

Trapped Gas Bubble Gas Volume

As documented in Reference 292, the trapped gas bubble gas volume is a maximum of the following for each layer:

- 10% by volume in settled sludge
- 20% by volume in slurried sludge
- 11% by volume in saltcake

Hydrogen Percent in Trapped Gas

As documented in Reference 292, the hydrogen percent in trapped gas is as follows. For seismic Waste Tank Explosion consequence analysis (Ref. 268), the hydrogen percent in trapped gas is 50%. In waste tanks with known chemistry and heat loads, the H_{Mix} equation (and supporting equations) stated below may be used (limited to a maximum value of 75%). Otherwise, the hydrogen percent in trapped gas is:

- 75% in waste tanks that contain slurried sludge
- 50% in other waste tanks

In waste tanks with known chemistry and heat loads, the following equation can be used in lieu of the above values:

$$H_{Mix} = H_{NO3} \times F_{NO3} \times G_{NO3} + H_{NO2} \times F_{NO2} \times G_{NO2}$$

Where (list includes variables and definitions of supporting equations below):

H_{Mix} = Percent hydrogen in the bubble gas (limited to a maximum value of 75%)

H_{NO3} = Fraction of hydrogen in the gas produced by radiolysis of nitrate

H_{NO2} = Fraction of hydrogen in the gas produced by radiolysis of nitrite

F_{NO3} = Fraction of nitrate in the supernate

F_{NO2} = Fraction of nitrite in the supernate

G_{NO3} = Hydrogen generation correction factor for nitrate to account for nitrate/nitrite interaction in mixed solution

G_{NO2} = Hydrogen generation correction factor for nitrite to account for nitrate/nitrite interaction in mixed solution

$[NO_{eff}]$ = Effective ion concentration, mol/L

$[NO_3]$ = Nitrate concentration in supernate, mol/L

$[NO_2]$ = Nitrite concentration in supernate, mol/L

g_{NO3} = Hydrogen generation correction factor based on the concentration of nitrate

g_{NO2} = Hydrogen generation correction factor based on the concentration of nitrite

g_{Mix} = Hydrogen generation correction factor based on the effective ion concentration

G_{α} = Hydrogen yield in molecules per 100 electron volts of radiation produced by alpha radiation

$G_{\beta/\gamma}$ = Hydrogen yield in molecules per 100 electron volts of radiation produced by beta/gamma radiation

a_{hf} = Fraction of radiolytic heat rate that is contributed to alpha radiation

$H_{\alpha\text{-sludge}}$ = Heat generated by alpha decay in the sludge, BTU/hr

$H_{\beta/\gamma\text{-sludge}}$ = Heat generated by beta and gamma decay in the sludge, BTU/hr

$H_{\alpha\text{-salt}}$ = Heat generated by alpha decay in the saltcake, BTU/hr

$H_{\beta/\gamma\text{-salt}}$ = Heat generated by beta and gamma decay in the saltcake, BTU/hr

The values of H_{NO3} and H_{NO2} are given by the equations:

$$H_{NO3} = 0.0242[NO_3]^3 - 0.076[NO_3]^2 - 0.2101[NO_3] + 0.69, \text{ for } [NO_3] \geq 0M$$

$$H_{NO2} = 1.0213[NO_2]^2 - 1.2235[NO_2] + 0.9821, \text{ for } [NO_2] < 1M$$

$$H_{NO2} = 0.035[NO_2] + 0.74, \text{ for } [NO_2] \geq 1M$$

The values of F_{NO3} and F_{NO2} are given by the equations:

$$F_{NO3} = \text{moles gas}^{NO3} / (\text{moles gas}^{NO3} + \text{moles gas}^{NO2}) = [NO_3] / ([NO_3] + [NO_2])$$

$$F_{NO2} = \text{moles gas}^{NO2} / (\text{moles gas}^{NO3} + \text{moles gas}^{NO2}) = [NO_2] / ([NO_3] + [NO_2])$$

The values of G_{NO3} and G_{NO2} are given by the equations:

$$G_{NO3} = g_{Mix} / g_{NO3}$$

$$G_{NO2} = g_{Mix} / g_{NO2}$$

The value for g_{Mix} is given by the equations:

$$g_{Mix} = G_{\alpha} * a_{hf} + G_{\beta/\gamma} * (1-a_{hf})$$

$$G_{\alpha} = 1.3 - 0.79*[NO_{eff}]^{1/3} - 0.13*[NO_{eff}]^{2/3} + 0.11*[NO_{eff}]$$

$G_{\beta/\gamma} = 0.466 - 0.51*[NO_{eff}]^{1/3} + 0.14*[NO_{eff}]^{2/3} + 0.0055*[NO_{eff}]$

$a_{hf} = (H_{\alpha\text{-sludge}} + H_{\alpha\text{-salt}}) / (H_{\alpha\text{-sludge}} + H_{\beta/\gamma\text{-sludge}} + H_{\alpha\text{-salt}} + H_{\beta/\gamma\text{-salt}})$

$[NO_{eff}] = [NO_3] + ½[NO_2]$

The value for g_{NO3} is given by the equations:

$g_{NO3} = G_\alpha * a_{hf} + G_{\beta/\gamma} * (1-a_{hf})$

$G_\alpha = 1.3 - 0.79*[NO_3]^{1/3} - 0.13*[NO_3]^{2/3} + 0.11*[NO_3]$

$G_{\beta/\gamma} = 0.466 - 0.51*[NO_3]^{1/3} + 0.14*[NO_3]^{2/3} + 0.0055*[NO_3]$

$a_{hf} = (H_{\alpha\text{-sludge}} + H_{\alpha\text{-salt}}) / (H_{\alpha\text{-sludge}} + H_{\beta/\gamma\text{-sludge}} + H_{\alpha\text{-salt}} + H_{\beta/\gamma\text{-salt}})$

The value for g_{NO2} is given by the equations:

$g_{NO2} = G_\alpha * a_{hf} + G_{\beta/\gamma} * (1-a_{hf})$

$G_\alpha = 1.3 - 0.79*(0.5*[NO_2])^{1/3} - 0.13*(0.5*[NO_2])^{2/3} + 0.11*(0.5*[NO_2])$

$G_{\beta/\gamma} = 0.466 - 0.51*(0.5*[NO_2])^{1/3} + 0.14*(0.5*[NO_2])^{2/3} + 0.0055*(0.5*[NO_2])$

$a_{hf} = (H_{\alpha\text{-sludge}} + H_{\alpha\text{-salt}}) / (H_{\alpha\text{-sludge}} + H_{\beta/\gamma\text{-sludge}} + H_{\alpha\text{-salt}} + H_{\beta/\gamma\text{-salt}})$

Non-Seismic Trapped Gas Retention/Release Rates (Settled Sludge and Slurried Sludge)

The amount of trapped hydrogen gas retained/released varies for different release mechanisms and type of solids layers (saltcake, settled sludge, and slurried sludge). The trapped gas retention/release rates for various non-seismic release mechanisms for settled sludge and slurried sludge are as follows (Ref. 292):

- Settled sludge retains hydrogen up to its maximum retained hydrogen value determined using the maximum trapped gas bubble gas volume and associated hydrogen percent in trapped gas.
- The percentage of hydrogen generated that is retained in slurried sludge is based on the following slurried sludge depths (until the maximum retained hydrogen value is reached as determined using the maximum trapped gas bubble gas volume and associated hydrogen percent in trapped gas):
  - Less than 40 inches – 25% of the hydrogen generated is retained
  - Greater than or equal to 40 inches, but less than 90 inches – 50% of the hydrogen generated is retained
  - Greater than or equal to 90 inches, but less than 110 inches – 75% of the hydrogen generated is retained
  - Greater than or equal to 110 inches – 100% of the hydrogen generated is retained

- The trapped hydrogen release percentage for settled sludge agitation (using waste tank mixing devices) is as follows:
  - 100% release from 100% of the tank cross sectional area (accounting for sludge disturbance depth) if the agitation source is a single SMP, multiple slurry pumps, or multiple CSMPs.
  - 100% release from 50% of the tank cross sectional area (accounting for sludge disturbance depth) if the agitation source is a single slurry pump or a single CSMP.

  The settled sludge disturbance depth for releasing trapped gas is the settled sludge 24 inches below the bottom of the waste tank mixing device and the entire depth of the settled sludge above the bottom of the mixing device for all pumps but the quad-volute slurry pumps. The quad-volute slurry pumps release the entire depth of settled sludge regardless of the installation height.

- The trapped hydrogen release percentage for slurried sludge agitation (using waste tank mixing devices, even if using a single mixing device) is 100% of the entire slurried sludge inventory in the waste tank. For the purposes of quiescent time calculations for the Waste Tank Quiescent Time Program, refer to Section 3.4.2.11.1.

Non-Seismic Trapped Gas Retention/Release Rates (Saltcake)

For the purpose of this DSA related to trapped hydrogen retention/release from saltcake (and associated flammability related inputs below), the following terms are defined:

- Supernate Coverage: A layer of liquid (i.e., free supernate) which covers the Bulk Saltcake Layer in a waste tank. Small salt peaks (height and base measured in inches, not feet) and salt on cooling coils which are above the liquid layer are acceptable since they would provide an insignificant hydrogen release if dissolved by the influent liquid.
- Concentrated Supernate: Supernate which has an average bulk concentration greater than or equal to 9.6M [Na] or has an average bulk density of greater than or equal to 1.45 g/mL.
- Dilute Supernate: Any supernate which does not meet the above criteria for Concentrated Supernate.
- Mixing Eductor: Typically used in conjunction with the DWS, Mixing Eductors are submerged in the tank liquid near the saltcake layer. The supplied dissolution water is accelerated through a nozzle, discharging into an open suction eductor. Tank liquid is entrained with the dissolution water, promoting mixing of the combined solution and enhancing dissolution of saltcake.
- Bulk Saltcake Layer: When supernate is present in a waste tank above saltcake, the Bulk Saltcake Layer is the saltcake level in the tank as determined by measurement or engineering evaluation. When Supernate Coverage is being removed from a waste tank containing saltcake, the Bulk Saltcake Layer is the level within a waste tank where Supernate Coverage is at its minimum; further liquid removal will uncover

sufficient saltcake requiring consideration as interstitial liquid removal (e.g., uncovered salt peaks' height and base measurement transitions from inches to feet).

The amount of trapped hydrogen gas retained/released varies for different release mechanisms and type of solids layers (saltcake, settled sludge, and slurried sludge). The trapped gas retention/release rates for various non-seismic release mechanisms for saltcake are as follows (Ref. 292):

- Saltcake retains hydrogen up to its maximum retained hydrogen value determined using the maximum trapped gas bubble gas volume and associated hydrogen percent in trapped gas.
- For saltcake dissolution due to liquid addition to saltcake with no Supernate Coverage, the trapped hydrogen released is equivalent to the hydrogen trapped in the volume of saltcake dissolved, where (input is valid at a temperature of less than or equal to 70°C):
  - One gallon of water added dissolves one gallon of saltcake.
  - One gallon of Dilute Supernate added dissolves one gallon of saltcake.
  - Addition of Concentrated Supernate results in insignificant saltcake dissolution.
- For saltcake dissolution due to liquid addition to saltcake with Supernate Coverage, the trapped hydrogen released is equivalent to the hydrogen trapped in the volume of saltcake dissolved, where:
  - If Supernate Coverage over saltcake has been present for less than or equal to four days or if concurrent additions are made at more than one location (e.g., riser, downcomer), then adding one gallon of water or Dilute Supernate dissolves one gallon of saltcake. Addition of Concentrated Supernate (under the same conditions) results in insignificant saltcake dissolution. This input is valid at a temperature of less than or equal to 70°C.
  - If Supernate Coverage over saltcake has been present for greater than four days, any addition of water, Dilute Supernate, or Concentrated Supernate (regardless of the location of the point of entry of the incoming liquid [i.e., in the vapor space, in the supernate, or in the saltcake]), results in insignificant saltcake dissolution. This allowance does not apply for concurrent additions at more than one location (e.g., riser, downcomer). This input is not dependent on temperature.
- For saltcake dissolution due to waste tank mixing device operation, the trapped hydrogen released is equivalent to the hydrogen trapped in the volume of saltcake dissolved, where (input is valid at a temperature of less than or equal to 70°C):
  - One gallon of liquid in the tank above the Bulk Saltcake Layer, whether the tank contains Dilute Supernate or Concentrated Supernate, dissolves one gallon of saltcake.
  - One gallon of any liquid being introduced (e.g., dissolution water) dissolves one gallon of saltcake.

- For saltcake dissolution associated with Mixing Eductors, the trapped hydrogen released is equivalent to the hydrogen trapped in the volume of saltcake dissolved, and is dependent upon the following (input is valid at a temperature of less than or equal to 70°C):
  - Water added through a Mixing Eductor at the start of a dissolution campaign and after a Mixing Eductor is lowered dissolves saltcake at the following ratio, until the total volume of water added through the Mixing Eductor(s) equals 1/4 of the liquid volume initially above the Bulk Saltcake Layer:
    - One gallon of water added dissolves five gallons of saltcake (one gallon of saltcake dissolved for each gallon added, plus four gallons of saltcake dissolved due to the mixing of the liquid in the tank, whether the tank contains Dilute Supernate or Concentrated Supernate).
  - After the total volume of water added through the Mixing Eductor(s) equals 1/4 of the liquid volume initially above the Bulk Saltcake Layer, subsequent water additions through a Mixing Eductor at the same Mixing Eductor(s) elevation or if the Mixing Eductor(s) are raised dissolve saltcake at the following ratio:
    - One gallon of water added dissolves one gallon of saltcake.
- For saltcake dissolution due to transfer pump operation for the purpose of waste tank recirculation, the trapped hydrogen released is equivalent to the hydrogen trapped in the volume of saltcake dissolved, where (input is valid at a temperature of less than or equal to 70°C):
  - One gallon of Dilute Supernate in the tank above the Bulk Saltcake Layer dissolves one gallon of saltcake.
  - Waste tank recirculation of Concentrated Supernate results in insignificant saltcake dissolution.

  Recirculation with a transfer pump is defined as the planned movement of waste tank contents through a flow path (which may or may not be exclusively internal to the waste tank) that concludes with the bulk of the material being returned to the same waste tank. Flow that returns to the waste tank through an engineering feature (such as a siphon break in the transfer line) or minor leakage from valves, fittings, etc. is not considered recirculation, as long as the bulk of the material is being removed from the waste tank.

In addition to the methodology and inputs stated above, the following conservative assumptions shall be used for trapped gas retention/release for saltcake (dependent on activity):

- For bulk saltcake dissolution, assume that the amount of saltcake dissolved in the affected tank is equal to the smaller of the total volume of saltcake in the tank or the volume of the water source which will be used for bulk saltcake dissolution (assuming the source does not have continuous makeup capability). The liquid source system shall be considered to have continuous makeup capability if the system has an automatic or manual fill provision that is not electrically or mechanically

isolated. The electrical or mechanical isolation shall contain two independent means of isolation (e.g., two isolation valves; one isolation valve and open disconnect for liquid source transfer pump). Liquid additions to the waste tank from the DWS do not have continuous makeup capability as described in Section 3.4.1.5.2.

- For saltcake interstitial liquid removal, assume that all interstitial liquid in the saltcake above the transfer pump suction is removed.

Seismic Trapped Gas Retention/Release Rates

The amount of trapped hydrogen gas retained/released varies for different release mechanisms and type of solids layers (saltcake, settled sludge, and slurried sludge). The trapped gas retention/release rates for various seismic release mechanisms are as follows (Ref. 292):

- Settled sludge and saltcake retains hydrogen up to its maximum retained hydrogen value determined using the maximum trapped gas bubble gas volume and associated hydrogen percent in trapped gas.
- The percentage of hydrogen generated that is retained in slurried sludge is based on the following slurried sludge depths (until the maximum retained hydrogen value is reached as determined using the maximum trapped gas bubble gas volume and associated hydrogen percent in trapped gas):
  - Less than 40 inches – 25% of the hydrogen generated is retained
  - Greater than or equal to 40 inches, but less than 90 inches – 50% of the hydrogen generated is retained
  - Greater than or equal to 90 inches, but less than 110 inches – 75% of the hydrogen generated is retained
  - Greater than or equal to 110 inches – 100% of the hydrogen generated is retained
- The trapped hydrogen release percentage for settled sludge following a seismic event is as follows. If greater than 40 inches of saltcake is overlying the settled sludge, the trapped hydrogen release percentage for the settled sludge is 0%. Otherwise, use the following equation to determine the trapped hydrogen release percentage for settled sludge:

  [Settled Sludge Level + Total Overlying Waste Level] (inches) / 400 inches x 50%

  Total Overlying Waste Level includes slurried sludge, supernate, and saltcake. Saltcake beneath the settled sludge layer does not have to be factored into the settled sludge or overlying waste levels.
- The trapped hydrogen release percentage for slurried sludge following a seismic event is 100% of the entire slurried sludge inventory in the waste tank.

- The trapped hydrogen release percentage for saltcake following a seismic event is 50% from the region affected by mobilization. The saltcake depth/region that becomes mobilized is the lesser of the following three values:
  - Depth of total overlying waste level (including settled sludge, slurried sludge, and supernate) above the saltcake
  - Depth of the saltcake
  - 40 inches

Trapped Gases other than Hydrogen

The only trapped gas quantified in the explosion scenarios is hydrogen (Ref. 307). N-paraffin is not likely to be trapped (or available for release) since it is evaporated from the surface and not generated below the surface in the aqueous sludge. Any n-butanol (as well as n-paraffin) in the sludge would likely be in liquid form. Because ammonia is very soluble, it would likely be absorbed in the trapped gas as the bubbles rise to the surface.

For Tank 50, Isopar® L is not likely to be trapped (Ref. 307). Based on the estimated evaporation rate for Isopar® L, little, if any, accumulation is anticipated assuming that the MCU solvents separate and form a separate phase on the surface of the supernate. Even if the entire inventory of MCU solvents enter Tank 50, the bulk of the Isopar® L should evaporate and be discharged to the atmosphere by the Waste Tank Purge Ventilation System. Any layer present in Tank 50 will form small "puddles" of solvent floating on the surface of the supernate so that the "floating" layer will not impede the release of hydrogen, ammonia, and benzene from the bulk supernate. The potential accumulation of Isopar® L within any settled solids is not a flammability hazard. Since the waste temperature in Tank 50 is limited to a temperature of 43°C (see Section 3.4.2.11), the impact of agitation of the solids on the release of any solid-retained Isopar® L is bound by the assumption of a floating layer. As long as the vapor space is saturated, any additional Isopar® L reaching the liquid-vapor interface will not exacerbate the composition of flammables.

3.4.1.5.3.7 <u>Dissolved Hydrogen Release</u>

Dissolved hydrogen release is primarily due to supernate temperature increase or significant supernate agitation (e.g., mixer operation). Increases in waste temperature can result in reduced hydrogen solubility, releasing hydrogen previously retained in the waste in a soluble form (dissolved hydrogen). Temperature increases due to steam used in a steam jet transfer can result in a significant dissolved hydrogen release. However, steam jet transfers from H-Canyon waste headers do not result in significant dissolved hydrogen release and transport to CSTF tanks, as the hydrogen is released through the H-Canyon vent header (Ref. 166). The amount of dissolved hydrogen released for various temperature increase rates is specified in Section 3.4.1.5.5. Waste agitation from seismic motion will release insignificant, if any, quantities of dissolved hydrogen (Ref. 58). Operating experience has shown that dissolved hydrogen release due to mixer operation is not a prompt release. In addition, continued long-term waste tank mixing device operation is not credible in the absence of ventilation. The hydrogen release due solely to supernate agitation (i.e., no trapped gas release from sludge) is therefore not considered a

significant independent hydrogen source and does not have to be factored in to pump/mixer control determinations.

3.4.1.5.3.8 Organics

Excluding Tank 50, "organics" as used in this DSA is defined as flammable vapors other than hydrogen contributing to the LFL, including both organic vapors and other flammable vapors (e.g., ammonia). Tank 50 has a higher assumed initial percent of CLFL due to potential organic contributions from carryover of MCU transfers (due to the solvent used in the MCU process). The assumed initial flammable concentration in Tank 50 is due to contributions from hydrogen, trace organics (less than or equal to 5%), and Isopar® L. Because of these flammable vapor contributions, the Tank 50 accident analyses considered their effect on flammable vapor generation and energy contribution to an explosion. The Tank 50 accident analyses assumed that the solvent carryover concentrations present in the DSS from the MCU process were limited to the values defined in Section 3.4.1.5.2. Tank 50 residual tetraphenylborate (TPB) solids are considered stable such that they pose no effective contribution to the Tank 50 bulk vapor space flammability. As such, the 5% contribution from trace organics permitted in Tank 50 and in any waste receipts into Tank 50 can exclude any contribution from benzene generated by the Tank 50 residual TPB solids (Ref. 252).

Although the solvent used in the MCU contains other organics, Isopar® L is the only MCU organic of analytical concern on flammable vapor generation and energy contribution to an explosion. The masses and vapor pressures of the other MCU solvent organic components are small enough to discount (Ref. 224, 286).

In addition, the Tank 50 accident analysis assumed that the bulk vapor space temperature was maintained less than or equal to 43°C. Because this temperature limit will be protected, it can be utilized for all flammability calculations (e.g., trace organics) for Tank 50. Use of this temperature limit for the trace organics is only applicable to Tank 50 since its effluent is only transferred to the Saltstone Facility (i.e., is not transferred to the CST Evaporator System).

The remainder of Section 3.4.1.5.3.8 does not apply to Tank 50.

The effects on flammable vapor generation and explosion consequences of individual flammable vapors other than hydrogen were not specifically analyzed in any of the accident analyses. The contribution of organic vapors to LFL was addressed as described below.

During Chemical Cleaning of Type I/II Waste Tanks, nominal 8 wt. % OA will be added to the tank. Although OA is an organic species, it does not contribute to organic flammable gases and is not considered a fire hazard due to the low vapor pressure (Ref. 274).

During Waste Tank Grouting, the organic content of the components that will comprise the grout will contribute insignificant quantities to the flammable vapor space concentration. As such, the contribution from trace organics assumed in waste tanks undergoing grouting will bound any volatile releases from the grout (Ref. 281).

Prior to waste streams entering the CSTF, the waste stream shall be evaluated and shown to have less than or equal to a 5% organic contribution to the hydrogen LFL (at 100°C) according to the following formula (applicable to organics evaluated in Ref. 164):

$$\%LFL = \sum^{N} \frac{[N]}{LFL_N} \leq 5\%$$

Where:

N = flammable species

LFL_N = Lower Flammability Limit for the flammable species

Because of this WAC requirement, the flammability contribution of organics in CSTF locations can be considered bounded by 5% of the hydrogen LFL without reliance on any temperature controls. The energy contribution of organics to an explosion is accounted for by adding an extra 0.96 vol. % H_2 to the calculated H_2 volume (Ref. 187). Meeting the 5% limit will require WAC restrictions on waste senders, with the nature and extent of the restriction varying by waste stream (e.g., see Ref. 164). For example, requiring that non-Process Vessel Ventilation (PVV) transfers from the Canyons undergo decanting and evaporation may be sufficient to ensure the 5% limit is met for a given stream. Other senders (e.g., Defense Waste Processing Facility [DWPF]) may require limits on the waste stream constituents (e.g., toluene, ammonia). Programmatic controls have also been established to prevent the introduction (via air compressors) of other significant flammable vapors into analyzed vapor spaces (i.e., the effect of the flammable vapors from the air compressors is so small as to have a negligible effect on the flammable vapor concentration for any affected location).

Waste streams that exceed the 5% limit (e.g., PVV flushes) may be transferred into the CSTF if they are evaluated and shown to have:

- Less than or equal to a 20% organic contribution to the hydrogen LFL in the receipt pump tank (at 100°C), and
- Less than or equal to a 5% organic contribution to the hydrogen LFL in locations downstream of the receipt pump tank (at 100°C).

The evaluation of effects downstream of the receipt pump tank may take credit for actual facility conditions in showing the organic contribution to the hydrogen LFL is less than or equal to 5%. The required purge flow of receipt pump tanks for transfers exceeding a 5% organic contribution (up to a 20% organic contribution) is adjusted to account for the additional contribution of the organics. To transition the flow requirement back to the non-PVV flow requirement, sufficient pump tank flushes shall be performed to reduce the organic contribution to LFL to less than or equal to 5% (at 100°C). The number of flushes required shall be determined on a case by case basis by an engineering evaluation of the organic concentrations required to meet the 5% limit. This engineering evaluation shall be performed using the methodology outlined in Reference 164. The energy associated with the Pump Tank Explosion was not adjusted to account for the additional organics, since SS controls are already required to prevent a Pump

Tank Explosion and the effect of the energy increase on the mitigated consequences would be minor.

If a leak were to occur simultaneous with the organic transfer, exceeding a 5% organic contribution in a receipt pump tank could affect the flammable vapor concentration in the transfer route to the receipt pump tank and in the receipt pump tank secondary containment. Based on the low probability of these events occurring simultaneously and the limited increase in flammability, the effect of the increased organics on the transfer route and secondary containment is judged to be insignificant.

3.4.1.5.4 FLAMMABLE VAPOR ACCUMULATION BY PROCESS AREA

In determining the flammable vapor concentration in a given process area, the multiple flammable vapor sources described in the preceding sections must be considered. The total flammable vapor concentration shall include the applicable sources for that area, as discussed below.

3.4.1.5.4.1 Waste Tanks

Direct radiolytic hydrogen release to the vapor space is a primary contributor to total flammable vapor concentration in a waste tank, excluding Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks. Contributors to the flammable vapor concentration in Tank 50 are from hydrogen, trace organics (less than or equal to 5%), and Isopar® L. The radiolytic hydrogen release rate for individual tanks will typically be calculated using actual tank parameters, rather than bounding values. The flammability and energy contribution of organics in waste tanks is discussed in Section 3.4.1.5.3.8.

Corrosion induced hydrogen release to the vapor space is a primary contributor to total flammable vapor concentration in Type I/II Acidic Chemical Cleaning Waste Tanks. The total hydrogen generation rate for Type I/II Acidic Chemical Cleaning Waste Tanks (waste tanks and annuli) is the sum of radiolytic decomposition and corrosion induced hydrogen. Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 248).

Because trapped hydrogen release from waste can be a concern for waste tanks, the contribution of released trapped gas must be accounted for in the total flammable vapor concentration. Dissolved hydrogen can be a significant contributor in the waste tanks and therefore must be accounted for in the total flammable vapor concentration. Any dissolved hydrogen contribution should account for release due to temperature increase. Dissolved hydrogen release in Tank 50, Tanks 40 and 51 (when classified as an ESP Sludge Slurry Waste Tank), and Type I/II Chemical Cleaning Waste Tanks need not be accounted for since steam jetted transfers into these tanks are prohibited. The trapped gas contribution is very dependent on the specific release or agitation mechanism and can vary widely, as discussed previously in Section 3.4.1.5.3.6.

3.4.1.5.4.2 Evaporator Pots

Direct radiolytic hydrogen release to the vapor space is a primary contributor to total flammable vapor concentration in an evaporator pot. The radiolytic hydrogen release rate in the evaporator pot will typically be calculated using bounding generation rates for expected feed. The flammability and energy contribution of organics in the evaporator pot is discussed in Section 3.4.1.5.3.8.

Because trapped hydrogen release from waste in the evaporator pot is not a concern (Ref. 307), no contribution due to released trapped gas is required in the total flammable vapor concentration. Dissolved hydrogen can be a significant contributor in the evaporator pot and therefore must be accounted for in the total flammable vapor concentration. Any dissolved hydrogen contribution should account for release due to temperature increase.

The steam generated during normal evaporator operation is more than adequate to remove any hydrogen or other flammables generated in the pot. Only when the evaporator is not in operation and waste is left in the evaporator pot is flammable vapor accumulation a concern (assuming no dip tube purge).

3.4.1.5.4.3 Pump Tanks

Direct radiolytic hydrogen release to the vapor space is a primary contributor to total flammable vapor concentration in a pump tank. The radiolytic hydrogen release rate for pump tanks will be calculated using a bounding value. The flammability and energy contribution of organics in pump tanks is discussed in Section 3.4.1.5.3.8.

Because trapped hydrogen release from waste in the pump tanks is not a concern (Ref. 307), no contribution due to released trapped gas is required in the total flammable vapor concentration. Dissolved hydrogen can be a significant contributor in the pump tanks and therefore must be accounted for in the total flammable vapor concentration. Any dissolved hydrogen contribution should account for release due to temperature increase.

Hydrogen from corrosion during Chemical Cleaning Transfers (or related vent/drain operations) is a contributor to total flammable vapor concentration in a pump tank. Although, the pump tanks are constructed of stainless steel, components associated with the pump tank may contain carbon steel. Therefore, corrosion induced hydrogen is a contributor to total flammable vapor concentration. Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 248).

3.4.1.5.4.4 Core Pipes

The primary flammable vapor of concern in the core pipe vapor space is hydrogen, excluding transfer lines associated with transfers of MCU material to/from Tank 50. The primary source of hydrogen is the radiolytic decomposition of water from residual liquid waste that may remain in the core pipe after a waste transfer. In addition to hydrogen, flammable vapor contributors in the core pipe vapor space for transfer lines associated with transfers of MCU material to/from

Tank 50 include trace organics (less than or equal to 5%) and Isopar® L. The radiolytic hydrogen release rate in the core pipe will typically be calculated using bounding generation rates for expected waste transfers. The flammability and energy contribution of organics is discussed in Section 3.4.1.5.3.8.

Because trapped hydrogen release from waste in the core pipe is not a concern (Ref. 307), no contribution due to released trapped gas is required in the total flammable vapor concentration. Dissolved hydrogen is not a contributor in the core pipe and therefore need not be accounted for in the total flammable vapor concentration. Any dissolved hydrogen contribution due to residual waste would be negligible at the anticipated temperatures.

Hydrogen from corrosion during Chemical Cleaning Transfers (or related vent/drain operations) is not a contributor in core pipes constructed of stainless steel or other corrosion resistant material and therefore need not be accounted for in the total flammable vapor concentration. Corrosion induced hydrogen is a contributor to total flammable vapor concentration in core pipes constructed of carbon steel during Chemical Cleaning Transfers (or related vent/drain operations). Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 248).

3.4.1.5.4.5 Secondary Containments

The secondary containments addressed here include waste tank annuli, evaporator cells, DBs, VBs, drain VBs, PPs, catch tanks, HPFP, waste tank transfer pump/jet risers, transfer line jackets, transfer line encasements, LDBs, MLDBs, LPSs, COPs, and the LDB Drain Cell.

The primary flammable vapor of concern in the secondary containments vapor space is hydrogen excluding secondary containments associated with transfers of MCU material to/from Tank 50. The source of hydrogen is the radiolytic decomposition of water from the liquid waste that has leaked into the secondary containment. In addition to hydrogen, flammable vapor contributors in the secondary containments associated with transfers of MCU material to/from Tank 50 include trace organics (less than or equal to 5%) and Isopar® L. The radiolytic hydrogen release rate in the secondary containment will typically be calculated using bounding generation rates for expected waste transfers. The flammability and energy contribution of organics in the secondary containments is discussed in Section 3.4.1.5.3.8.

For Transfer Facilities associated with Chemical Cleaning Transfers (or related vent/drain operations), the hydrogen generation from leaked material is assumed to be from radiolytic as well as from corrosion of abandoned carbon steel material within the facility. For transfer line jackets associated with Chemical Cleaning Transfers (or related vent/drain operations), the hydrogen generation is from leaked material interacting with carbon steel jackets as well as from radiolysis. For waste tank annuli associated with Type I/II Acidic Chemical Cleaning Waste Tanks, the hydrogen generation is from leaked material interacting with carbon steel walls as well as from radiolysis. Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 248).

Because trapped hydrogen release from waste in the secondary containment is not a concern (Ref. 307), no contribution due to released trapped gas is required in the total flammable vapor concentration. Dissolved hydrogen can be a contributor in the secondary containment and therefore must be accounted for in the total flammable vapor concentration. Any dissolved hydrogen contribution should account for release due to temperature increase.

An additional concern unique to secondary containments is higher than normal flammable vapor concentrations that are not linked to the presence of waste. For areas in close proximity to a radiological hazard, flammable vapor accumulation in an enclosed space could result in an explosion that would result in a radiological release even if the explosion itself was not attributed to radiological material. Past secondary containment sampling and observation has provided indication of higher than normal flammable vapor concentrations (that are not linked to waste) in a few select locations (i.e., Type IIIA Waste Tank underliner sumps, Type IV Waste Tank leak detection sumps, and some transfer line jackets). Because of this, these locations were required to be analyzed in Sections 3.4.2.6 and 3.4.2.12. No other areas in proximity to a radiological hazard were identified as requiring analysis, in many cases due to the confinement characteristics of some secondary containments not being an enclosed space that would support flammable vapor accumulation.

Enclosed spaces without a radiological hazard in close proximity are also not considered hazard locations requiring analysis, since an explosion would not result in radiological consequences. Explosion prevention as part of overall facility safety is provided by the sitewide programs discussed in Section 3.3.3.3.2.

3.4.1.5.5 FLAMMABLE VAPOR RELEASE INPUTS AND ASSUMPTIONS

3.4.1.5.5.1 Flammable Vapor Concentration

- The LFL for hydrogen at 25°C is 4% by volume.
- The LEL of hydrogen in air is 12% by volume. Reference 123 provides a value of 18% for the LEL for hydrogen. However, detonations at concentrations down to 12.5% hydrogen have been reported in large-scale explosion tests (Ref. 150). The conditions for achieving a Deflagration to Detonation Transition (DDT) deal in particular with the geometry and path of the flame front. Since some process areas have a geometry that is favorable for DDTs (e.g., transfer lines), a LEL of 12% is conservatively used. Other factors, such as presence of water vapor and energy of the ignition source, affect this parameter and would make a detonation less likely, but are conservatively ignored.
- The LFL for Isopar® L at 25°C is 0.60% by volume.
- The vapor space in the waste tanks, pump tanks, evaporators, and transfer facilities is uniformly mixed. Hydrogen, as well as any organics, would diffuse over time throughout the available vapor space. Hydrogen in particular has a high diffusivity in air. Furthermore, the release of hydrogen is relatively slow, except following agitation (e.g., seismic event, waste tank mixing device operation).

3.4.1.5.5.2 Residual Waste Quantities in CSTF Secondary Containments

It is recognized that a small quantity of waste could be present in CSTF secondary containments at the onset of a DBA event. This "residual" quantity of waste is the assumed waste volume used as an initial condition in the DBA progressions. The residual waste would typically result in an equilibrium hydrogen concentration of no more than 25% of the LFL, considering only the effects of atmospheric breathing. The residual waste volumes for various CSTF secondary containments are given in Tables 3.4-1, 3.4-3, and 3.4-4. Residual details unique to specific secondary containments are discussed below:

- The residual waste volumes for Type III/IIIA Waste Tank annuli are given in Table 3.4-3. The residual volumes for Type III/IIIA Waste Tank annuli, except for Waste Tanks 40 and 50, use a bounding hydrogen generation rate of 1.5E-05 ft^3/gal-hr. Waste Tank 40 annulus uses a bounding hydrogen generation rate of 5.0E-05 ft^3/gal-hr. This amount of waste would result in an equilibrium hydrogen concentration of 25% of the LFL considering only the effects of atmospheric breathing in the annulus (Ref. 92). For Waste Tank 50, flammable vapor concentration is assumed to reach stoichiometric conditions (for Isopar® L) and no maximum residual waste volume is assumed.
- The residual waste volumes for Type I and Type II Waste Tank annuli are given in Table 3.4-3. The residual volumes for Type I and Type II Waste Tank annuli (except for the annuli of Type I/II Acidic Chemical Cleaning Waste Tanks) use a hydrogen generation rate of 5.6E-06 ft^3/gal-hr. This amount of waste would result in a maximum hydrogen concentration of 25% of the LFL, provided that the annulus is sufficiently purged with active ventilation every 108 days. If the Waste Tank Annulus Ventilation System were not run, equilibrium hydrogen concentration in the annulus, considering only the effects of atmospheric breathing, would be 50% of the LFL (Ref. 95).
- The residual waste volumes for the annuli of Type I/II Acidic Chemical Cleaning Waste Tanks are given in Table 3.4-3. The residual volumes for the annuli use a bounding radiolytic hydrogen generation rate of 1.5E-05 ft^3/gal-hr and a bounding corrosion induced hydrogen generation rate of 4.3E-05 ft^3/min-ft^2. The corrosion induced hydrogen generation is based on carbon steel surface area contacted by acidic waste. These hydrogen generation rates are utilized for determining the required annulus ventilation flow rate.
- The residual waste volumes and equilibrium hydrogen concentrations for the various transfer facilities (excluding the evaporator cells) are given in Table 3.4-1. Considering only atmospheric breathing, this amount of waste would result in an equilibrium hydrogen concentration of 25% of the LFL in most transfer facilities. The residual volumes use a bounding hydrogen generation rate of 1.5E-05 ft^3/gal-hr for all locations except Tank 50 VB, LPDT Cell, and the transfer paths for ESP Sludge Slurry, as shown in Figure 3.7-1. The bounding hydrogen generation rate is 5.0E-05 ft^3/gal-hr for ESP Sludge Slurry transfer paths (Ref. 98). For Tank 50 VB and LPDT Cell, flammable vapor concentration is assumed to reach stoichiometric conditions (for Isopar® L) and no maximum residual waste volume is assumed.

During Chemical Cleaning Transfers (or related vent/drain operations), acidic material leaked to transfer facilities could produce additional hydrogen due to the corrosion of carbon steel components. However, the Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) prevents corrosion induced hydrogen generation from contributing to the flammable vapor concentration (see Sections 3.4.2.7 and 3.4.2.8).

- The residual waste volume and equilibrium hydrogen concentration for the 242-16H Evaporator Cell are given in Table 3.4-4. Considering only atmospheric breathing, this amount of waste (assumed to be Bounding Sludge Slurry with the corresponding bounding radiolytic hydrogen generation rate) in the evaporator cell would result in an equilibrium hydrogen concentration of 25% of the LFL. Since Bounding Sludge Slurry transfers are not permitted through the 242-16H Evaporator Cell, the residual waste volume protected by monitoring the cell sump is judged sufficiently bounding to account for any additional hydrogen contribution from immobile waste deposits in the cell.

3.4.1.5.5.3 Atmospheric Breathing

Reference 292 justifies a minimum value of 5 mbar/day for atmospheric pressure variation. Fractional air changes are proportional to the total pressure change (1,013 mbar is standard atmosphere). Therefore, effective airflow due to breathing is represented as the fractional volume change on a daily basis times the volume of the facility vapor volume. For conditions in which there is no forced ventilation, atmospheric breathing is a valid transport mechanism for flammable vapors as well as radioactive materials. Additionally, no specific control of the opening size is required for the locations (e.g., boxes, cells, waste tanks, and waste tank annuli) that assume atmospheric breathing, since the required opening size is extremely small (Ref. 178). The design of the cell covers, penetrations, riser plugs, etc., is such that the locations crediting atmospheric breathing will have more than enough openings. Sealing techniques (e.g., taping, sealant application) implemented on these locations for weather proofing or contamination control historically have not sealed the location such that it eliminated atmospheric breathing capability (Ref. 273). As long as similar techniques are implemented, sealing of these locations is permitted.

The pressure variation on a daily basis provided here is an average over a long period of time. The statistical variation on a daily basis would normally be applied to a calculation using a day-to-day breathing factor. Use of the mean pressure fluctuation values is acceptable because of the long times to reach LFL involved in the events where atmospheric breathing is a significant influence on the total time to LFL (e.g., Waste Tank Explosion for Very Slow Generation Tanks). Atmospheric breathing has a minimal effect on total time to LFL for those events that could reach LFL rapidly (i.e., in a day or less) (Sections 3.4.2.7 and 3.4.2.8).

3.4.1.5.5.4 Hydrogen Generation Rates – Transfers/Evaporators/General

Unless specified otherwise, the hydrogen generation rates provided below are evaluated at 25°C.

- The bounding radiolytic hydrogen generation rate for ESP Sludge Slurry is 5.0E-05 ft^3/gal-hr (Sections 3.4.2.7, 3.4.2.12, 3.4.2.18) (Ref. 196).

- The bounding radiolytic hydrogen generation rate for evaporator scale is 4.75E-05 ft^3/gal-hr (Section 3.4.2.1) (Ref. 58).
- The bounding radiolytic hydrogen generation rate for Bounding Sludge Slurry, Type I/II Waste Tank Chemical Cleaning Slurry, and Chemical Cleaning Transfers is 1.5E-05 ft^3/gal-hr (Sections 3.4.2.6, 3.4.2.7, 3.4.2.8, 3.4.2.11, and 3.4.2.12) (Ref. 58, 246).
- The bounding radiolytic hydrogen generation rate for Bounding Supernate and for 242-16H and 242-25H Evaporator Bottoms is 9.6E-06 ft^3/gal-hr (Sections 3.4.2.1, 3.4.2.2, 3.4.2.6, 3.4.2.7, 3.4.2.8, and 3.4.2.12) (Ref. 58). This hydrogen generation rate is also applicable during chemical cleaning operations of the 242-16H Evaporator.
- The radiolytic hydrogen generation rate for Type I and Type II Waste Tank annuli (except for the annuli of Type I/II Acidic Chemical Cleaning Waste Tanks) is 5.6E-06 ft^3/gal-hr (Ref. 284).
- For the annuli of Type I/II Acidic Chemical Cleaning Waste Tanks, the bounding radiolytic hydrogen generation rate of 1.5E-05 ft^3/gal-hr and bounding corrosion induced hydrogen generation rate of 4.3E-05 ft^3/min-ft^2 will be applied. The corrosion induced hydrogen generation is based on carbon steel surface area contacted by acidic waste (Section 3.4.2.12) (Ref. 248). These rates do not include dissolved hydrogen release, since steam jetted transfers are prohibited. Application of the corrosion induced hydrogen generation rate does not require temperature correction below 75°C (Ref. 248). Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 248).
- The amount of dissolved hydrogen released for a 20°C temperature rise is ≤ 0.67 mg/L of waste (Sections 3.4.2.7, 3.4.2.8, and 3.4.2.12) (Ref. 58).
- The amount of dissolved hydrogen released for a 20 – 100°C temperature rise is ≤ 1.51 mg/L of waste (Section 3.4.2.1) (Ref. 58).
- The temperature increase during transfers using transfer pumps is considered negligible for determining dissolved hydrogen releases (Sections 3.4.2.1, 3.4.2.2, 3.4.2.7, and 3.4.2.8).

3.4.1.5.5.5 <u>Hydrogen Generation Rates – Waste Tanks</u>

The hydrogen generation rates provided below are utilized in Section 3.4.2.11 and are evaluated at 25°C.

The hydrogen generation rates provided below are in addition to the waste tank flammability classification requirements as defined in Section 3.4.2.11.1 (e.g., a Slow Generation Tank must have at least 28 days to LFL, following a loss of ventilation, and have a total radiolytic hydrogen generation rate less than or equal to the value stated below):

- The maximum radiolytic hydrogen generation rate for a Rapid Generation Tank (excluding the third, fourth, and fifth bulleted items below) is 19.6 ft^3/hr (Ref. 251).

This total tank radiolytic hydrogen generation rate, in addition to the dissolved hydrogen release rate associated with transfers, is utilized for determining the required ventilation purge rate.

- The maximum radiolytic hydrogen generation rate for a Slow Generation Tank (excluding the third, fourth, and fifth bulleted items below) is 8.1 ft^3/hr (Ref. 251). This total tank radiolytic hydrogen generation rate, in addition to the dissolved hydrogen release rate associated with transfers, is utilized for determining the required ventilation purge rate.
- The maximum radiolytic hydrogen generation rate for Tanks 40 and 51, when classified as an ESP Sludge Slurry Waste Tank, is 65.3 ft^3/hr (Ref. 251). This total tank radiolytic hydrogen generation rate is utilized for determining the required ventilation purge rate.
- The maximum radiolytic hydrogen generation rate for Tank 50 (when classified as either a Rapid or Slow Generation Tank) is 5.9E-02 ft^3/hr (Ref. 251). This total tank radiolytic hydrogen generation rate is utilized for determining the required ventilation purge rate.
- The maximum radiolytic hydrogen generation rate for Type IV tanks, is 3.2 ft^3/hr (Ref. 251). This total tank radiolytic hydrogen generation rate, in addition to the dissolved hydrogen release rate associated with transfers, is utilized for determining the unmitigated Type IV Waste Tank Explosion consequences.
- For Type I/II Acidic Chemical Cleaning Waste Tanks, the bounding radiolytic hydrogen generation rate of 1.5E-05 ft^3/gal-hr and bounding corrosion induced hydrogen generation rate of 4.3E-05 ft^3/min-ft^2 will be applied. The corrosion induced hydrogen generation is based on carbon steel surface area contacted by acidic waste (limited by the waste tank fill limit, Section 3.4.2.11) (Ref. 246). These rates do not include dissolved hydrogen release, since steam jetted transfers are prohibited. Application of the corrosion induced hydrogen generation rate does not require temperature correction below 75°C (Ref. 246). Corrosion induced hydrogen generation from OA is assumed to contribute to total flammable vapor concentration after 48 hours (> 4 wt. % OA) or 70 days (≤ 4 wt. % OA) of contact with carbon steel (Ref. 246).
- During acidic spray washing activities on Type I/II Acidic Chemical Cleaning Waste Tanks, flammable vapor accumulation rate does not include the effects of corrosion induced hydrogen generation from the sprayed wetted surface area of the tank wall/internals (above the liquid level) since the acid does not remain in contact with vertical tank surfaces for longer than 48 hours (Ref. 246).

3.4.1.5.6 SUMMARY OF GENERAL CONTROLS

The following controls are required to protect general assumptions upon which the AA calculations are based or which apply to numerous DBAs.

242-16H Evaporator Scale Evaluation: Controls shall be established to ensure that the total accumulated scale in the 242-16H Evaporator is less than or equal to 300 gallons.

Chemical Inventory Control Program: Programmatic controls shall be established to ensure 1) control over new materials brought into the facility and 2) that chemical inventories are within the assumptions of the analyses (documented in Table 3.3-5).

Conduct of Operations Program: A Conduct of Operations Program shall be established to address the applicable topical areas from DOE requirements. The facility shall follow site and facility procedures for implementing Conduct of Operations.

Configuration Management Program: A Configuration Management Program shall be implemented that:

1) Identifies and documents the technical baseline of SSCs and computer software.

2) Ensures that changes to the technical baseline are properly developed, assessed, approved, issued, and implemented.

3) Maintains a system for recording, controlling, and indicating the status of technical baseline documentation on a current basis.

4) Controls the configuration of the SSCs specified in Chapter 4 to maintain their design function.

5) Determines and implements testing/inspection requirements to ensure temporary modifications, used as credited SC or SS SSCs, meet Chapter 4 requirements.

Connector Installation Program: Connectors (e.g., Hanford, Grayloc®) shall be installed properly to ensure they maintain primary waste containment.

Corrosion Control Program: Programmatic controls shall be established governing corrosion control for credited safety SSCs.

Critical Lift Program: The Critical Lift Program shall ensure that movement of loads over SC and SS SSCs is conducted in a manner that will minimize the potential for damaging safety-related SSCs due to load drops (e.g., minimization of lifting heights, verification of load charts, lift stability, verification of rigging, and positioning of lifting equipment in a safe manner when not in use).

Evaporator Feed Qualification Program: Controls shall be established to ensure that the composition of waste streams received into the Evaporator Feed Tanks is within analyzed limits prior to transfer to the evaporator pot. Ensuring that the waste composition is within analyzed limits ensures that the assumptions made in the safety analysis are maintained. The program shall address hydrogen generation rate limits and shall contain attributes to preclude unacceptable uranium bearing/ hydrogen producing solids (scale) formation within the 242-25H Evaporator.

Event Response Program: Procedures shall be established governing the required actions in the event of control room abandonment. These procedures shall require the following operator actions (actions apply to activities associated with the evacuated control room):

1) Secure liquid transfers

2) Shut down evaporators (secure steam to tube bundles and lances) and secure evaporator feed pumps

3) Secure pump tank agitators, waste tank mixing devices, and power to SMPs

4) Secure transfer pumps associated with waste tank recirculation

Fire Protection Program: Programmatic controls shall be established to minimize the threats to the public health or welfare as well as the hazards to site personnel resulting from a fire.

HEPA Filter Efficiency Testing: Controls shall be established to ensure that HEPA filters credited for filtration in forced ventilation systems are periodically efficiency tested.

HEPA Filter Program: Controls shall be established to ensure that HEPA filters are periodically tested to ensure the filter is replaced prior to exceeding the analyzed radiological loading associated with the HEPA filter. Roughing filters do not have to be tested for radiological loading. Since any roughing filter with the potential for significant radiological loading is located adjacent to a HEPA filter, any roughing filter radiological loading of concern would be detected during periodic HEPA filter monitoring.

Hydrogen Generation Rate Control: Controls shall be established addressing protection of assumed hydrogen generation rates.

Industrial Hygiene Program: Programmatic controls shall be established to ensure employee exposure to chemical, physical, and biological hazards are within safe levels.

Inhalation Dose Potential Control: Controls shall be established to ensure that the inhalation dose potentials are within assumed values.

Oil Control Program: Programmatic controls shall be established to prevent the introduction (e.g., via air compressors, transfer pumps, waste tank mixing devices) of significant flammable vapors from lubricating or hydraulic oil into analyzed vapor spaces (e.g., evaporator pots, evaporator cells, transfer facilities, waste tanks, and waste tank annuli).

Nuclear Maintenance Management Program (NMMP): Controls shall be established and implemented to ensure that effective measures are taken so that SSCs that are part of the safety basis are capable of performing their intended function.

Radiological Protection Program: Procedures for personnel radiological protection shall be approved, maintained, and adhered to for all operations involving personnel radiation exposure in order to ensure radioactive releases are minimized and detected such that personnel are protected from radiation exposure.

Secondary Containment Waste Control: Controls shall be established addressing waste tank annuli, the 242-16H Evaporator Cell, DBs, PPs, VBs, HPFP, and LDB Drain Cell residual waste levels and Type I/II Waste Tank Annulus Ventilation System operation to ensure the hydrogen concentrations in these secondary containments are within the assumptions of the analyses. This control is not required for annuli on Closure Waste Tanks. For Type I/II Acidic Chemical Cleaning Waste Tanks, Type I/II Waste Tank Annulus Ventilation System operation requirements are controlled per Section 3.4.2.12.

Severe Weather Response Program: Programmatic controls shall be established during freezing conditions to ensure that SC and SS equipment remains functional. Affected equipment may be removed from service with appropriate compensatory measures (see Chapter 5) in lieu of meeting applicable severe weather controls.

Sludge Carryover Minimization Program: Suction of transfer devices (pumps and jets) shall be a minimum of 24 inches from the sludge layer to minimize sludge entrainment during supernate transfers (including feeding the evaporators).

Additional controls shall be implemented as necessary to minimize the amount of sludge solids carried over in supernate transfers based on evaluation of the following phenomena:

- Tank Agitation
- Effects of receiving waste transfers concurrent with an out-going transfer.

Transfers not meeting this program are considered sludge slurry transfers.

Structural Integrity Program: Programmatic controls shall be established to ensure structural integrity is maintained on credited safety SSCs.

Tank Top/Secondary Containment Loading Program: Programmatic controls governing loads placed on tank tops and secondary containments shall be established to ensure structural integrity is maintained on credited safety-related SSCs.

Traffic Control Program: Programmatic controls governing vehicle traffic shall be established to ensure primary containment is maintained on credited safety-related SSCs.

Transfer Control Program: A Transfer Control Program shall be established governing all facility-initiated waste transfers and transfers into and out of Tank 50.

Transfers into and out of Tank 50 are considered non-waste transfers (see Section 3.4.1.5.1). However, to preclude potential accident scenarios, portions of the Transfer Control Program apply to Tank 50 related transfers.

Contingency Transfer System transfers are transfers of waste from the annulus of a leaking waste tank back to the primary side of the same waste tank using the Contingency Transfer System. Contingency Transfer System transfers shall have an inhalation dose potential less than or equal to 9.8E+07 rem/gal (see Section 3.4.1.5.2); therefore, waste transfer requirements for High-Rem and sludge slurry waste, as defined below and in the controls sections of the individual accident

scenarios, do not apply to Contingency Transfer System transfers. In addition, siphon evaluations are not required for Contingency Transfer System transfers because the transfer will terminate in the vapor space of the primary waste tank.

The Transfer Control Program shall include the following attributes (additional attributes of the Transfer Control Program specific to certain DBAs are provided in the Summary of Controls section of the applicable DBAs):
(Only Items 3, 6, 7, 12, and 13 apply to transfers into and out of Tank 50)
(Only Items 3, 4, 6, 7, 8, and 10 apply to Contingency Transfer System transfers)

1) Prior to transfer initiation, determine the type of transfer. This evaluation will distinguish between High-Rem, Low-Rem, Chemical Cleaning, ESP Sludge Slurry, or sludge slurry transfers (see Section 3.4.1.5.1) for planned transfers. FTF sludge slurry transfers shall be less than or equal to 16.7 wt. % sludge-solids or have an inhalation dose potential that meets the Low-Rem Waste Transfer criteria (as determined by engineering evaluation). Sludge slurry transfers out of Waste Tanks 33 and 34 when the suction of the transfer device (pump or jet) is below the sludge layer shall be verified by sampling to meet the Low-Rem Waste Transfer criteria (see Section 3.4.1.5.1).

2) Prior to transfer initiation, determine the transfer path, including determination of sound isolation points and leak detection locations needed to support the transfer. Prior to transfer initiation of a High-Rem transfer, two physically separated functional transfer isolation devices shall be identified.

3) Prior to transfer initiation, a determination of the equipment needed to stop transfers shall be performed.

4) Waste transfers shall be monitored periodically for indications of transfer events (i.e., transfer error, siphoning, leakage). Monitoring shall extend beyond the transfer path to locations (e.g., pump tanks, waste tanks) determined by evaluation. The evaluation to determine the monitoring locations beyond the transfer path shall consider the isolation method used to define the transfer path (e.g., non-leak tested valve versus leak-tested valve, double valve isolated, blanked). The frequency and method (e.g., level/leak monitoring) of transfer monitoring and material balances shall be determined on an individual basis.

   Waste transfers with the potential to transfer material in amounts greater than 15,000 gallons require material balances. Material balance discrepancies shall be less than or equal to 15,000 gallons. In general, increased monitoring frequency is appropriate during the initial stages of the transfer, with a lesser frequency required once a transfer has been established. Material balances are not required for Contingency Transfer System transfers or waste transfers involved with feed to and receipt from an evaporator. Contingency Transfer System transfers are transfers of waste from the annulus of a leaking waste tank back to the primary side of the same waste tank using the Contingency Transfer System. Material balances are required for evaporator recycle transfers.

5) Prior to transfer initiation, a siphon evaluation shall be performed. The evaluation shall identify the potential for siphons and identify methods/equipment needed to stop siphons.

6) Prior to transfer initiation, a transfer pump speed evaluation shall be performed. The evaluation shall identify the potential for over-pressurization of the transfer path (exceeding system design pressure) or exceedance of transfer path flow rate limitations and identify methods/equipment needed to prevent the identified potential.

   A VFD speed setting (or operating speed for single speed pump) check shall be performed prior to any liquid transfer using a transfer pump. The check shall ensure that the maximum speed setting /operating speed is less than or equal to the value allowed to protect the most limiting of the following:

   - Ensure system design pressure (or pressure permitted by an approved engineering evaluation) is not exceeded.
   - Ensure flow rate is less than or equal to 360 gpm at the first above-ground leak location (the point of lowest system resistance that results in leakage outside the tank, assuming a guillotine break of the piping).
   - Ensure flow rate is less than or equal to 250 gpm for the intended transfer path (assuming intact path).

   Reference 260 indicates that no failure would occur within the CSTF transfer systems (e.g., piping, valves, connectors) due to a postulated transfer pump VFD over speed event. However to provide further defense, a VFD speed setting check shall be performed prior to any liquid transfer using a VFD driven pump. If the required VFD speed setting (or operating speed for single speed pump) could cause the transfer system design pressure to be exceeded, an engineering evaluation shall be completed and provided to DOE.

   Reference 261 evaluated IW and flush water system pumps that can exceed transfer system design pressure. Based on this evaluation, operation of these pumps is acceptable and will not cause over-pressurization of the transfer system (pressures are within code allowable pressure).

   Transfer jet flow rate is highly dependent on plant conditions, including jet submergence, specific gravity of material being transferred, and steam supply pressure. In general, transfer jets have a flow rate less than transfer pumps, and significantly below transfer path flow rate limitations stated above. The normal steam supply pressure to transfer jets is such that the transfer system design pressure will not be exceeded. Therefore, no evaluation is required for flow rate limitations or over-pressurization potential of the transfer path for jetted transfers.

7) Prior to transfer initiation, a water hammer evaluation shall be performed. The evaluation shall identify the potential for water hammer and identify methods/equipment needed to prevent water hammer.

8) Prior to transfer initiation, independent verification of correct transfer path alignment shall be completed. After initiating the transfer, use of correct motive force shall be independently verified.

9) Following an ESP Sludge Slurry transfer, a three volume core pipe flush shall be performed. The flush will ensure that the final hydrogen generation rate in the affected process areas is less than or equal to the bounding radiolytic hydrogen generation rate assumed for that location.

10) Actual missing waste shall be less than or equal to 5,000 gallons.

11) ESP Sludge Slurry shall only be transferred along the transfer path shown in Figure 3.7-1.

12) Prior to transfer initiation through HDB-7, isolation shall be established in HDB-7 to prevent waste from entering the Tank 50 VB except during intended transfers from HDB-7 through the Tank 50 VB.

    This control precludes potential accident scenarios associated with waste that may have a higher inhalation dose potential than Tank 50 Supernate. As stated previously, transfers through the Tank 50 VB and receipt transfer lines into Tank 50 will have an inhalation dose potential less than or equal to 2.09E+05 rem/gal.

13) Prior to transfer initiation from Tank 50, isolation shall be established in the Tank 50 VB to prevent Tank 50 material from entering HDB-7 and HDB-8 (via the ETP DB).

    This control precludes potential accident scenarios associated with Tank 50 material that may contain organics (e.g., Isopar® L) due to potential carryover from MCU transfers.

<u>WAC Program</u>: The WAC Program shall ensure that the composition of waste streams received into the facility is within analyzed limits. Waste streams received into the facility shall comply with limits/requirements for inhalation dose potential, fissile material, fissile poisoning, organic contribution to flammable vapors, heat generation rate, hydrogen generation rate, and MCU Hazard Categorization.

<u>Waste Characterization System Control Program</u>: The Waste Characterization System Control Program shall characterize the waste tank contents within the CSTF (e.g., isotopic and chemical makeup).

3.4.2 DESIGN BASIS ACCIDENTS

This section provides the AA for the DBAs at the CSTF, with the exception of analyses specific to Waste Tank 48. The safety basis for Waste Tank 48 is made up of (a) the DBAs in Section 3.4.2, excluding Waste Tank Explosion (Section 3.4.2.11) and Waste Tank Annulus Explosion (Section 3.4.2.12), and (b) the DBAs contained in Chapter 18, which were extracted from previous analyses. DBAs are defined as those credible accidents with the potential for consequences that require SC SSCs and/or TSR controls.

Whenever possible, DBAs are analyzed using the simplest applicable deterministic, phenomenological calculations. The frequencies for the DBAs analyzed were similarly simplified, when appropriate, by estimating frequencies for initiator or overall sequences for categorizing into broad frequency bins.

NPH and external events are special cases. NPH DBAs are those events with a phenomenon initiating frequency as specified in DOE-STD-1020-2016 (Ref. 19). External events are analyzed as DBAs if their frequency of occurrence is estimated to exceed 1E-06/yr conservatively calculated, or 1E-07/yr realistically calculated.

According to Procedure Manual E7, Procedure 2.25, Revision 14 (Ref. 16), each facility shall evaluate the impact of not having a frequency cut off (previously Beyond Extremely Unlikely [BEU]) for internal events. Process related internal events that are not covered by external or NPH events are assumed to be credible events, regardless of frequency. An evaluation was performed and documented in Reference 218 that evaluated the accidents defined in the Hazard Analysis for the CST Facility (Ref. 1); the Submersible Mixer Pump Consolidated Hazards Analysis; and the Consolidated Hazard Analysis for the Waste on Wheels Process (Ref. 242) to determine the impact of eliminating the frequency cut off to define credible scenarios for internal events in response to Procedure Manual E7, Procedure 2.25, Revision 14 (Ref. 16). Based on the evaluation, it was found that no internal events with significant consequences were eliminated from controls consideration based on frequency, and therefore, no further evaluation is required for compliance with Procedure Manual E7, Procedure 2.25, Revision 14 (Ref. 16). Subsequent hazard analyses also evaluated BEU internal events and found that no internal events with significant consequences were eliminated from controls consideration based on frequency; therefore, no further evaluation is required in response to Procedure Manual E7, Procedure 2.25, Revision 14 (Ref. 16).

The DBAs were analyzed to determine the consequences to the MOI and the OEP. The discussion for each DBA includes scenario development, frequency determination, ST analysis, consequence analysis, comparison to guidelines, and a summary of controls. The description of facility DID in Section 3.3.3.3.2 provides additional information about SSCs and administrative controls that exist in the facility but are not credited in the AA.

3.4.2.1 Evaporator Pot Explosion

3.4.2.1.1 SCENARIO DEVELOPMENT

3.4.2.1.1.1 Background

The purpose of the evaporators in the CSTF is to concentrate high level radioactive waste by evaporation. Waste in the evaporator pot generates hydrogen as a result of the radiolytic decomposition of water. In addition, dissolved (soluble) hydrogen and organics may be released from the waste (for further details on flammable vapor generation refer to Section 3.4.1.5.3). Because the evaporator pots have an air atmosphere, quantities of oxygen sufficient to allow an explosion were assumed available. For the purpose of this scenario, no ignition source controls were credited and it is assumed that an ignition source is present.

During evaporator operation, the steam generated by boiling of the waste is adequate to remove any hydrogen or other flammables generated. When the evaporator is not in operation and waste is left in the evaporator pot, air flow through level measurement devices (dip tubes) may remove

any flammable vapors that are generated. If flammable vapors are allowed to accumulate in the pot and the LFL is exceeded, an explosion (deflagration or detonation) could occur.

For an explosion to occur in the evaporator, the concentration of hydrogen mixed with air in the vapor space must be at or above the LFL. In order for the hydrogen concentration to reach these levels, the waste must be left in the evaporator well beyond procedural limits and both air and steam purging must be lost, otherwise the hydrogen gas will be swept out of the vessel. For further detail on the evaporator description and operation, refer to Sections 2.4.2 and 2.4.3.

3.4.2.1.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with an Evaporator Pot Explosion that have non-negligible risk.

3.4.2.1.1.3 Unmitigated Accident Progression

Three accident progressions are analyzed, evaporator startup, evaporator shutdown, and evaporator chemical cleaning. For evaporator startup and shutdown progressions, no mitigating actions are assumed for 10 days. Therefore, the evaporator startup and shutdown scenarios below are analyzed at 10 days, just before steam/air is restored. The conditions and parameters defining these scenarios are described in the following.

Startup Scenarios

Two startup cases are defined. These are:

1) Startup with rapid heating of a maximum fill volume to 100°C. All dissolved hydrogen/organics instantaneously released, and

2) Startup with rapid heating of a partial fill volume to 100°C. All dissolved hydrogen/organics instantaneously released.

The general startup accident progression applicable to both cases is as follows:

- Transfer through the cell is in progress,
- The evaporator is being started up,
- Air to the level measuring dip tubes and steam to the lance are in operation,
- The vapor space is initially filled with air at 0% LFL, due to the purging airflow from the dip tubes and eventually by the additional uncondensed steam flow from the lance as the waste liquid heats,
- Waste liquid at 20°C is pumped into the vessel,
- The waste liquid is rapidly heated to 100°C, and all dissolved hydrogen and organics are released to the vapor space,
- At some fill level from zero up to maximum, steam supply to the tube bundles is lost,

- Concurrently, air to the dip tubes and steam/air to the lance is also lost,
- Feed flow is immediately terminated,
- The soluble hydrogen and organics released from the feed provide an initial background concentration in the vapor space,
- The demister is assumed to be plugged,
- Hydrogen begins to fill the vapor space due to continued radiolytic hydrogen generation from waste and scale (significant hydrogen generation from scale in 242-16H only),
- Ignition source is present (no ignition source controls are credited),
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes the pot to fail, ejects any installed HEPA filters, and/or creates other openings (vent paths) in the evaporator cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material (from the evaporator pot) that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion causes loss of core pipe containment for the transfer jumper running through the evaporator cell 242-16H only), thereby initiating a transfer jumper leak/break in the evaporator cell (progression discussed in Section 3.4.2.3).
- Evaporator cell retains any liquid waste that spills from failed evaporator pot and transfer jumper (242-16H only) (based on a review of the cell design (Ref. 62), the evaporator cells will relieve pressure following an explosion via cell cover lifting, preventing the cell from failing).

Shutdown Scenarios

Three shutdown cases are defined. These are:

1) Shutdown with no temperature decrease and a maximum fill at 160°C (242-16H), 186°C (242-25H). All of the dissolved hydrogen/organics contained in the fill needed to raise the evaporator operating level from minimum to maximum is instantaneously released.

2) Shutdown with no temperature decrease and a minimum fill at 160°C (242-16H), 186°C (242-25H). No dissolved hydrogen/organics is involved.

3) Shutdown with a temperature decrease to 100°C (242-16H/242-25H) and a maximum fill. All of the dissolved hydrogen/organics contained in the fill needed to raise the evaporator operating level from minimum to maximum is released and retained until 100°C is reached.

The general shutdown accident progression applicable to all three cases is as follows:

- Transfer through the cell is in progress,
- The evaporator is operating at 160°C (242-16H) or 186°C (242-25H), at minimum operating liquid level,
- Air to the level dip tubes and steam/air to the lance are in operation,
- The vapor space is at 0% LFL, due to the steam flow from the boiling liquid,
- All soluble hydrogen and organics released from the waste liquid are being swept from the vapor space,
- At 160°C or 186°C steam supply to the tube bundle is lost,
- Concurrently, steam/air to the lance and air to the dip tubes are also lost,
- In the minimum fill case, feed flow is terminated immediately. In the maximum fill cases, feed flow is not terminated until maximum operating level is reached,
- The soluble hydrogen and organics in the additional feed flow provide an initial background concentration of flammables in the vapor space,
- The demister is assumed to be plugged,
- Hydrogen begins to fill the vapor space due to continued radiolytic hydrogen generation,
- Ignition source is present (no ignition source controls are credited),
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes the pot to fail, ejects any installed HEPA filters, and/or creates other openings (vent paths) in the evaporator cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material (from the evaporator pot) that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion causes loss of core pipe containment for the transfer jumper running through the evaporator cell (242-16H only), thereby initiating a transfer jumper leak/break in the evaporator cell (progression discussed in Section 3.4.2.3),
- Evaporator cell retains any liquid waste that spills from failed evaporator pot and transfer jumper (242-16H only) (based on a review of the cell design (Ref. 62), the evaporator cells will relieve pressure following an explosion via cell cover lifting, preventing the cell from failing).

Chemical Cleaning Pot Explosion Scenario (242-16H only)

- No transfer through the cell in progress (transfers through 242-16H Evaporator Cell transfer jumpers are prohibited during chemical cleaning),
- The evaporator is operating at 100°C, at minimum operating liquid level,
- Air to the level dip tubes and steam/air to the lance are in operation,
- The vapor space is at 0% LFL, due to the steam flow from the boiling liquid and air flow from level dip tubes,
- All soluble hydrogen and organics released from the waste liquid are being swept from the vapor space,
- Steam supply to the tube bundle is lost,
- Concurrently, steam/air to the lance and air to the dip tubes are also lost,
- The demister is assumed to be plugged,
- Hydrogen begins to fill the vapor space due to continued radiolytic hydrogen generation,
- The evaporator contents cool to 20°C by the time flammable vapor concentration reaches stoichiometric conditions,
- Ignition source is present (no ignition source controls are credited),
- An explosion occurs,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes the pot to fail, ejects any installed HEPA filters, and/or creates other openings (vent paths) in the evaporator cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material (from the evaporator pot) that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors.

3.4.2.1.1.4 Mitigated Accident Progression

The unmitigated consequences of the Evaporator Pot Explosion do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.1.4). Because the unmitigated accident scenarios do not challenge the Offsite or exceed the Onsite EGs, no mitigated analysis is required.

The scenarios for the 242-16H Evaporator Pot at the end of the 10-day event duration yields deflagration pressures below the yield stress of the lower and upper parts of the evaporator vessel (Ref. 152). Therefore, the evaporator structure remains intact and the Evaporator Pot Explosion scenario does not fail the transfer jumper running through the Evaporator Cell. During chemical cleaning operations of the 242-16H Evaporator, the Evaporator Pot Explosion scenario would

have the potential to fail the transfer jumper running through the Evaporator Cell; however, transfers through the 242-16H Evaporator Cell transfer jumpers are prohibited.

3.4.2.1.2 FREQUENCY DETERMINATION

The HA classifies Evaporator Pot Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, normal operating procedures and the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduce the probability of an Evaporator Pot Explosion.

3.4.2.1.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.1.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the explosion STs and are all taken from Reference 152 and 306, unless otherwise stated:

- HEPA ventilation filters have a maximum loading of 1 Ci of Cs-137. This comes from the Cs-137 originating in the supernate feed that collects in the evaporator bottoms. The bounding concentration of the Cs-137 in supernate is 42 Ci/gal. The 242-16H Evaporator Cell has a total of three HEPA filters, one inlet and two outlet. The 242-25H Evaporator has a total of 15 HEPA filters, three inlet and twelve outlet.
- 2,595 gallons in the 242-16H Evaporator and 11,250 gallons in the 242-25H Evaporator are used to evaluate the dose consequences of an explosion subsequent to loss of steam/air during startup with maximum fill. For a deflagration, there are two possible mechanisms that could generate an airborne source factor, rapid boiling or liquid entrainment from high velocity gas flowing over the waste liquid surface of the evaporator.
- 1,570 gallons in the 242-16H Evaporator is used to evaluate the dose consequences of an explosion subsequent to loss of steam/air during chemical cleaning operations at minimum waste level.

3.4.2.1.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion

(detonation or deflagration) model. For this analysis, there are two containment/confinement boundaries considered – the evaporator vessel and the evaporator cell.

Material at Risk

The MAR waste stream for the Evaporator Pot Explosion accident is Evaporator Bottoms (this includes material in the pot and material deposited on the evaporator cell HEPA filters). The waste characteristics and inhalation dose potential on a per unit volume basis for this stream is given in Section 3.4.1.5.1.

The volume of MAR for the explosion ST is the waste liquid contents of the evaporator. The volume of MAR for the HEPA filter ST is as discussed previously in the ST inputs and assumptions.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations.

ARFs for the release mechanisms associated with the deflagration/detonations are as follows (Ref. 152, 306). The values are based on Reference 14.

- The Rapid Boiling ARF for upper vessel failure is 0.1.
- The Blowdown Entrainment ARF for upper vessel failure is 5.0E-05.
- The Spray ARF for lower vessel failure is 1.0E-04.
- The Splashing ARF for lower vessel failure is 2.0E-05.
- The Blast Effects HEPA filter failure ARF is 1.0E-02.
- The Impact Effects HEPA filter failure ARF is 5.0E-04.
- The Aerodynamic Entrainment ARR for lower vessel failure is 4.0E-07/hour.

Respirable Fraction

RF is the fraction of the airborne material that escapes to the atmosphere outside evaporator cell that is of respirable size. It depends on the local release mechanism, and whether any additional filtering/wall condensation is available.

Since the HEPA filters are assumed to fail and wall effects are conservatively neglected, a bounding unfiltered release is used for the HEPA filter release (RF = 1 for both Blast Effects and Impact Effects).

The RF values for the other release mechanisms are as follows (Ref. 152, 306). The values are based on Reference 14.

- The Rapid Boiling RF for upper vessel failure is 1.0.
- The Blowdown Entrainment RF for upper vessel failure is 0.8.
- The Spray RF for lower vessel failure is 1.0.
- The Splashing RF for lower vessel failure is 1.0.
- The Aerodynamic Entrainment RF for lower vessel failure is 1.0.

Leak Path Factor

The LPF is assumed to be one for all scenarios.

3.4.2.1.3.3 Flammable Vapor Concentration Models

For the 242-16H Evaporator chemical cleaning analysis, a flammable vapor concentration of hydrogen at stoichiometric conditions was used. For the remaining pot explosion analyses, the flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present. The hydrogen concentration and percent LFL at the time of the explosion is determined in the analysis (Ref. 152) using the flammable vapor concentration formulas described in Section 3.4.1.1.2.

3.4.2.1.3.4 Explosion Effects on Evaporator Vessel Integrity

If the resulting pressure from an explosion exceeds the rated pressure of the 242-16H vessel top head or that of the 242-25H de-entrainment column flat plate, material will be released through the top of the affected vessel. If the explosion pressure further exceeds the rated pressure of the lower vessel cone sections, there will be additional spray or spill and splashing releases through the bottom of the vessel too. These will gather in the evaporator cell. Vapor entrainment will occur in the cell and continue until the waste liquid is removed. The vessel is conservatively assumed to fail at the ASME rated pressure.

The maximum explosion pressures in the evaporator that would be reached after explosions are those that would result from Adiabatic, Isochoric (constant volume), Complete Combustion (AICC). The transition from deflagration to detonation may occur at hydrogen concentrations from 12%-18% by volume. At the upper 18% value, the AICC pressure is about 75 psig, which is below the lower head failure pressure of the 242-16H Evaporator (85 psig) and near that of the 242-25H Evaporator (75.7 psig). Therefore, deflagrations are assumed to generally result in upper head failure only.

Until an explosion raises the pressure inside the evaporator vessel beyond the rated pressures of the vessels, the release of material will be only through the vent in the evaporator overheads condenser to the evaporator cell secondary containment. The hydrogen concentrations needed to fail parts of the evaporator vessel containment are given in Reference 152.

3.4.2.1.3.5 HEPA Filter Source Term

During normal operation, the HEPA filters in the evaporator cells provide confinement (filtering) of modest releases from the evaporator. In time, radioactive material builds up on the filter media. Since the differential pressure to fail a HEPA filter is quite low (~ 10 inches water column), the filters are modeled as failing as the result of an analyzed explosion. Of the material resident on the filter media, about 1% is assumed to be released during the explosion, based on consideration of airborne release and RFs associated with blast effects and impact stresses from falls. For the HEPA filter MAR, a blast dislodges the filters releasing or freeing all of the MAR to the environment outside the evaporator cell (LPF = 1.0). Some of the MAR remains airborne due to the blast, while the rest falls to the ground with the filters, only to have some become airborne again upon impact. Two possible release mechanisms from a filter failure are considered concurrently in the determination of the filter ST; namely, blast effects and free-fall impact (Ref. 152).

3.4.2.1.3.6 Explosion (Deflagration/Detonation) Source Term

For the 242-16H Evaporator chemical cleaning analysis, a detonation is assumed to occur and the TNT equivalent model is used. The mass of liquid (ST) made airborne by the detonation is set equal to the mass of TNT that produces the same energy as is produced by the combustible gas mixture consumed during the detonation. A stoichiometric mixture for hydrogen is assumed in the analysis.

For the remaining pot explosion analyses, the ST is dependent on whether a deflagration or detonation occurs. If the hydrogen concentration is between the LFL and the LEL, a deflagration is assumed to occur. If the hydrogen concentration is at LEL or above, a detonation is assumed to occur. If the hydrogen concentration is below the LFL, no event will occur. The explosion is modeled in the ST calculation using the deflagration model (discussed further in Section 3.4.1.1.2).

3.4.2.1.3.7 Explosion (Deflagration) Source Term

For the deflagration, there are two possible mechanisms that could generate an airborne source factor, rapid boiling or liquid entrainment from high velocity gas flowing over the waste liquid surface of the evaporator. These terms were evaluated independently with the most conservative result used to determine the consequences.

3.4.2.1.3.8 Spray Source Term

If the pressure resulting from the explosion is only great enough to partially fail (e.g., crack) the lower evaporator vessel, then a spray release may result during vessel depressurization below the

liquid surface. In this case, the containment failure ARF is applied to the contents of the evaporator, which are released.

3.4.2.1.3.9 Splashing Source Term

If the pressure resulting from the explosion is great enough to substantially fail the lower part of the evaporator vessel, there will be a ST resulting from the splashing of material on the cell floor.

3.4.2.1.3.10 Long-term Aerodynamic Entrainment Source Term

In addition to the splashing term, if the pressure resulting from the explosion is great enough to substantially fail the lower part of the evaporator vessel, there may also be a long-term ST associated with aerodynamic entrainment of the material remaining on the cell floor. The aerodynamically entrained material will be exhausted from the evaporator cell through the failed HEPA filters by the ventilation system flow, which is conservatively modeled as remaining functional after an explosion within an evaporator vessel.

3.4.2.1.3.11 Rapid Boiling Source Term

It is assumed that all available explosion energy is transferred to thermal energy for boiling of the waste liquid (MAR) for complete combustion of the reactant gas mixture. This energy is deposited in all the surfaces exposed to the explosion. The amount deposited in the liquid surface vaporizes the liquid. For conservatism, all available energy is modeled to strike the liquid. The amount of vapor released containing radioactive material is combined with the RF and LPF for the rapid boiling source term.

3.4.2.1.3.12 Blowdown and Entrainment Source Term

This term describes the liquid entrainment in the evaporator during a high pressure blowdown through a containment vent or breach in the environment. It is also extended to a high pressure blowdown following an explosion. For conservatism all available explosion energy is transformed into mechanical energy that strips (entrains) droplets from the liquid surface of the MAR.

3.4.2.1.3.13 Source Term Calculation

For the 242-16H Evaporator chemical cleaning analysis, the explosion STs were calculated in Reference 306 using the detonation model described in Section 3.4.1.1.2. To determine the overall scenario unmitigated and mitigated consequences for the 242-16H Evaporator Cell, the explosion ST was not added to transfer jumper leak/break STs (calculated in Reference 60 and discussed in Section 3.4.2.3.3) because transfers through the 242-16H Evaporator Cell transfer jumpers are prohibited during chemical cleaning operations.

For the remaining pot explosion analyses, the STs were calculated in Reference 152 using the methodologies previously discussed. To determine the overall scenario unmitigated and mitigated consequences for the 242-16H Evaporator Cell, the explosion ST was not added to transfer jumper leak/break ST (calculated in Reference 60 and discussed in Section 3.4.2.3.3)

because the 242-16H Evaporator Pot remains intact and the Evaporator Pot Explosion scenario does not fail the transfer jumper running through the Evaporator Cell.

The analysis showed that the hydrogen concentration at 10 days for all cases is relatively low, ranging from approximately 2% to 8% by volume. The 8% hydrogen concentration was reached in 10 days in the "startup with rapid heating of a maximum fill" case for the 242-16H Evaporator. The minimum and partial fill cases are not flammable in 10 days. The hydrogen concentrations for these cases range from approximately 2% to 3% by volume. These are less than the corresponding temperature adjusted hydrogen LFLs.

The cases indicate that if the feed is immediately terminated upon loss of steam/air during operation, when lower levels of fill are in the evaporators, the subsequent hydrogen generation is insufficient to allow an explosion in 10 days. The other cases are flammable, but with concentrations well below the LEL at which a detonation could occur. At the other concentration end, the analysis indicates that to reach a stoichiometric mixture takes approximately 60 to 300 days, with the partial fill at startup cases significantly exceeding the others.

3.4.2.1.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Evaporator Pot Explosion event are given in Table 3.4-7 (Ref. 152, 255, 306).

The unmitigated and mitigated Offsite (≤ 0.1 rem) consequences for the bounding scenario (deflagration occurring during startup of the 242-25H Evaporator Pot with maximum fill) do not challenge the Offsite EGs.

The unmitigated and mitigated Onsite (≤ 41 rem) consequences for the bounding scenario (deflagration occurring during startup of the 242-25H Evaporator Pot with maximum fill) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the presence of the evaporator cell and the length of time to reach LFL.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.1.5. The consequences of an Evaporator Pot Explosion event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.1.5 SUMMARY OF CONTROLS

Since the unmitigated Evaporator Pot Explosion event consequences do not challenge the Offsite or exceed the Onsite EGs (as discussed in Section 3.4.2.1.4), no controls are required beyond the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3 4.1.5.2.

3.4.2.2 Evaporator Cell Explosion

3.4.2.2.1 SCENARIO DEVELOPMENT

3.4.2.2.1.1 Background

The purpose of the evaporators in the CSTF is to concentrate high level radioactive waste by evaporation. If a jumper, gasket, valve, or evaporator vessel leak occurs inside the evaporator cell, the leakage is contained within the containment structure of the evaporator cell. The leaked waste may generate hydrogen as a result of the radiolytic decomposition of water. In addition, dissolved (soluble) hydrogen and organics may be released from the leaked waste (for further details on flammable vapor generation refer to Section 3.4.1.5.3).

If the flammable vapors are allowed to accumulate, an explosion (deflagration or detonation) could occur. Since evaporator cells have an air atmosphere, quantities of oxygen sufficient to allow a deflagration were assumed available. For the purpose of this scenario, no ignition source controls were credited and it is assumed that an ignition source is present.

For further detail on the evaporator cell description, refer to Sections 2.4.2 and 2.4.3.

3.4.2.2.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with an Evaporator Cell Explosion that have non-negligible risk. The events concern an explosion in the evaporator cell caused by a buildup of flammable vapors. The accident progressions have been categorized based on whether a transfer jumper leak (242-16H only) or Evaporator System leak (fast leak, slow leak, or seismic event) initiated the event.

3.4.2.2.1.3 Unmitigated Accident Progression

The transfer jumper leak scenario considers a leak from a transfer jumper running through the evaporator cell (242-16H) that results in 15,000 gallons of waste emptying into the cell. A seismic event or a non-seismic initiator can cause the transfer jumper leak scenario. The general progression for leaks originating from a transfer jumper running through the evaporator cell is provided below, with specific scenario variations denoted throughout (the following progression is applicable only to the 242-16H Evaporator):

- A small initial quantity of waste is present in the evaporator cell,
- Flammable vapors in the evaporator cell accumulate until the vapor space reaches an equilibrium hydrogen concentration of 25% of the LFL (determined by the hydrogen release caused by the initial volume and atmospheric breathing, as discussed in Section 3.4.1.5.5),
- The evaporator is operating,
- A waste transfer is in progress through the evaporator cell,

- A primary containment leak occurs (i.e., transfer jumper failure). The maximum assumed missing waste volume is 15,000 gallons (Section 3.4.1.5.2),
- Waste accumulates in the evaporator cell,
- The initial leak is assumed to go undetected (i.e., no credit for leak detection instrumentation),
- Cell ventilation (other than atmospheric breathing) is not functional,
- Flammable gas is generated via radiolysis of the waste in the cell and release of dissolved hydrogen from the leaked material during the time of the leak (steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through the evaporator cell transfer jumper are prohibited),
- Additional flammable vapors are released for ≤ 10 days (the vapor is assumed to be at the same temperature as the spilled or transferred waste),
- Hydrogen is assumed to mix uniformly with the air in the vapor space (i.e., there is no stratification or pocketing),
- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages the evaporator pot and/or evaporator jumpers, thereby initiating an Evaporator System leak/break in the cell (progression discussed in Section 3.4.2.3),
- Evaporator cell retains any liquid waste that spills from failed transfer jumper and evaporator pot (based on a review of the cell design [Ref. 62], the evaporator cells will relieve pressure following an explosion via cell cover lifting, preventing the cell from failing).

The Evaporator System leak scenarios consider a leak from the evaporator vessel or from a line (including jumpers, gaskets, valves, etc.) connected to the evaporator vessel.

The fast leak rate scenario considers an Evaporator System leak that is large enough to be detected and terminated by the operators. The slow leak rate scenario considers an Evaporator System slow leak that goes undetected until it overflows into the ventilation ductwork. The Evaporator System seismic event scenario considers a seismic event occurring during normal operation of the evaporator, which results in the entire contents of the pot emptying into the cell with additional waste feed from the evaporator feed pump before the operator can terminate operation. The general progression for leaks originating for the Evaporator System is provided below, with specific scenario variations denoted throughout:

- The evaporator cell sump is assumed to be full of waste (97 gallons for 242-25H, 75 gallons for 242-16H),
- The cell vapor space is assumed to be initially at 0% LFL,
- Evaporator cell ventilation is operational,
- The evaporator is operating (feed pump flow at 55 gpm for 242-25H, 42 gpm for 242-16H),
- Evaporator cell ventilation fails,
- Waste accumulates in the evaporator cell due to a waste containment (e.g., jumper) failure (fast leak/slow leak) or due to total pot failure (seismic event),
- No credit is taken for evaporator cell leak detection,
- In the case of the slow leak only, the leak continues until it overflows into the ventilation system,
- The operators detect the leak and terminate feed to the pot (for fast leak/slow leak) or the feed pump continues to run for one hour before feed being stopped (for seismic),
- Flammable gas is released into the cell vapor space for 10 days via radiolysis of the waste,
- An ignition source is present (no ignition source controls are credited),
- Flammable vapors in the cell vapor space deflagrate or detonate (depending on when ignition occurs relative to the flammable gas concentration). The ignition is assumed to occur when the volume of hydrogen is reached that produces the maximum consequences within the specified event duration,
- The heat from deflagration causes some of the liquid waste from the top layer of the waste to boil. This boiling evaporation from the explosion causes a portion of the radioactive material in the facility to become airborne. The blast and/or shock wave effects from detonations cause material to become airborne,
- The overpressure from the explosion causes the cell covers to lift off of the cell, ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell. The explosion is assumed to produce insufficient force to dislodge the cell covers such that they fall into the cell,

- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages the evaporator pot and/or transfer jumper running through the evaporator cell (applicable only to the 242-16H Evaporator), thereby initiating a transfer jumper leak/break in the cell (progression discussed in Section 3.4.2.3),
- Evaporator cell retains any liquid waste that spills from failed transfer jumper and evaporator pot (based on a review of the cell design [Ref. 62], the evaporator cells will relieve pressure following an explosion via cell cover lifting, preventing the cell from failing).

3.4.2.2.1.4 Mitigated Accident Progression

The unmitigated consequences of the Evaporator Cell Explosion do not challenge the Offsite EGs, but do exceed the Onsite EGs (as documented in Section 3.4.2.2.4). Where the Evaporator Cell Explosion unmitigated consequences exceed the Onsite EGs, two SS levels of control are required. Because the event involves an explosion, one additional SS level of control is required.

As discussed in Section 3.4.2.2.3, the hydrogen concentration does not exceed the LFL in less than 10 days for a transfer jumper leak from a transfer jumper in the evaporator cell (242-16H) (Ref. 71). Mitigated analysis is not required for this event.

The hydrogen concentration does not exceed the LFL in less than 10 days for the Evaporator System fast leak rate scenario because the operators terminate the leak, such that the hydrogen concentration does not exceed LFL within 10 days (Ref. 71).

The hydrogen concentration exceeds the LFL in less than 10 days only in the Evaporator System slow leak rate scenario. However, the time period between the start of the slow leak and the time to LFL is greater than 10 days (due to the large volume of the evaporator cell) (Ref. 71). In consideration of the slow leak in a large volume, the first level of control selected (below) prevents an explosion from causing an Evaporator Pot failure or transfer line jumper failure in the evaporator cell, eliminating the spill component of the event (242-16H).

Evaporator Cell Explosion (242-16H only)

Because the bounding unmitigated Evaporator Cell Explosion (explosion following a slow leak into the 242-16H Evaporator Cell) exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences for the slow leak evaporator scenario. For the evaporator leak, the slow leak scenario is the contributor to an explosive flammable mixture of hydrogen in the evaporator cell within 10 days. The first level of control is verification of level in the Evaporator Cell structure (Evaporator Cell sump level) to ensure that hydrogen concentration in the Evaporator Cell is within the assumption of the analysis. Because this is an initial condition, instrumentation is not required. For the second

level of control, the evaporator cell structure provides airborne waste confinement following an explosion in the evaporator cell. The controls supporting Evaporator Cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Evaporator Cell Explosion (242-16H only) event and response to the event to minimize the potential release/personnel exposure.

3.4.2.2.2 FREQUENCY DETERMINATION

The HA classifies Evaporator Cell Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduces the probability of an Evaporator Cell Explosion.

3.4.2.2.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

The overall Evaporator Cell Explosion ST varies depending on whether the cell explosion was initiated by a transfer jumper leak or an Evaporator System leak (fast leak, slow leak, or seismic event). Separate analysis was not performed for a 242-16H Evaporator Cell explosion initiated by a transfer jumper leak because this event is bounded by an HDB-7 Transfer Facility Explosion (for non-ESP Sludge Slurry transfers), which was shown not to reach 100% of the LFL during the unmitigated progression (see Section 3.4.2.7). The only difference between the HDB-7 Transfer Facility Explosion and 242-16H Evaporator Cell explosion (initiated by a transfer jumper leak) is the cell size. The hydrogen generation rate of the waste used in the HDB-7 Transfer Facility Explosion bounds any waste that might be present for a 242-16H Evaporator Cell explosion initiated by a transfer jumper leak. Since the 242-16H Evaporator Cell is larger than HDB-7, the cell will take longer to reach 100% of the LFL. Discussion of the derivation and calculation of an HDB-7 Transfer Facility Explosion ST is provided in Section 3.4.2.7. The overall Evaporator Cell Explosion unmitigated ST is made up of an explosion ST and transfer jumper leak/break ST (calculated in Reference 60 and discussed in Section 3.4.2.3.3). The overall Evaporator Cell Explosion mitigated ST is made up of an explosion ST only.

3.4.2.2.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Evaporator Cell Explosion STs and are all taken from Reference 71, unless otherwise stated:

- It is reasonably conservative to assume that the initial hydrogen concentration in the cell vapor space at the start of the event (i.e., loss of ventilation) is very small and can be neglected (assumed to be zero), based on the following. The evaporator cells are relatively large with high flow ventilation systems (approximately 2,800 standard cubic feet per minute (scfm) for 242-25H, 800-900 scfm for 242-16H). These ventilation systems are in operation whenever the evaporator is in operation. The hydrogen concentration with the ventilation operating would be essentially zero. If ventilation were to be shutdown for an extended period of time, hydrogen concentration (assuming a hydrogen generation rate of 9.6E-06 ft^3/gal-hr at 25°C, 5% contribution of organics) would take greater than 40 days to reach 25% of the LFL, assuming the evaporator cell contains 11,250 (242-25H) or 5,150 (242-16H) gallons of waste.

3.4.2.2.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion (detonation or deflagration) model.

Material at Risk

The MAR waste stream for the transfer jumper leak scenario is Bounding Supernate, since transfers through this jumper are limited to Bounding Supernate. However, since LFL was not reached for the accident progression following a transfer jumper leak into the cell, consequences using Bounding Supernate were not calculated for this scenario. The MAR waste stream for other Evaporator Cell Explosion accident scenarios is Evaporator Bottoms. The waste characteristics and inhalation dose potential on a per unit volume basis for this stream is given in Section 3.4.1.5.1.

For the unmitigated analysis, the volume of MAR for this event is all of the waste in the evaporator cell prior to the time of a leak plus any of the waste that leaks into the cell. For the mitigated analysis, the volume of MAR for this event is all of the waste in the evaporator cell prior to the time of a leak.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1).

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.2.3.3 Flammable Vapor Concentration Models

The flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present. The hydrogen concentration and percent LFL at the time of the explosion is determined in the analysis (Ref. 71) using the flammable vapor concentration formulas described in Section 3.4.1.1.2. For the three cases analyzed (fast leak, slow leak, seismic), the ST is the result of a deflagration, because the hydrogen concentration does not reach LEL (detonation) in the 10 days between termination of the spill inside evaporator cell and addressing the spill (e.g., ventilation operation, removal of spilled waste). The bounding hydrogen concentration was determined to occur in the slow leak scenario (the LFL was not exceeded for the other two cases).

3.4.2.2.3.4 Source Term Calculation

The STs for the various cases associated with a cell explosion initiated by an Evaporator System leak were calculated in Reference 71 using the deflagration model described in Section 3.4.1.1.2 (detonation analysis was not required at the calculated hydrogen concentrations). The bounding case was the slow leak case.

Since LFL was not reached following a transfer jumper leak into the cell, this scenario is also bounded by the slow leak case.

To determine the overall scenario unmitigated consequences for the 242-16H Evaporator Cell, the explosion ST was added to transfer jumper leak/break ST (calculated in Reference 60 and discussed in Section 3.4.2.3.3). To determine the overall scenario mitigated consequences for the 242-16H Evaporator Cell, the explosion ST was not added to transfer jumper leak/break ST because the 242-16H Evaporator Pot remains intact and the Evaporator Cell Explosion scenario does not fail the transfer jumper running through the Evaporator Cell.

3.4.2.2.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Evaporator Cell Explosion event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 60, 71, 255).

The unmitigated and mitigated Offsite (≤ 0.1 rem) consequences for the bounding scenario (explosion following a slow leak into the 242-16H Evaporator Cell) do not challenge the Offsite EGs.

The unmitigated Onsite (> 100 rem) consequences for the bounding scenario (explosion following a slow leak into the 242-16H Evaporator Cell) exceed the Onsite EGs. The mitigated Onsite (≤ 7 rem) consequences for the bounding scenario (explosion following a slow leak into the 242-16H Evaporator Cell) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the length of time to reach LFL and the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.2.5. The consequences of the Evaporator Cell Explosion event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.2.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of an Evaporator Cell Explosion event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.2.5.1 Safety Significant Controls

242-16H Evaporator Cell: The evaporator cell structure provides airborne waste confinement following an explosion in the evaporator cell.

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following an Evaporator Cell Explosion (242-16H only) event and response to the event to minimize the potential release/personnel exposure.

3.4.2.3 Evaporator Overflow, Leaks, and Spills

3.4.2.3.1 SCENARIO DEVELOPMENT

3.4.2.3.1.1 Background

The purpose of the evaporators in the CSTF is to concentrate high level radioactive waste by evaporation. Waste is transferred from the evaporator feed tank to the evaporator pot, with overheads being removed via the overheads system, and the concentrated waste being lifted to the evaporator drop tank. Liquids other than waste (e.g., flush water) are also added to the pot through various penetrations. In addition, waste may be transferred via a jumper through the 242-16H Evaporator Cell simultaneously with evaporator operation. Evaporator Overflow,

Leaks, and Spills are possible when waste leaks into the evaporator cell or pot additions cause the pot to overflow. If a jumper, gasket, valve or evaporator vessel leak occurs inside the evaporator cell, the leakage is contained within the cell structure. Further details regarding the Evaporator System designs are provided in Sections 2.4.2 and 2.4.3.

3.4.2.3.1.2 Accident Initiators

Evaporator Overflow, Leaks, and Spills encompass a broad range of activities that could potentially lead to various types of material release. Unmitigated releases of radioactive material from transfer jumpers, evaporator vessels and associated equipment in their respective buildings, (242-16H and 242-25H) can occur into the 242-16H and 242-25H Evaporator Cells, and into the outdoor overheads receiver cell of 242-16H. Table 3.3-17 identifies the HA events associated with an Evaporator Overflow, Leak, or Spill that have non-negligible risk. For the purpose of this analysis, the Evaporator Overflow, Leaks, and Spills events have been grouped into six different categories:

- Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only)
- Evaporator System Leaks/Breaks in the Evaporator Cell
- Evaporator Waste Overfeed
- Evaporator Non-Waste Overfill
- Rainfall Flooding
- Liquid Addition Resulting in Overpressurization

The various categories are discussed in detail in Section 3.4.2.3.1.3. The same events that evolve into Evaporator Overflows, Leaks, and Spills are, in many instances, the same initiators for an Evaporator Cell Explosion. The Evaporator Cell Explosion scenarios are discussed in Section 3.4.2.2.

3.4.2.3.1.3 Unmitigated Accident Progression

Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only)

Transfer jumper leaks and breaks in the evaporator cell involve leaks from jumpers used to transfer waste through the 242-16H Evaporator Cell. The possible initiators for a leak/break could be caused by corrosion, vibration, brittle fracture, and connector failure, or the leak/break could be the result of a seismic event.

The worst case scenario would be a leak of 15,000 gallons of waste from the transfer jumper into the evaporator cell, where it would collect in the cell sump. The highest elevation for a leak would be at the high point of the transfer jumper, and the analyzed elevation is at the bottom of the evaporator cell covers, which bounds any transfer jumper elevation.

The accident progression for the transfer jumper leak/spills is as follows: Waste is being transferred through the cell at 250 gpm. A section of the transfer jumper breaks or leaks, and

waste is spilled into the evaporator cell. The bounding scenario is a leak (versus a spray). The leak scenario was shown to bound the spray scenario in Reference 60. The leak continues to release waste into the evaporator cell until the transfer pump is shutdown (up to a 15,000 gallon release).

Evaporator System Leaks/Breaks in the Evaporator Cell

Evaporator System leaks and breaks in the evaporator cell involve leaks within the evaporator cell from the vessel, or from pipes, jumpers or valves going to or from the evaporator. The possible initiators for an Evaporator System leak/break could be caused by corrosion, vibration, brittle fracture, jumper connector failure, and valve leaks, or the leak/break could be the result of a seismic event. The 242-25H Evaporator leak parameters are larger than the 242-16H Evaporator leak parameters, making the 242-25H events bounding.

The worst case non-seismic scenario would be a fast leak spilling waste from the evaporator lift into the evaporator cell, where it would collect in the cell sump. A slow leak could eventually result in a larger maximum spill volume, but the time frame required to reach the maximum spill volume is so long that the fast leak consequences are bounding. The highest elevation for a non-seismic fast leak would be at the high point of the lift jumper, and the analyzed elevation is at the bottom of the evaporator cell covers, which bounds any lift jumper elevation.

The worst case seismic scenario would be a rupture of the 242-25H pot with the spilled waste collecting in the evaporator cell. The lift break was chosen as the bounding non-seismic accident instead of the feed break because the lift break has a larger associated maximum spill volume; even though the feed rate is larger, the feed break would be detected and addressed much sooner due to more indications of the leak. The isotopic concentrations used in the Evaporator Bottoms ST bounds both the feed and lift material.

The accident progression for the Evaporator System leak/spills is as follows: Waste is either 1) being fed to or lifted from the pot, or 2) being transferred through the cell (bypassing the pot) using the feed pumps. One of the feed/lift line/jumper breaks or leaks, and waste is spilled into the evaporator cell. As described earlier, the bounding leak is considered to be a fast leak. The fast leak scenario bounds the slow leak scenario because the time required to spill a larger amount of material at a slower rate (as in the slow leak scenario) exceeds the 8-hour exposure requirements of Reference 4. For the seismic initiated evaporator leak/spill, the evaporator is assumed to be at the high level limit when the seismic event occurs. The pot is assumed to fail, and the entire contents empty into the evaporator cell with the feed pump being shutdown within one hour.

Evaporator Waste Overfeed

Evaporator overfeed events involve overfilling of the 242-16H and 242-25H Evaporator vessels with feed material from their respective feed tanks. It is assumed that operator error or equipment failure causes feed material to be unintentionally pumped into the evaporator via its normal path through the feed nozzle. If the evaporator vessel and connected equipment retain

their boundary integrity, feed material would eventually backup and spill from the overheads condenser non-condensable gas vent, from the MRT vent, or (in 242-16H only) from the CRC feed tank vent. Spillage from the overheads condenser vent is directly into the evaporator cell from an elevated location. Spillage from the combined vent that serves the 242-16H MRT/CRC feed tank is initially into the overheads condenser cell, but flows across the floor to the evaporator cell, where it enters near the top of the evaporator cell and falls to the floor. Spillage from the MRT vent in the 242-25H Evaporator is directly into the evaporator cell from an elevated location well above the floor.

In the 242-16H Evaporator System, one of two CRC pumps is normally in service directing overheads condensate to one of the two overheads receiver tanks. Excess feed that passes through the overheads condenser would be pumped to the in-service overheads receiver tank. In the 242-25H Evaporator System, overheads condensate drains from the overheads condenser to the in-service overheads receiver tank, as would excess feed that passes through the overheads condenser. However, the overheads receiver tanks are alarmed on high level (not credited) and the fill status of the overheads receiver tanks is monitored frequently during evaporator operations (not credited). Operator action (not credited) would prevent the overheads receiver tanks from overflowing. If overflow should occur, the excess feed would be directed back to the feed tank via the tanks' overflow line. Waste remaining in the overheads receiver tank could pose an As Low As Reasonably Achievable concern, but has been shown to have a low dose risk to the FW (Ref. 153).

For the purposes of this event scenario, no credit is taken for diversion of excess feed back to a feed tank or for excess feed material moving to the overheads receiver tanks. Taking no credit is conservative for this event in that overflow through the overheads condenser and Mercury/CRC feed tank vents, and accumulation in the evaporator cell, is maximized.

The overfeed event is bounded by the Evaporator System Leaks/Breaks event because there are less means of detecting that event and more volume of material spilled than in the overfeed event. The maximum waste release due to a waste feed overflow is bounded by the maximum spill volume for an evaporator leak/break (14,647 gallons for a 242-25H seismic event, 8,500 gallons for all non-seismic events). This is based on the waste feed overflow being detected much sooner than the Evaporator System leak/break. Normal evaporator operating activities would preclude the overflow resulting in a larger maximum spill volume. Therefore, the unmitigated consequences calculated for the Evaporator System leak/break are used for the waste feed overflow.

Evaporator Non-Waste Overfill

This event involves addition of non-waste liquid to the evaporator pot while the pot is full of waste. Potential sources include (but are not limited to) flushwater through the flushwater addition line, flushwater through the Gravity Drain Line (GDL), flushwater through the demister spray, flushwater through the dip tubes, well water (242-16H only), nitric acid or caustic during chemical cleaning operations (242-16H only), condensing steam from the lance, and cooling water from an overheads condenser tube rupture. By inspection, it is clear that these events would be radiologically bounded by the waste overfeed event because the addition of non-waste

would dilute the waste, resulting in lesser amounts of MAR than are present in other events. In addition, overfill by non-waste feed sources (with the exception of well water and overheads condenser cooling water for 242-16H Evaporator) is not considered possible to occur because:

- Evaporator operation is deliberate and level is constantly monitored and alarmed.
- Flushwater additions are deliberate activities and are performed on a batch basis, and multiple flushwater tank refills during flushwater additions would be required to reach the pot overflow volume.
- Volume in the cooling tower basin, along with makeup water, cannot physically fill the 242-25H Evaporator (i.e., approximately 7,360 gallons needed to overfill when at the high level limit but only 4,208 gallons available from the basin). If a tube leak did occur in the overheads condenser, the liquid would typically drain out the overheads condenser to the overheads system and/or out the overheads condenser vent instead of making its way to the evaporator pot. The overheads condenser vent itself would be able to handle the leak rate and prevent liquid backing up to the evaporator pot.

Rainfall Flooding

Rainfall flooding involves flooding of the evaporator cell by natural precipitation events and consequential rupture of the evaporator vessel and/or related components. The HA attributes the rupture to "moving" of the equipment caused by the flooding. Because the evaporator cell structures are constructed of reinforced concrete with design provisions to preclude in-leakage, there is no credible mechanism for floodwaters to flow through the cells with sufficient lateral force to dislodge the evaporator vessel or other related components. The judgment is that only buoyant forces in the vertical direction would cause the damage.

In order for the evaporator vessel to become buoyant, the mass of the evaporator and connected piping, the mass of the contained feed material (nominal specific gravity of 1.3) and concentrated evaporation product (maximum specific gravity of 1.6 [242-16H] or 1.8 [242-25H]), and the anchorage of the equipment to the concrete cell structure would have to be overcome. For this to happen, the level of rainwater inside the evaporator cell (outside the pot) would have to significantly exceed the level of feed material inside the pot.

The normal operating level within the vessel is above the evaporator's vertical midpoint. Accumulation of rainwater to this depth is not credible. Even if the cell cover and rain cover were removed, the worst precipitation event cannot fill the cell to that level. Because each evaporator cell has at least one exterior wall exposed at grade level, and the surrounding grade does not impound water against the building, it is not possible to surround the cell with flood waters of sufficient depth to fill the interior of the cells, even if in-leakage were possible.

For the above-mentioned reasons, this event is considered not credible and thus not addressed further.

Liquid Addition Resulting in Overpressurization

Pressurized liquid additions to the pot (e.g., cooling water and waste feed) could cause pot pressure to increase but would not result in a pot breach because the demister (and downstream piping) does not plug and the liquid is allowed to flow to the overheads system. The pressure sources to the pot include the feed pumps and cooling tower pumps (242-16H only). The flow into the pot by these sources is either limited by the pump pressures (i.e., feed pump and cooling tower pump) and/or by the supply piping configuration. For these reasons, the pressure sources cannot provide enough flow to exceed the capacity of the exit piping of the evaporator. Specific information about each source is given below:

- Feed Pump – The 242-16H feed pump discharge pressure exceeds the pot failure pressure of 44 psig and the 242-25H feed pump discharge pressure exceeds the pot failure pressure of 32 psig. The feed pumps are capable of providing maximum flow rates of 42 gpm for 242-16H and 55 gpm for 242-25H.
- Cooling Tower Pumps – The cooling tower pumps discharge pressure for the 242-16H Evaporator exceeds the pot failure pressure of 44 psig. The maximum supply pressure, with no losses taken into account, of the pumps is ~75 psig (242-16H cooling tower). If an overheads condenser tube encountered a double-ended guillotine break (1-inch pipe), the flow rate could theoretically achieve 520 gpm (Ref. 154) out the overheads condenser vent (routes to evaporator cell) and outlet (routes to overheads receiver tanks) once the system (evaporator and overheads condenser) was filled (assumes no flow out the GDL).

Overpressurization by the sources discussed above is prevented by the relief capacity of the evaporator overheads condenser vent and outlet. For the 242-16H Evaporator, the overheads condenser vent along with the outlet could theoretically discharge up to 850 gpm at 40 psig without taking pressure losses into account (Ref. 154). The 242-25H Evaporator overheads condenser has a 6-inch vent. Per Reference 154, a 6-inch schedule 40 line can discharge greater than 3,000 gpm at a pressure of 10 psig. Although pressure losses exist, the outlet capacity of the overheads condensers greatly exceeds the sources and thus it can be concluded that pot overpressure is not a concern.

Based on a review of the demister properties in Reference 148, liquid level increases are not assumed to cause pluggage of the demister. Pot liquid level control is not credited in preventing an overpressurization due to uncontrolled liquid addition. Based on the preceding assessment, overpressurizing the evaporator pot to failure is judged not to occur and is not addressed further.

3.4.2.3.1.4 Mitigated Accident Progression

The unmitigated consequences of the Evaporator Overflow, Leaks, and Spills do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.3.4) with the exception of Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only). The unmitigated consequences of the Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only) exceed the Onsite EGs. Mitigated analysis is required for the Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only).

Transfer Jumper Leaks/Breaks in the Evaporator Cell (242-16H only)

For a core pipe failure into the evaporator cell during a transfer through the evaporator cell, two levels of control are required. Core pipe integrity and controls supporting core pipe integrity were chosen as the first level of control to prevent a core pipe failure into the evaporator cell. The controls supporting core pipe integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations). For large secondary containments such as the evaporator cell (greater than or equal to 15,000 gallons), the evaporator cell structure was credited as a second level of control. The evaporator cell structure provides containment of liquid waste and provides airborne waste confinement following a core pipe failure. The controls supporting evaporator cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

3.4.2.3.2 FREQUENCY DETERMINATION

The HA classifies Evaporator Overflow, Leak, and Spill events in the anticipated frequency bin. No detailed frequency analyses were performed for the anticipated events to lower the assumed frequency. Other potential initiators of an evaporator pot release (i.e., rainfall flooding or liquid addition resulting in overpressurization) were assessed, as discussed previously, and judged to be not credible.

3.4.2.3.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.3.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Evaporator Overflow, Leaks, and Spills STs and are all taken from Reference 60:

- Leak/break/spill height of material in the 242-16H Evaporator Cell is less than or equal to 762 cm (except as described below).
- Leak/break/spill height of material in the 242-25H Evaporator Cell is less than or equal to 997 cm (except as described below).
- The free-fall distance for liquid spilling into an evaporator cell for a non-seismic event is assumed to be entirely from the highest of the possible sources for each event, which would be from the lift jumper. However, this analysis uses the height from the bottom of the cell covers, which bounds any lift jumper elevation.

- The free-fall distance for liquid spilling into an evaporator cell for a seismic event is assumed to be at 3 meters.
- The seismic scenario is a complete yet instantaneous rupture of the evaporator pot vessel, however, the duration of the event is assumed to last for one hour because the feed pump continues to operate for one hour.
- For the non-seismic scenarios, the duration of the event is based upon the MAR and the rate (gpm) at which the material is spilled.

3.4.2.3.3.2 Source Term Derivation

Unmitigated STs were derived using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. Analysis was performed in Reference 60 for the Evaporator System fast leak and seismic cases, for both 242-25H and 242-16H. Analysis was performed in Reference 60 for the transfer jumper leaks/breaks in the evaporator cell (242-16H only). The terms in the five-factor ST formula are discussed below, including discussion of case specific parameters.

Material at Risk

The MAR waste stream for the transfer jumper leaks/breaks scenario is Bounding Supernate, since transfers through this jumper are limited to Bounding Supernate. The MAR waste stream for all other Evaporator Overflow, Leaks, and Spills accident scenarios is Evaporator Bottoms. The waste characteristics and inhalation dose potential on a per unit volume basis for these streams are given in Section 3.4.1.5.1.

The volume of MAR for the Evaporator System leaks/breaks in the evaporator cell event is the waste volume assumed to leak undetected into the evaporator cell. This volume varies for the different cases with the bounding MAR being 14,647 gallons in the 242-25H seismic case. The volume of MAR for the transfer jumper leaks/breaks in the evaporator cell event is 15,000 gallons (242-16H only).

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

Evaporator System Leaks/Breaks In The Evaporator Cell

The ARFs and RFs associated with an evaporator system leak/break in the evaporator cell are similar to those discussed in Section 3.4.2.9 (Transfer Error), with the primary difference being a greater spill height for this event in all non-seismic cases. The ARFs and RFs are described in detail in Reference 60.

Transfer Jumper Leaks/Breaks In The Evaporator Cell

The ARFs and RFs associated with a transfer jumper leak/break in the evaporator cell are similar to those discussed in Section 3.4.2.9 (Transfer Error), with the primary difference being a greater spill height for this event. The ARFs and RFs are described in detail in Reference 60.

Leak Path Factor

The LPF is assumed to be one for all scenarios. No credit is taken for plateout on the cell walls or leakage paths.

3.4.2.3.3.3 Source Term Calculation

STs were calculated in Reference 60 for the fast leak and seismic cases, for both 242-25H and 242-16H. A ST was calculated in Reference 60 for the 242-16H Evaporator Cell transfer jumper leak/break event. The bounding ST resulted from the 242-16H Evaporator Cell transfer jumper leak/break event.

3.4.2.3.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Evaporator Overflow, Leaks, and Spills event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 60).

The unmitigated and mitigated Offsite (≤ 0.1 rem) consequences for the bounding scenario (transfer jumper leak/break in the 242-16H Evaporator Cell) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding scenario (transfer jumper leak/break in the 242-16H Evaporator Cell) exceed the Onsite EGs. The mitigated Onsite consequences for the bounding scenario (transfer jumper leak/break in the 242-16H Evaporator Cell) are zero because the event is prevented. The unmitigated and bounding mitigated Onsite consequences (≤ 35 rem) for the seismic initiated 242-25H Evaporator System leak/break in the evaporator cell do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to the presence of the evaporator cell and controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.3.5. The consequences of the Evaporator Overflow, Leak, or Spill event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.3.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of an

Evaporator Overflow, Leaks, and Spills event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.3.5.1 Safety Significant Controls

242-16H Evaporator Cell: The evaporator cell structure provides airborne waste confinement following a primary containment waste release into the evaporator cell. The evaporator cell structure also provides liquid waste containment.

Transfer Line Core Pipe: Transfer Line integrity (e.g., core pipe, valves, jumpers, connectors, and associated gaskets) shall ensure primary waste containment (242-16H only).

3.4.2.4 Evaporator Overpressure

3.4.2.4.1 SCENARIO DEVELOPMENT

3.4.2.4.1.1 Background

The purpose of the evaporators in the CSTF is to concentrate high level radioactive waste by evaporation. Waste is transferred from the evaporator feed tank to the evaporator pot, with overheads being removed via the overheads system, and the concentrated waste being lifted to the evaporator drop tank. Various equipment used to heat, agitate, or measure the pot liquid level uses high-pressure steam and/or air sources. It is possible as a result of equipment malfunction or a break in a steam or air line that high-pressure steam or air will impinge on the liquid waste and generate aerosols.

A breach in the evaporator pot is considered possible if the internal pressure in the evaporator pot exceeds the design pressure. Over-pressurization may occur from multiple mechanisms such as a steam tube leak with failure to isolate steam supply or loss of steam/air pressure control to the tube bundle or lance. Airborne waste release from the evaporator vessel and overheads system could occur following the overpressurization. Further details regarding the Evaporator System designs are provided in Sections 2.4.2 and 2.4.3.

3.4.2.4.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with an Evaporator Overpressurization that have non-negligible risk.

3.4.2.4.1.3 Unmitigated Accident Progression

Based on analyses of the various overpressurization cases, the evaporator overpressurization following a seismic event was determined to be the bounding case and is the case that was analyzed (Ref. 155). The general progression is provided below, with specific evaporator variations denoted throughout:

- Evaporator in operation (i.e., steam to the tube bundle, maximum 370 psig)

- Lance in steam operation (maximum 370 psig steam, maximum 200 psig air)
- Dip tube airblow underway for six dip tubes, max five minutes per airblow (242-25H only)
- Seismic event occurs, causing:

  - Loss of Cooling Water to overheads condenser

  - Pressure Control Valves (PCVs)/Pressure Relief Valves (PRVs) fail
- Tube bundle crack assumed to be present
- Airborne release vents to cell and out to atmosphere
- The demister and cell are not assumed to mitigate the release (LPF of 1 assumed)
- Steam isolated to tube bundle in one hour, air supplied to tube bundle from normal air line
- Steam isolated to lance in one hour, air supplied to lance from normal or bypass air line
- Air to tube bundle and lance isolated two hours after event initiated

3.4.2.4.1.4 Mitigated Accident Progression

The unmitigated consequences of the Evaporator Overpressure accident do not challenge the Offsite EGs. The unmitigated consequences of the Evaporator Overpressure accident for the 242-25H Evaporator Overpressure event exceed the Onsite EGs (as documented in Section 3.4.2.4.4). The unmitigated consequences of the Evaporator Overpressure accident for the 242-16H Evaporator Overpressure event do not exceed the Onsite EGs; however, the consequences were qualitatively judged to exceed the applicable Onsite EGs for the FW in the immediate vicinity of the event. Because the unmitigated accident scenarios exceed the EGs, mitigated analysis is required.

The mitigated Evaporator Overpressure accident progression differs from the unmitigated accident progression in that tube bundle integrity and steam/air pressure control is required in evaporator systems of concern. For the non-seismic case, tube bundle integrity and steam/air pressure control is maintained, thereby preventing the accident. For the seismic case, multiple simultaneous failures could occur in the evaporator system that results in bypassing the demister (e.g., pot failure), venting airborne release to cell and out to atmosphere. Therefore, maintaining tube bundle integrity and steam/air pressure control only serve to protect assumed accident conditions and mitigate the release.

242-16H Evaporator Overpressure

For a non-seismic initiated 242-16H Evaporator Overpressure event, the following control set applies. Because only the FW in the immediate vicinity of the event was at risk during the 242-16H Evaporator Overpressure event, just one SS level of control is required. The first level of control includes the 242-16H Evaporator Tube Bundle pressure boundary to prevent the

leakage of steam to the evaporator pot from the tube bundle and the 242-16H Evaporator Tube Bundle Steam PCV to limit the steam pressure and flow into the evaporator pot. The controls supporting the evaporator tube bundle include critical lift controls, structural integrity controls, and corrosion controls. The controls supporting the evaporator tube bundle steam PCV include critical lift controls and NMMP.

In addition to the first levels of control discussed above, the following SS controls are required to protect the initial accident assumptions:

- 242-16H Evaporator Lance Steam Supply Line Orifice to limit the steam pressure and flow into the evaporator pot to within assumed overpressurization analysis values.
- 242-16H Evaporator Lance Air Supply Line Orifices to limit the air pressure and flow into the evaporator pot to within assumed overpressurization analysis values.

For a seismic initiated 242-16H Evaporator Overpressure event, the following control set applies. Because only the FW in the immediate vicinity of the event was at risk during the 242-16H Evaporator Overpressure event, just one SS level of control is required. The first level of control includes the 242-16H Evaporator Tube Bundle to minimize the leakage of steam to the evaporator pot from the tube bundle and the 242-16H Evaporator Tube Bundle Steam PCV to limit the steam pressure and flow into the evaporator pot. The controls supporting the evaporator tube bundle include critical lift controls, structural integrity controls, and corrosion controls. The controls supporting the evaporator tube bundle steam PCV include critical lift controls and NMMP.

In addition to the first levels of control discussed above, the following SS controls are required to protect the initial accident assumptions:

- 242-16H Evaporator Lance Steam Supply Line Orifice to limit the steam pressure and flow into the evaporator pot to within assumed overpressurization analysis values.
- 242-16H Evaporator Lance Air Supply Line Orifices to limit the air pressure and flow into the evaporator pot to within assumed overpressurization analysis values.

242-25H Evaporator Overpressure

For both the non-seismic and seismic initiated 242-25H Evaporator Overpressure event, two SS levels of control are required. The 242-25H Evaporator Tube Bundle pressure boundary was chosen as the first level of control to prevent the leakage of steam to the evaporator pot from the tube bundle. The controls supporting pressure boundary integrity were also chosen as part of the first level of control. The controls supporting the evaporator tube bundle pressure boundary integrity include critical lift controls, structural integrity controls, and corrosion controls. To mitigate steam pressure and flow to the evaporator pot from the lance, the 242-25H Evaporator Lance Steam PCV was also chosen as a first level of control. The controls supporting the evaporator lance steam PCV include critical lift controls and NMMP.

In addition to the first levels of control discussed above, the following SS controls are required to protect the initial accident assumptions:

- 242-25H Evaporator Lance Steam Supply Line Orifice to limit the steam pressure and flow into the evaporator pot to within assumed overpressurization analysis values.
- 242-25H Evaporator Lance Air Supply Line Orifices to limit the air pressure and flow into the evaporator pot to within assumed overpressurization analysis values.

For the second level of control, the 242-25H Evaporator Lance Steam PRV was credited to provide some accident mitigation by limiting steam pressure and flow at the 242-25H Evaporator lance line.. The controls supporting the lance steam PRV include critical lift controls and NMMP. The Emergency Response Program is also part of the second level of control. This program governs personnel evacuation following the 242-25H Evaporator Overpressure event and response to the event to minimize the potential release/personnel exposure.

3.4.2.4.2 FREQUENCY DETERMINATION

The HA classifies Evaporator Overpressure events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.4.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.4.3.1 <u>Source Term Inputs and Assumptions</u>

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Evaporator Overpressure STs. These inputs and assumptions are also valid during chemical cleaning operations of the 242-16H Evaporator. The inputs and assumptions are all taken from Reference 155, unless otherwise stated:

- The steam pressure in the 242-16H tube bundle is less than or equal to 150 psig for mitigated consequence determination. The 242-16H Evaporator Tube Bundle Steam PCV is credited to protect this pressure.
- The steam pressure in the 242-16H lance gang valve is less than or equal to 170 psig for mitigated consequence determination. The 242-16H Evaporator Tube Bundle Steam PCV is credited to protect this pressure.
- The steam pressure in the 242-25H lance gang valve is less than or equal to 30 psig for mitigated consequence determination. The 242-25H Evaporator Lance Steam PCV is credited to protect this pressure.

- The 242-16H dip tubes are not considered as a contributing gas source during the overpressure accident.
- The maximum 242-16H tube bundle crack size is (0.6 in x 0.0415 in). Per Reference 78, the crack length does not become unstable until it reaches a length of 0.57 inches (the worse case was for 242-16F). Even though Reference 78 has proven that a pit could not reach this crack length under accident conditions, the 0.6-inch value will be used as a conservative value for analysis. This crack length also bounds potential multiple cracks (i.e., multiple cracks would not exceed the maximum length of 0.6 inches). This is based on the detectable size leak (just under 0.01 inch pit diameter) by the hydrotest once every two years and the fact that the 242-16H cracks increase less than 10% in two years under the loads analyzed (Ref. 78). Using NUREG-0800 (Ref. 76) for a moderate pressure system as a guideline, one half of the tube wall thickness is used as the width of the crack. The tube thickness for the 242-16H tube bundle averages 0.083 inches. The dominant mechanism for tube bundle failure is pitting (Ref. 77). The tube bundle is not susceptible to degradation from exposure to nitric acid during chemical cleaning (Ref. 243); therefore, the mechanism for tube bundle failure described above remains valid during evaporator chemical cleaning with nitric acid.
- The maximum 242-25H tube bundle crack size is (0.6 in x 0.0728 in) for unmitigated consequence determination. For mitigated consequence determination, the crack size is zero since the tube bundle will not leak. Per Reference 78, a crack length in the tubes does not become unstable until it reaches a length of 0.39 inches (assuming full corrosion allowance for 242-25H). Even though Reference 78 has proven that a pit could not reach this crack length under accident conditions, the 0.6-inch value will be used as a conservative value for analysis. This crack length will also bound potential multiple cracks (i.e., multiple cracks combined would not exceed the maximum length of 0.6 inches). This is based on the detectable leak size (just under 0.01 inch pit diameter) by the hydrotest once every two years and the fact that the cracks in the 242-25H increase less than 15% in two years under the loads analyzed (Ref. 78). Using NUREG-0800 (Ref. 76) for a moderate system as a guideline, one half of the tube wall thickness is used as the width of the crack. The tube thickness for the 242-25H tube bundle average is 0.1455 inches. The dominant mechanism for tube bundle failure is pitting (Ref. 77).
- The minimum amount of liquid covering the 242-16H/242-25H tube bundles is three inches. The highest point of the uppermost tube of the evaporator tube bundles is normally covered by six inches of waste during normal operation. The tube bundle is of a bent tube configuration and therefore slopes downward. Therefore, the lowest point of the uppermost tube is covered by greater than six inches during normal operations (~10 inches). There are times during operation that the evaporator is operated at a lower level to suppress foaming. At these times, the highest point of the uppermost tube is covered by approximately three inches of waste. Attempting to operate, with a lower level than this, could cause erratic operation and approaches the low level alarm/interlock (interlock on 242-25H only). For this reason, three inches is appropriate to use as a minimum value.

- Inside diameter of 242-25H Evaporator dip tubes less than or equal to 0.622 inches.
- Number of dip tubes (242-25H) capable of supplying high pressure air less than or equal to six.
- Blowdown time (per dip tube) for the 242-25H Evaporator dip tubes less than or equal to 5 minutes.
- The unmitigated time required to shutoff steam to the 242-16H/242-25H Evaporator tube bundle and/or lance ≤ one hour. A tube bundle break can be detected by several means (two independent pressure monitors, overheads condenser vent temperature, cell sump probe, cell sump dip tubes, increase in overheads rates, and evaporator ARMs). One hour is adequate time for trained operators to detect the abnormality and mitigate it by isolation of steam to the tube bundle/lance. This time is assumed to be the worst case under seismic conditions.
- The unmitigated time required to shutoff air to the 242-16H/242-25H Evaporator tube bundle and/or lance ≤ two hours. Two hours is adequate time for trained operators to detect the abnormality and mitigate it by isolation of air to the tube bundle/lance via lance gang valve controls from the control room or multiple manual valves in the field. This time is assumed to be the worst case under seismic conditions.
- The tube bundles will not be subjected to water hammer loads or pressure surges based on the system configuration design and system operating (start-up) procedures (Ref. 91). Reference 91 takes credit for condensate drainage in that it assumes that condensate doesn't sit in the low point of the tube bundle. It is understood that there is a buildup with condensate in the end bell and that steam condenses in the tube bundle. The conclusion is still valid that the tube bundle was designed to continually drain the condensate out of the tubes. The startup procedures and tube bundle configuration precludes the water hammer. Operating experience has shown that water hammer is not an issue, even when steam is introduced to the tube bundle quickly during a descale operation.

The following operational activities are judged to have negligible effects on the Evaporator Overpressure event:

- The 242-16H Evaporator steam tube bundle pressure may rise above the assumed maximum mitigated tube bundle pressure during steam startup due to the presence of condensate. This temporary transient does not indicate a loss of tube bundle safety function. The condensate that is being blown out during this temporary transient is what sits in the end bell of the tube bundle.
- Manually flushing the foam level dip tube with flushwater and then removing the flushwater using the normal dip tube air purge (~2 scfh) is permitted during 242-16H Evaporator operation. This limited activity is judged to have a negligible effect on the overall pot pressure.

3.4.2.4.3.2 Source Term Derivation

Unmitigated STs were derived for three different cases using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. Analysis was performed for the seismic case for 242-16H and 242-25H. The terms in the five-factor ST formula are discussed below, including discussion of case specific parameters.

Material at Risk

The MAR waste stream for the Evaporator Overpressure accident is Evaporator Bottoms. The waste characteristics and inhalation dose potential on a per unit volume basis for this stream is given in Section 3.4.1.5.1. The volume of MAR for this event is the total gas flow rate multiplied by the duration of the flow rates.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

A bounding ARF of 2E-03 and RF of one for boiling liquids from Reference 14 is applied to the total gas flow rate (overheads, leak, steam lance, and dip tube) to determine the ST (Ref. 155). If re-entrainment is predicted to occur, an ARF x RF of 6E-03 is applied to the total gas flow rate (Ref. 155).

Leak Path Factor

The LPF is assumed to be one in all cases. No credit is taken for the demister or plateout on the cell walls.

3.4.2.4.3.3 Re-Entrainment Potential

If too much liquid is transported to the demister, the demister can flood and potentially overload the demister. Reference 55 shows that the pressure drop across the demister is small even if the demister is flooded. However, this reference does not address the issue of re-entrainment. In this case, the liquid loading to the demister is so high, that liquid can collect on top of the demister column and gas flow can entrain some of the liquid, thereby creating an additional ST. Reference 155 demonstrated that re-entrainment was only possible if the demister velocity exceeded the re-entrainment velocity limit.

3.4.2.4.3.4 Source Term Calculation

STs were calculated in Reference 155 for the bounding (seismic) case for 242-16H and 242-25H. It is assumed that the steam or air jet resulting from the small, pinhole leak or crack (equivalent diameter of 0.178 inches for 242-16H and 0.236 inches for 242-25H) will breakup into a bubble

column and does not lead to a steam jet. Re-entrainment does not occur for 242-16H and 242-25H as the maximum calculated demister velocity is below the corresponding re-entrainment velocity limit.

3.4.2.4.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Evaporator Overpressure event are given in Table 3.4-7 (Ref. 155).

The unmitigated and mitigated Offsite consequences (≤ 0.2 rem) for the bounding Evaporator Overpressure scenario (seismic initiated 242-25H Evaporator Overpressure) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding Evaporator Overpressure scenario (seismic initiated 242-25H Evaporator Overpressure) exceed the Onsite EGs. The bounding mitigated Onsite consequences (≤ 93 rem) for the Evaporator Overpressure scenario (seismic initiated 242-25H Evaporator Overpressure) do not exceed the Onsite EGs. The mitigated Onsite consequences for the non-seismic initiated 242-16H/242-25H Evaporator Overpressure scenario are zero because the event is prevented. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.4.5. The consequences of the Evaporator Overpressure event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.4.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of an Evaporator Overpressure event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.4.5.1 Safety Significant Controls

242-16H/242-25H Evaporator Lance Air Supply Line Orifices: The Evaporator Lance Air Supply Line Orifices limit air pressure and flow to the evaporator pot to within assumed overpressurization analysis values.

242-16H/242-25H Evaporator Lance Steam Supply Line Orifices: The Evaporator Lance Steam Supply Line Orifices limit steam pressure and flow to the evaporator pot to within assumed overpressurization analysis values.

242-16H/242-25H Evaporator Tube Bundles: The Evaporator Tube Bundles are passive design features that provide air/steam containment and protect assumed initial conditions (242-16H crack size following a seismic event).

242-16H Evaporator Tube Bundle Steam Pressure Control Valve : The Evaporator Tube Bundle Steam PCV is required to limit steam pressure and flow to the evaporator tube bundle and lance line. A manually operated valve on the PCV bypass line for the 242-16H Evaporator must be administratively controlled closed during evaporator operation.

242-25H Evaporator Lance Steam Pressure Control Valve and Lance Steam Pressure Relief Valve: The Evaporator Lance Steam PCV and Lance Steam PRV are required to limit steam pressure and flow to the evaporator lance line. A manually operated valve on the PCV bypass line for the 242-25H Evaporator must be administratively controlled closed during evaporator operation.

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following an evaporator overpressure event and response to the event to minimize the potential release/personnel exposure.

3.4.2.5 Transfer Facility Fire

3.4.2.5.1 SCENARIO DEVELOPMENT

3.4.2.5.1.1 Background

For a Transfer Facility Fire of consequence to occur, waste must be in the process area and sufficient solids combustible material must be in the process area to cause a large enough fire to boil the liquid waste. An ignition source is assumed present from an electrical short, lightning, or other unspecified source.

Transfer facilities are typically underground or partially underground reinforced concrete vaults lined with stainless steel. They are covered with a removable concrete lid or stainless steel cover, which is generally in place but can be removed for maintenance activities requiring cell entry. Transfer system/facility (e.g., DB, PP, and VB) details are provided in Section 2.4.4.

3.4.2.5.1.2 Accident Initiators

Transfer Facility Fire encompasses a broad range of activities that could potentially lead to a fire in one of these process areas. Table 3.3-17 identifies the HA events associated with a Transfer Facility Fire that have non-negligible risk. “Transfer Facilities” addressed in this AA section include the following process areas:

- DBs
- PPs
- VBs
- HPFP
- LDB Drain Cell

- Evaporator Cells

3.4.2.5.1.3 Unmitigated Accident Progression

The general transfer facility fire progression is provided below:

- There is some amount of solids combustible material in the cell,
- Waste accumulates in the cell due to a waste containment failure (the analysis is only sensitive to the quantity of combustible material burned in the cell, not to the amount of waste),
- No credit is taken for cell leak detection,
- An ignition source causes the combustible material in the facility to ignite (no ignition source controls are credited),
- The heat from the fire causes some of the liquid waste at the bottom of the cell to boil (one tenth of the energy liberated by the burning material is absorbed by the liquid waste and is used to vaporize the liquid),
- The boiling evaporation causes a portion of the radioactive material in the process area to become airborne,
- Air expansion from the heat of the fire causes air to be expelled from the facility,
- The expelled air carries with it the previously described material made airborne by the fire,
- The airborne material that has escaped from the facility during the fire is transported to Onsite and Offsite receptors.

3.4.2.5.1.4 Mitigated Accident Progression

The unmitigated consequences of the Transfer Facility Fire accident do not challenge the Offsite EGs (due to the initial conditions established by the Fire Protection Program), but exceed the Onsite EGs (as documented in Section 3.4.2.5.4). In the Transfer Facility Fire case, where the Transfer Facility Fire accident unmitigated consequences exceed the Onsite EGs (i.e., High-Rem transfer through HTF transfer facilities), two levels of control are required. The unmitigated consequences of a Low-Rem Transfer Facility Fire (20-minute duration fire in a transfer facility) do not challenge the Offsite or exceed the Onsite EGs.

H-Area Transfer Facility Fire

Because the bounding unmitigated Transfer Facility Fire exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated fire consequences. For High-Rem transfers, two (SS) levels of control are required.

The first level of control for High-Rem transfers through an H-Area transfer facility is the Transfer Control Program, which will verify combustible loading prior to initiating the transfer. The second level of control is the Emergency Response Program, which will govern personnel

evacuation following the H-Area Transfer Facility Fire event and response to the event to minimize the potential release/personnel exposure.

3.4.2.5.2 FREQUENCY DETERMINATION

The HA classifies Transfer Facility Fire events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present concurrent with a significant combustible loading reduces the probability of a Transfer Facility Fire.

3.4.2.5.3 SOURCE TERM ANALYSIS

The Transfer Facility Fire consequence assumes that the MAR is Bounding Sludge Slurry and assumes twice the worst actual fire loading, as recorded in the 50-year operating history at CSTF (Ref. 156). This fire loading is in an F-Area Transfer Facility. F-Area may only perform Low-Rem transfers.

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.5.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Transfer Facility Fire STs and are all taken from Reference 156 and 255, unless otherwise stated.

- Maximum amount of readily combustible material contributes no more than 2.5 million BTUs (approximately 313 lb_{wood} equivalent) of energy. In H-Area, the mitigated ST for an HTF transfer facility fire is approximately 630,000 BTUs (approximately 79 lb_{wood} equivalent).

3.4.2.5.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below.

Material at Risk

The MAR waste stream for this accident is Bounding Sludge Slurry for HTF. In FTF, only Low-Rem transfers are permitted. Therefore, the Onsite consequences for an FTF Transfer Facility Fire are based on Low-Rem material (Ref. 255) and assumes maximum BTU loading

(2.5 million BTUs). The waste characteristics and inhalation dose potential on a per unit volume basis for this waste stream are given in Section 3.4.1.5.1.

The volume of MAR for this event is based on the amount of material that is boiled dry by the assumed fire. It is assumed that one tenth of the energy liberated by the burning material is absorbed by the liquid waste and is used to vaporize the liquid. The amount of waste available for release was not limited, so the analysis is sensitive only to the amount of combustible material available.

From Reference 127, it was determined for each pound of wood equivalent burned, approximately 1.031 gallons of liquid would evaporate if all the heat from the fire is transferred to the liquid and is used to vaporize the liquid. This was using water as the liquid being evaluated. Applying the one-tenth efficiency described above results in 0.1031 gallons of liquid being evaporated per pound of wood equivalent burned. The MAR can be calculated directly by assuming all combustible material available burns.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

The assumed release mechanism for a liquid is boiling to dryness. An ARF value of 0.014 and a RF value of 0.4 are applied (Ref. 156).

Leak Path Factor

The LPF is assumed to be one.

3.4.2.5.3.3 Source Term Calculation

The basic ST methodology was applied to the bounding transfer facility and calculated in Reference 156. The ST used in determining the unmitigated consequences was based on the maximum amount of readily combustible material contributing no more than 2.5 million BTUs of energy. Applying DOE-EM Interim Guidance Methodology (Ref. 255), the maximum BTU loading for HTF was reduced to 630,000 BTUs for the mitigated scenario.

3.4.2.5.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Transfer Facility Fire event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 156, 255).

The unmitigated and mitigated Offsite (≤ 1 rem) consequences for the Bounding Sludge Slurry scenario (20 minute duration fire in an HTF transfer facility) do not challenge the Offsite EGs.

The unmitigated and mitigated Offsite (≤ 1 rem) consequences for a Low-Rem Transfer Facility Fire (20-minute duration fire in an FTF transfer facility) do not challenge the Offsite EGs.

The unmitigated Onsite (> 100 rem) consequences for the Bounding Sludge Slurry scenario (20-minute duration fire in an HTF transfer facility) exceed the Onsite EGs. The mitigated Onsite (≤ 72 rem) consequences for the High-Rem H-Area Transfer Facility Fire do not exceed the Onsite EGs. The unmitigated and mitigated Onsite (≤ 38 rem) consequences for a Low-Rem Transfer Facility Fire (20-minute duration fire in an FTF transfer facility) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the controls in place, the presence of the transfer facility structure, and the length of time to burn the postulated combustible material.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.5.5. The consequences of a Transfer Facility Fire event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.5.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Transfer Facility Fire event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The analysis assumes a maximum amount of readily combustible material within the transfer facility. The Fire Protection Program will protect this assumption by minimizing the combustible loading in the applicable transfer facilities.

3.4.2.5.5.1 Safety Class Controls

Fire Protection Program: The Fire Protection Program shall minimize the combustible loading in the transfer facilities.

3.4.2.5.5.2 Safety Significant Controls

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a H-Area Transfer Facility Fire event and response to the event to minimize the potential release/personnel exposure.

Transfer Control Program: Prior to initiation of a High-Rem waste transfer through an H-Area transfer facility, the transient fire loading energy contribution in the affected transfer facility shall be less than or equal to 630,000 BTUs (approximately 79 lb_{wood} equivalent).

3.4.2.6 Transfer Line and Transfer Line Jacket/Encasement Explosions

3.4.2.6.1 SCENARIO DEVELOPMENT

3.4.2.6.1.1 Background

Waste handling in the CSTF requires multiple transfers of liquid solutions or slurries containing radioactive waste. Waste is transferred between various process areas (e.g., waste tanks, pump tanks, evaporator pots) and out of secondary containment sumps through core piping. The CSTF core piping consists of a variety of connected configurations. Since some residual waste may remain within the core pipe following a transfer, flammable vapors may accumulate in the transfer line and pose an explosion hazard. The term core pipe as used throughout this DBA includes all components that make up primary waste containment along the transfer path (e.g., core pipe, valves, jumpers, connectors, and other pressure retaining components).

Transfer lines typically have a secondary containment available to mitigate any primary containment releases. Most core piping is jacketed for secondary containment, but some sections of transfer lines may either be unjacketed (have no secondary containment at all) or have secondary containment provided by concrete encasements. The term transfer line jacket as used throughout this DBA includes connected secondary containments (i.e., LDBs, MLDB, LPSs, and COPs). If a core pipe leak occurs inside one of these secondary containments, the leakage is contained within the containment structure. If not mitigated, the leaked waste could result in flammable vapors accumulating in the secondary containment.

For further detail on the transfer systems (including transfer lines and transfer line jackets), refer to Section 2.4.4. For further detail on flammable vapor generation, refer to Section 3.4.1.5.3.

3.4.2.6.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Transfer Line and Transfer Line Jacket/Encasement Explosions that have non-negligible risk.

The HA considers core pipe leak initiators that allow waste into the jacket/encasement such as corrosion, fatigue, thermal stress, valve leaks, valve misalignments, procedure errors, starting the wrong pump, inadvertently starting a pump, DCS failure, etc. Similarly, the HA considers spark initiators (e.g., maintenance activities, welding, static discharge, electrical equipment, lightning, pump heat, exothermic chemical reaction) to be available.

Process areas prohibited from being placed in a transfer path are stated in Section 3.4.1.5.2. Events that could lead to a Transfer Line/Transfer Line Jacket/Encasement Explosion in these areas were not analyzed since these process areas are isolated. A discussion of transfer path determination is provided in Section 5.4.2.

The Contingency Transfer System flexible hose-in-hose transfer line high point is designed to continuously slope back to the annulus and to the waste tank, permitting free draining to prevent

residual waste material hold-up in the transfer line. This eliminates the potential for the accumulation of radiolytic hydrogen in the transfer line.

3.4.2.6.1.3 Unmitigated Accident Progression

In lieu of individually analyzing over 300 transfer lines in the CSTF, the analysis postulates bounding scenarios to represent all credible accident scenarios involving any individual transfer line. Separate analyses are performed for both sludge slurry and supernate waste transfers. The explosions are assumed to originate in three general locations; (1) inside the core pipe, (2) the transfer line jacket, and (3) the concrete encasement.

Core Pipe Explosion

- Waste remains in the core pipe following a transfer/flush,
- Flammable vapor concentration develops,
- Transfer startup is in progress,
- Ignition source causes detonation in core pipe (no ignition source controls are credited),
- Core pipe and jacket/encasement are breached,
- Pressurized gases vented to atmosphere,
- Waste spills to ground.

Transfer Line Jacket/Encasement Explosion

- Core pipe leaks waste into the transfer line jacket/encasement,
- Leaking material is held up in the jacket/encasement,
- Transfer leak detection fails to detect the leak,
- Flammable vapor concentration develops,
- Ignition source causes an explosion in the jacket/encasement (no ignition source controls are credited),
- If deflagration occurs, pressurized gases are vented from the jacket/encasement to atmosphere through the conductivity probe stoppers or Encasement Riser Inspection Ports (ERIPs),
- If detonation or DDT explosion occurs, pressurized gases are vented to atmosphere. If the detonation or DDT explosion occurs during a transfer, the transfer line/jacket/encasement is also breached and an above-ground spill results.

3.4.2.6.1.4 Mitigated Accident Progression

The unmitigated consequences for Transfer Line and Transfer Line Jacket Explosion events associated with Tank 50 to Z-Area transfers and receipt transfers into Tank 50 (from HDB-7 or ETP through the Tank 50 VB, MCU to Tank 50) do not challenge the Offsite or exceed the Onsite EGs; therefore, mitigated analysis is not required for those affected transfer lines/jackets (hereafter referred to in this section as "Tank 50/MCU" transfer lines/jackets or analyses).

The unmitigated consequences for Transfer Line and Transfer Line Jacket Explosion events associated with the Contingency Transfer System flexible hose-in-hose transfer line do not challenge the Offsite or exceed the Onsite EGs. The Contingency Transfer System flexible hose-in-hose transfer line high point is designed to continuously slope back to the annulus and to the waste tank, permitting free draining to prevent residual waste material hold-up in the transfer line. This eliminates the potential for the accumulation of radiolytic hydrogen in the transfer line, eliminating the requirement to flush the hose.

For the remaining scenarios, the unmitigated consequences of the Core Pipe Explosion and Transfer Line Jacket/Encasement Explosion events do not challenge the Offsite EGs, but do exceed the Onsite EGs (as documented in Section 3.4.2.6.4). Because the Onsite EGs are exceeded, mitigated analysis is required.

Core Pipe Explosions

As a first level of control for core pipe explosions, the Transfer Control Program will require that, upon completion of a waste transfer, the core pipe is sufficiently flushed to reduce the inhalation dose potential to ≤ 3.5E+07 rem/gal. If the waste transfer is a batch transfer, a single flush may be performed after the last waste transfer in the batch. The required flush may not prevent a core pipe explosion from occurring, but will reduce the explosion ST to less than supernate levels. The flushing is required for waste transfers with an inhalation dose potential greater than 3.5E+07 rem/gal to reduce the consequences of the event. If the inhalation dose potential of the waste transfer is less than or equal to 3.5E+07 rem/gal, core pipe flushing is not required. The difference between the unmitigated and mitigated progression is that the MAR for the mitigated progression is reduced due to the flushing.

As a second level of control, the secondary containments (e.g., transfer line jackets/encasements, VBs, DBs, PPs, evaporator cells) surrounding the core pipe will be credited with providing some accident mitigation through passive confinement. The controls supporting secondary containment structure integrity include (depending on the scenario) critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Core Pipe Explosion event and response to the event to minimize the potential release/personnel exposure.

Transfer Line Jacket/Encasement Explosions

The primary containment (e.g., core pipe, including jumpers, valves, connectors, and associated gaskets) and controls supporting containment integrity were chosen as the first level of control to prevent a Transfer Line Jacket/Encasement Explosion. The controls supporting primary containment integrity include (depending on the scenario) critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

As a second level of control, the Flammable Vapor Sampling Program will require monitoring of the vapor space of the jackets/encasements (at times set by evaluation) to determine if a flammable mixture is developing.

The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Transfer Line Jacket/Encasement Explosion event and response to the event to minimize the potential release/personnel exposure.

3.4.2.6.2 FREQUENCY DETERMINATION

The HA classifies Transfer Line or Transfer Line Jacket/Encasement Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduces the probability of a Transfer Line or Transfer Line Jacket/Encasement Explosion.

3.4.2.6.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.6.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Transfer Line or Transfer Line Jacket/Encasement Explosion STs and are all taken from References 124, 242, and 255 unless otherwise stated:

- The bounding transfer line jacket volume is 992 ft^3 for analyses associated with Tank 50/MCU transfer line jackets (Ref. 228). For the remaining analyses, the bounding transfer line jacket volume is 957 ft^3.
- The bounding concrete encasement volume is 3,971 ft^3.
- The bounding core pipe volume is 779 ft^3 for analyses associated with Tank 50/MCU transfer lines (Ref. 228). For the remaining analyses, the bounding core pipe volume is 355 ft^3.

- The maximum amount of waste remaining in the core pipe following a transfer is 10% by volume.
- The maximum amount of waste remaining in the jacket/encasement is 10% by volume.
- In the event of a transfer line jacket/encasement deflagration, the maximum size breach would be 1.5 inches for jacketed lines and 4 inches for encasements. The peak pressure resulting from a deflagration is much lower than that from a detonation. In the case of a deflagration, therefore, it is expected that the transfer lines and transfer line jackets/encasements will be able to maintain their structural integrity. Potential explosion pressures at different hydrogen concentrations were evaluated in Reference 75, which indicated pressures ranging from 21 to 79 psig for hydrogen levels between 4% and 18%. The transfer line jackets are designed to handle pressures in this range. The LDBs are usually open to the overflow line, which typically drains to a DB or PP sump. For conservatism, however, it is assumed that a small breach occurs somewhere in the leak containment system, allowing the expanding gas to escape to the atmosphere. The overflow line, drain line and COPs are typically 1-inch in diameter. The largest lines from the LDBs to the atmosphere are 1.5-inch capped access lines. Therefore, 1.5 inches is considered the maximum size of a possible breach. The encasements contain access ports known as ERIPs. These ports are used for visual inspections of the transfer lines. ERIPs are typically 4-inches in diameter with a rain cover that could be lifted in the case of a deflagration allowing the encasement to vent to the atmosphere.
- Higher than normal flammable (but still less than 100% of the LFL) vapor concentrations that are not linked to waste being present in the transfer line jacket have been observed in some locations associated with transfer line jackets. Actions relating to normal facility configuration were taken to address these abnormal conditions, such as confirmation of installed plugs in LDB drain/overflow lines and isolation of underground steam lines near the affected location. In the unlikely event the transfer line jacket were to reach 100% of the LFL, but not LEL, the resulting pressure is not expected to cause failure of the core pipe (as discussed in the preceding paragraph), thus no release of waste would occur. A transfer line jacket explosion due to non-waste leak initiated flammable gases is therefore bounded by the analyzed transfer line jacket explosion with no additional controls required.

3.4.2.6.3.2 <u>Source Term Derivation</u>

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion (deflagration/DDT/detonation) model.

Material at Risk

The characteristics of the MAR vary for the different explosion scenarios. The waste stream involved is assumed to be Bounding Sludge Slurry when the event is a Transfer Line Jacket/Encasement Explosion or an unmitigated Transfer Line Explosion, excluding Tank 50/MCU. The waste stream involved is assumed to have an inhalation dose potential of 3.5E+07 rem/gal when the event is a mitigated Transfer Line Explosion, excluding Tank 50/MCU. The waste stream involved is assumed to be Tank 50 Supernate when the event is a Tank 50/MCU Transfer Line/Jacket Explosion. The waste characteristics and inhalation dose potential on a per unit volume basis for selected waste streams is given in Section 3.4.1.5.1.

The volume of MAR for the Transfer Line and Transfer Line Jacket/Encasement Explosion events is the waste in the line or jacket/encasement prior to the explosion plus the follow-on spill of 15,000 gallons, excluding Tank 50/MCU. The volume of MAR for the Tank 50/MCU Transfer Line/Jacket Explosion events is the waste in the line or jacket prior to the explosion plus the follow-on spill of 173,000 gallons.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1). The detonation also results in entrainment with an ARF of 1E-03 and RF of 0.4 applied to the entrained material.

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied. An ARF of 1E-03 and an RF of 0.4 is applied to the entrained material exiting the jacket/encasement or core pipe during blowdown (Ref. 124).

An ARR of 4E-06/hr and an RF of 1.0 is applied to the aerodynamic entrainment and resuspension of material from the core pipe spill.

Damage Ratio

The DR is assumed to be one.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.6.3.3 Flammable Vapor Concentration Models

For the transfer lines/jackets associated with Tank 50/MCU analyses, a flammable vapor concentration of Isopar® L at stoichiometric conditions was used. For the remaining transfer line and transfer line jacket/encasement analyses, the flammable vapor concentration used in the ST

calculations is determined by calculating the hydrogen concentration and correcting for any organics present for each of the locations of concern. The hydrogen concentration and percent LFL at the time of the explosion is determined in the analysis (Ref. 124) using the flammable vapor concentration formulas described in Section 3.4.1.1.2.

3.4.2.6.3.4 Deflagration to Detonation Transition Potential

A detonation can occur directly or as a result of transitioning from a deflagration. A direct hydrogen detonation requires a higher concentration of hydrogen, typically around 18%, and an energetic ignition source. The much more common weak ignition sources would most likely result in a deflagration or DDT. DDTs have been associated with pipes having a sufficient pipe Length to Diameter (L/D) ratio or "run-up distance" required for DDT. For hydrogen, the L/D is 100 (Ref. 74). Furthermore, any features within the pipe acting to promote turbulence will reduce the length required for DDT.

Four ST generation mechanisms are considered in the DDT scenario (Ref. 124):

- Deflagration aerosolization in a section of the transfer line jacket
- Detonative aerosolization of a TNT-equivalent amount of material in a section of the jacket
- Entrainment of waste from the jacket to the atmosphere in the vicinity of the breach
- Aerodynamic entrainment and resuspension from the core pipe spill

Only a fixed amount of energy is available from the combustion of the hydrogen gas in the jacket to be applied towards causing aerosolization, entrainment, and mechanical stress on the core pipe. In reality, some portion of the energy would be used for each mechanism. It is difficult to accurately model a DDT event and determine at what location the transition occurs because of its dependence on numerous variables such as hydrogen concentration and distribution, geometry of the transfer line, location and type of pipe support plates and spacer plates, etc. Therefore, since the TNT aerosolization is larger than the boil-off aerosolization from a deflagration, the boil-off term is neglected and all energy from the hydrogen goes towards generating the TNT aerosolization ST. It is also assumed that the line has been heated and pressurized to its AICC temperature and pressure, and that all energy goes towards generating an entrainment ST. Then the larger of the aerosolization or entrainment ST consequence is added to the core pipe spill ST consequence for the total accident consequence.

3.4.2.6.3.5 Explosion (Deflagration/Deflagration To Detonation Transition/Detonation) Source Term

For the Tank 50/MCU analyses, a detonation is assumed to occur and the TNT equivalent model is used. The mass of liquid (ST) made airborne by the detonation is set equal to the mass of TNT that produces the same energy as is produced by the combustible gas mixture consumed during the detonation. A stoichiometric mixture for Isopar® L is assumed in the analyses.

For the remaining transfer lines and transfer line jackets/encasements, the ST is dependent on whether a deflagration, DDT, or detonation occurs. If the hydrogen concentration is at or above

18%, a detonation is assumed to occur. If the hydrogen concentration is between the LEL (12%) and 18%, a detonation or DDT is assumed to occur. If the hydrogen concentration is below the LFL, no event will occur. The explosion is modeled in the ST calculation using either the detonation model, DDT model or deflagration model, depending on whether the LFL (deflagration) or LEL (detonation or DDT) has been reached (discussed further in Section 3.4.1.1.2).

3.4.2.6.3.6 Source Term Calculation

For the Tank 50/MCU related transfer line/jacket analyses, the explosion STs were calculated in Reference 228 using the detonation model described in Section 3.4.1.1.2. To determine the overall scenario consequences for the various locations, the explosion STs were added to Transfer Error STs (discussed in detail in Section 3.4.2.9.3).

For the remaining transfer lines and transfer line jackets/encasements, the STs for the various cases were calculated in Reference 124 using the preceding ST models. The bounding unmitigated scenario was an explosion in a transfer line encasement. The bounding mitigated scenario was an explosion in a transfer line core pipe.

3.4.2.6.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Transfer Line and Transfer Line Jacket/Encasement Explosion events, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 124, 228, 255).

For the Tank 50/MCU transfer line/jacket analyses, the unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding scenario (Tank 50 to Z-Area transfer line jacket explosion) do not challenge the Offsite EGs. For the remaining Transfer Line and Transfer Line Jacket/Encasement Explosion scenarios, the unmitigated and mitigated Offsite consequences (≤ 9.7 rem) for the bounding scenario (Bounding Sludge Slurry encasement explosion) do not challenge the Offsite EGs.

For the Tank 50/MCU transfer line/jacket analyses, the unmitigated and mitigated Onsite consequences (≤ 25.3 rem) for the bounding scenario (Tank 50 to Z-Area transfer line jacket explosion) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to presence of secondary waste containments and the Emergency Response Program.

For the remaining Transfer Line and Transfer Line Jacket/Encasement Explosion scenarios, the unmitigated Onsite consequences (> 100 rem) for the bounding scenario (Bounding Sludge Slurry encasement explosion) exceed the Onsite EGs. The mitigated Onsite consequences (≤ 95 rem) for the bounding scenario (core pipe explosion with 3.5E+07 rem/gal waste material) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.6.5. The consequences of the Transfer Line and Transfer Line Jacket/Encasement Explosion events following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.6.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Transfer Line or Transfer Line Jacket/Encasement Explosion event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.6.5.1 Safety Significant Controls

242-16H/242-25H Evaporator Cells: The evaporator cell structure provides airborne waste confinement following a core pipe explosion.

Diversion Box: The DB structure provides airborne waste confinement following a core pipe explosion.

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Transfer Line and Transfer Line Jacket/Encasement Explosion event and response to the event to minimize the potential release/personnel exposure.

Flammable Vapor Sampling Program: Programmatic controls shall be established to ensure jacket/encasement vapor spaces are sampled at times set by evaluation to determine if a flammable mixture is developing.

High Point Flush Pit: The HPFP structure provides airborne waste confinement following a core pipe explosion.

Pump Pit: The PP structure provides airborne waste confinement following a core pipe explosion.

Transfer Control Program: A Transfer Control Program shall be established to ensure that transfer lines are flushed after waste transfers to reduce the material in the transfer line such that the resulting inhalation dose potential is less than or equal to 3.5E+07 rem/gal.

Transfer Line Core Pipe: Transfer line integrity (e.g., core pipe, valves, jumpers, connectors, and associated gaskets) shall ensure primary waste containment.

Transfer Line Jacket, Transfer Line Encasement, Leak Detection Box, Modified Leak Detection Box, Leak Probe Sleeve, and Clean Out Port: The Transfer Line Jacket, Transfer Line Encasement, LDB, MLDB, LPS, and COP structures provide airborne waste containment/confinement following a core pipe explosion.

Valve Box: The VB structure provides airborne waste confinement following a core pipe explosion (includes Drain VBs).

3.4.2.7 Transfer Facility Explosions

3.4.2.7.1 SCENARIO DEVELOPMENT

3.4.2.7.1.1 Background

Waste handling in the CSTF requires multiple transfers of liquid solutions or slurries containing radioactive waste. Waste is transferred between various process areas through transfer facilities (e.g., DBs, VBs, HPFP) or through areas that drain to transfer facilities (e.g., LDB Drain Cell, H-Area Catch Tank). These transfer facilities serve as a secondary containment to mitigate any primary containment releases. If a core pipe leak occurs inside a DB or VB, the leakage is contained within the containment structure of the box. The term core pipe as used throughout this DBA includes all components that make up primary waste containment along the transfer path (e.g., core pipe, valves, jumpers, connectors, and other pressure retaining components). The term transfer line jacket (for the LDB Drain Cell Explosion) as used throughout this DBA includes connected secondary containments (i.e., LDBs). If not mitigated, the leaked waste could result in flammable vapors accumulating in the transfer facilities. For further detail on flammable vapor generation, refer to Section 3.4.1.5.3.

For further detail on the transfer systems (including transfer facility designs), refer to Section 2.4.4. The Transfer Facility Explosions events have the potential to evolve into Transfer Errors, and the Transfer Error consequences derived in Section 3.4.2.9 are used in determining the overall Transfer Facility Explosions consequences. Discussion of the derivation and calculation of the Transfer Error ST is provided in Section 3.4.2.9 and will not be discussed here.

3.4.2.7.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Transfer Facility Explosions that have non-negligible risk. The locations of concern for an explosion are as follows: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, Tank 21 VB, Tank 22 VB, VB-28a, VB-28b, Tank 40 VB, Tank 40 Drain VB, Tank 42 VB, Tank 49 VB, Tank 50 VB, Tank 51 VB, 241-96H VB, Tank 51 Drain VB, FDB-2, FDB-3, FDB-4, HDB-2, HDB-4, HDB-5, HDB-6, HDB-7, HDB-8, H-Area Catch Tank, LPDT Cell, the High Point Flush Pit, and the LDB Drain Cell. An Evaporator Cell Explosion (due to an Evaporator System leak/break or transfer jumper leak/break) is not addressed in this section since it is addressed in Section 3.4.2.2.

The transfer facilities addressed in this AA section as potential explosion locations are DBs, VBs, Drain VBs, Catch Tanks, LPDT Cell, HPFP, and LDB Drain Cell. Each transfer facility is considered independent of all other transfer facilities. Process areas prohibited from being placed in a transfer path are stated in the Section 3.4.1.5.2. Events that could lead to an explosion in these areas were not analyzed since these process areas are isolated. A discussion of transfer path determination is provided in Section 5.4.2.

3.4.2.7.1.3 Unmitigated Accident Progression

The following generic accident progression applies to all the explosion locations of concern, excluding transfer facilities associated with the Tank 50 to Z-Area transfer path, receipt transfers into Tank 50 (from HDB-7 or ETP through the Tank 50 VB, MCU to Tank 50), and Chemical Cleaning Transfers (or related vent/drain operations):

- A small initial quantity of waste is present in the transfer facility containment,
- Flammable vapors in the containment accumulate until the vapor space reaches an equilibrium hydrogen concentration (determined by the hydrogen release caused by the initial volume and atmospheric breathing),
- A transfer is in progress,
- A primary containment leak occurs (e.g., jumper failure or transfer line failure) as described in the HA scenarios (The maximum assumed missing waste volume is 15,000 gallons [Section 3.4.1.5.2]),
- Waste accumulates in the transfer facility structure,
- The initial leak is assumed to go undetected (i.e., no credit for leak detection instrumentation),
- Ventilation, where applicable, (other than atmospheric breathing) is not functional,
- Flammable gas is generated via radiolysis of the waste in the cell and release of dissolved hydrogen from the leaked material during the time of the leak (steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through transfer lines for which DBs or PPs are credited leak detection locations are prohibited)
- Additional flammable vapors are released for ≤ 10 days (the vapor is assumed to be at the same temperature as the spilled or transferred waste),
- Hydrogen is assumed to mix uniformly with the air in the vapor space (i.e., there is no stratification or pocketing),
- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,

- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

The following accident progression applies to the explosion locations of concern for transfer facilities associated with the Tank 50 to Z-Area transfer path, receipt transfers into Tank 50 (from HDB-7 or ETP through the Tank 50 VB, MCU to Tank 50):

- A transfer is in progress,
- A primary containment leak occurs (e.g., jumper failure or transfer line failure) as described in the HA scenarios,
- Waste accumulates in the transfer facility structure,
- The initial leak is assumed to go undetected (i.e., no credit for leak detection instrumentation),
- Ventilation, where applicable, (other than atmospheric breathing) is not functional,
- Flammable vapors are generated via radiolysis of the waste in the cell and evaporation of Isopar® L until stoichiometric conditions are reached,
- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

The following accident progression applies to the explosion locations of concern for transfer facilities associated with Chemical Cleaning Transfers (or related vent/drain operations) (applicable to FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, Tank 51 VB, Tank 51 Drain VB, H-Area Catch Tank, and LDB Drain Cell):

- A small initial quantity of waste is present in the transfer facility structure,

- Flammable vapors in the transfer facility accumulate until the vapor space reaches an equilibrium hydrogen concentration (determined by the hydrogen release caused by the initial volume and atmospheric breathing),
- A Chemical Cleaning Transfer or vent and drain is in progress,
- A primary containment leak occurs (e.g., jumper failure or transfer line failure) as described in the HA scenarios (The maximum assumed missing waste volume is 15,000 gallons [Section 3.4.1.5.2]),
- Waste accumulates in the transfer facility structure,
- The initial leak is assumed to go undetected (i.e., no credit for leak detection instrumentation),
- Ventilation, where applicable, (other than atmospheric breathing) is not functional,
- Flammable vapors are generated via radiolysis of the waste in the cell and corrosion induced hydrogen until stoichiometric conditions are reached,
- Hydrogen is assumed to mix uniformly with the air in the vapor space (i.e., there is no stratification or pocketing),
- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

3.4.2.7.1.4 Mitigated Accident Progression

The unmitigated consequences for Transfer Facility Explosions events associated with the Tank 50 to Z-Area (excluding LPDT Cell) and receipt transfers into Tank 50 (from HDB-7 or ETP through the Tank 50 VB, MCU to Tank 50) do not challenge the Offsite or exceed the Onsite EGs; therefore, mitigated analysis is not required for those affected transfer facilities (hereafter referred to in this section as "Tank 50/MCU" transfer facilities or analyses). However, as discussed in the LDB Drain Cell Explosion scenario, one level of control is required to preclude potential MCU material from reaching the LDB Drain Cell.

For the LPDT Cell, there is no potential for the vapor space to reach 100% of the CLFL, given only atmospheric breathing. This is based on a comparison of the results of Reference 315 with LPDT Cell parameters. Reference 315 determines when a vessel contains 65,500 gallons of Tank 50 waste material at 48°C with a vapor space of 9,995 gallons, the time to CLFL is infinite, given only atmospheric breathing. Based on Tank 50 Waste Temperature Monitoring (discussed in Section 3.4.2.11.1.6), the average bulk waste temperature in Tank 50 is maintained less than or equal to 43°C. Therefore, transfers from Tank 50 to Z-Area are less than or equal to 43°C. Additionally, there are no significant heat sources in the LPDT Cell that could increase waste temperature (e.g., no steam jets). If LPDT Cell contains 65,500 gallons with a resulting vapor space volume of 40,604 gallons, with atmospheric breathing only, then the time to CLFL must also be infinite. A leak of 65,500 gallons to the LPDT Cell would be readily detected (e.g., LPDT Cell sump conductivity probe). Average daily transfer volumes to Z-Area are approximately 30,000 gallons. Roughly two days of transfer would have to occur with no action taken to investigate lack of receipt in Z-Area. Mitigated analysis is not required for this event.

The unmitigated consequences for Transfer Facility Explosions events associated with Chemical Cleaning Transfers are assumed in Reference 274 to be bounded by those analyzed for Low-Rem transfers. The Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) ensures that Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA (at ≤ 60°C) and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration. These controls are considered SC to protect initial accident assumptions. The unmitigated consequences for Transfer Facility Explosions events associated with Chemical Cleaning Transfers do not challenge Offsite EGs, but do exceed the Onsite EGs (as documented in Section 3.4.2.7.4). In those cases where the Transfer Facility Explosions unmitigated consequences exceed the Onsite EGs, two SS levels of control are required. Because the event involves an explosion, one additional SS level of control is required.

For the remaining scenarios, the unmitigated consequences for Transfer Facility Explosions do not challenge Offsite EGs, but do exceed the Onsite EGs (as documented in Section 3.4.2.7.4). In those cases where the Transfer Facility Explosions unmitigated consequences exceed the Onsite EGs, two SS levels of control are required. Because the event involves an explosion, one additional SS level of control is required.

Valve Box Explosion (except Chemical Cleaning Transfers)

Because the bounding unmitigated VB explosion exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences. In FTF, only Low-Rem transfers are permitted. Additionally, High-Rem transfers are not permitted through the 241-96H VB. Therefore, controls associated with High-Rem transfers for FTF VBs and 241-96H VB are not identified below.

For High-Rem transfers, three levels of control are required for the following VBs: Tank 21 VB, Tank 22 VB, Tank 40 VB, Tank 40 Drain VB, Tank 42 VB, Tank 49 VB, Tank 51 VB, and Tank 51 Drain VB. For Low-Rem transfers, three levels of control are required for the following VBs: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, VB-28a, VB-28b, 241-96H VB,

Tank 40 VB, Tank 42 VB, Tank 49 VB, and Tank 51 VB. Because only the FW in the immediate vicinity of the event was at risk, one level of control is required for Low-Rem transfers through the following VBs: Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, and Tank 51 Drain VB. The first and third levels of control for High-Rem transfers will also serve as the first and third levels of control for Low-Rem transfers through the following VBs: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, VB-28a, VB-28b, 241-96H VB, Tank 40 VB, Tank 42 VB, Tank 49 VB, and Tank 51 VB. The first level of control for High-Rem transfers will also serve as the single control for Low-Rem transfers through the following VBs: Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, and Tank 51 Drain VB.

The first level of control for both High-Rem and Low-Rem transfers is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a VB explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for High-Rem transfers is instrumentation to detect the release (e.g., conductivity probes) and equipment to stop the release (e.g., transfer isolation devices) was credited. The instrumentation will alert operators to the event and allow for actions to minimize flammable vapor accumulation. The VB structure provides a liquid waste containment function to support conductivity probe functionality.

The third level of control for High-Rem transfers is the VB structure. The controls supporting VB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The VB structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

The second level of control for Low-Rem transfers through the following VBs: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, VB-28a, VB-28b, 241-96H VB, Tank 40 VB, Tank 42 VB, Tank 49 VB, and Tank 51 VB is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]).

The third level of control for Low-Rem transfers through the following VBs: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, VB-28a, VB-28b, 241-96H VB, Tank 40 VB, Tank 42 VB, Tank 49 VB, and Tank 51 VB is the VB structure. The controls supporting VB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The VB structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

Valve Box Explosion (Chemical Cleaning Transfers)

Because the bounding unmitigated VB explosion exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences. For Chemical Cleaning Transfers (or related vent/drain operations), three levels of control are required for the following VBs: VB-1, VB-2, VB-3, VB-4, VB-5, VB LDB-17, and

Tank 51 VB. Because only the FW in the immediate vicinity of the event was at risk, one level of control is required for Chemical Cleaning Transfers (or related vent/drain operations) through the Tank 51 Drain VB. The first level of control for Chemical Cleaning Transfers (or related vent/drain operations) will also serve as the single control for the Tank 51 Drain VB.

This event is prevented by crediting the primary containment (e.g., core pipe, including jumpers, valves, connectors, and associated gaskets) and controls supporting containment integrity. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

Also part of the first level of control is waste tank temperature monitoring and the Waste Tank Chemical Cleaning Program. Waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions. The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, and Tank 51 Drain VB. Chemical Cleaning Transfers (or related vent/drain operations) are also permitted in transfer paths that may leak from primary containment to VB-1 and VB-3. Additionally, the Waste Tank Chemical Cleaning Program ensures that Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.

The second level of control is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]). For the third level of control, the VB structure was credited. The controls supporting VB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The VB structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

DB Explosion (except Chemical Cleaning Transfers)

Because the bounding unmitigated DB explosion exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences. In FTF, only Low-Rem transfers are permitted. Additionally, High-Rem transfers are not permitted through HDB-2. Therefore, controls associated with High-Rem transfers for FTF DBs and HDB-2 are not identified below.

For High-Rem transfers, three levels of control are required for the following DBs: HDB-4, HDB-5, and HDB-6. For Low-Rem transfers, three levels of control are required for the following DBs: FDB-2, FDB-3, FDB-4, HDB-2, HDB-4, HDB-5, and HDB-6. For ESP Sludge Slurry transfers, three levels of control are required for HDB-7. No controls are required for HDB-7 (except during an ESP Sludge Slurry transfer) and HDB-8, since they will not reach the LFL during the event; however, controls were selected as described below.

The first level of control for High-Rem transfers through these DBs will serve as the first level of control for all Low-Rem transfers.

The first level of control for High-Rem transfers through HDB-4, HDB-5, and HDB-6 is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a DB explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for High-Rem transfers through HDB-6 is the DB active ventilation system, which will provide a minimum flow through the DB to prevent accumulation of a flammable mixture of hydrogen. For the second level of control for High-Rem transfers, the DB structure was also credited. The DB structure also supports ventilation system operation. The controls supporting DB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

The third level of control for High-Rem transfers through HDB-6 is instrumentation to detect the release (e.g., conductivity probe) and equipment to stop the release (e.g., transfer isolation devices). The instrumentation will alert operators to the event and allow for actions to minimize flammable vapor accumulation. The DB structure provides a liquid waste containment function to support conductivity probe functionality. To provide further defense for High-Rem transfers through HDB-7 and HDB-8, instrumentation to detect the release and equipment to stop the release are also credited for these DBs.

HDB-4 and HDB-5 have no installed ventilation system. Therefore, the second level of control for High-Rem transfers is instrumentation to detect the release (e.g., conductivity probes) and equipment to stop the release (e.g., transfer isolation devices). The DB structure provides a liquid waste containment function to support conductivity probe functionality. For the third level of control, the DB structure was credited. The controls supporting DB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The DB structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

The first level of control for an ESP Sludge Slurry transfer through HDB-7 is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a DB explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for an ESP Sludge Slurry transfer through HDB-7 is the DB active ventilation system, which will provide a minimum flow through the DB to prevent accumulation of a flammable mixture of hydrogen. For the second level of control for ESP Sludge Slurry transfers, the DB structure was also credited. The DB structure also supports ventilation system operation. The controls supporting DB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

The third level of control for an ESP Sludge Slurry transfer through HDB-7 is instrumentation to detect the release (e.g., conductivity probe) and equipment to stop the release (e.g., transfer isolation devices). The instrumentation will alert operators to the event and allow for actions to minimize flammable vapor accumulation. The DB structure provides a liquid waste containment function to support conductivity probe functionality.

For Low-Rem transfers through FDB-2, FDB-3, FDB-4, HDB-2, HDB-4, HDB-5, and HDB-6, transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]) provide the second level of control. The secondary containment structure (i.e., DB) was credited as the third level of control. The DB provides airborne waste confinement following a core pipe failure. The controls supporting secondary containment structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

DB Explosion (Chemical Cleaning Transfers)

Because the bounding unmitigated DB explosion exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences. For Chemical Cleaning Transfers (or related vent/drain operations), three levels of control are required for the following DBs: FDB-2, FDB-3, FDB-4, and HDB-2. For HDB-7, only the Waste Tank Chemical Cleaning Program and waste tank temperature monitoring is required (to prevent corrosion induced hydrogen generation from contributing to the flammable vapor concentration) since this DB will not reach the LFL during the event.

This event is prevented by crediting the primary containment (e.g., core pipe, including jumpers, valves, connectors, and associated gaskets) and controls supporting containment integrity. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

Also part of the first level of control is waste tank temperature monitoring and the Waste Tank Chemical Cleaning Program. Waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions. The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, and HDB-7. Additionally, the Waste Tank Chemical Cleaning Program ensures the Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.

The second level of control is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]). For the third level of control, the DB structure was credited. The controls supporting DB structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The DB

structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

H-Area Catch Tank Explosion (except Chemical Cleaning Transfers)

Because the unmitigated H-Area Catch Tank explosion exceeds the Onsite EGs, mitigated analysis is required. For both High-Rem and Low-Rem transfers, three levels of control are required for the H-Area Catch Tank explosion event.

The containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity were chosen as the first level of control to prevent an H-Area Catch Tank explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

For the second level of control, the H-Area Catch Tank Encasement and Transfer Line Encasements draining to the H-Area Catch Tank were credited. The controls supporting catch tank encasement structure integrity and transfer line encasement structure integrity include structural integrity controls. The H-Area Catch Tank Encasement and Transfer Line Encasements do not prevent the event, but do provide mitigation close to the immediate hazard through passive confinement. For the third level of control, the ground cover over the H-Area Catch Tank Encasement was credited. The H-Area Catch Tank ground cover does not prevent the event, but does provide passive mitigation.

H-Area Catch Tank Explosion (Chemical Cleaning Transfers)

Because the unmitigated H-Area Catch Tank explosion exceeds the Onsite EGs, mitigated analysis is required. For Chemical Cleaning Transfers (or related vent/drain operations), three levels of control are required for the H-Area Catch Tank explosion event.

The containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity were chosen as the first level of control to prevent an H-Area Catch Tank explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

Also part of the first level of control is waste tank temperature monitoring and the Waste Tank Chemical Cleaning Program. Waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions. The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through designated transfer facilities (permits transfers that may leak from primary containment to the H-Area Catch Tank). Additionally, the Waste Tank Chemical Cleaning Program ensures the Chemical Cleaning Transfer material

contains less than or equal to 4 wt. % OA and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.

For the second level of control, the H-Area Catch Tank Encasement and Transfer Line Encasements draining to the H-Area Catch Tank were credited. The controls supporting catch tank encasement structure integrity and transfer line encasement structure integrity include structural integrity controls. The H-Area Catch Tank Encasement and Transfer Line Encasements do not prevent the event, but do provide mitigation close to the immediate hazard through passive confinement. For the third level of control, the ground cover over the H-Area Catch Tank Encasement was credited. The H-Area Catch Tank ground cover does not prevent the event, but does provide passive mitigation.

High Point Flush Pit Explosion

Because the bounding unmitigated HPFP explosion exceeds the Onsite EGs, mitigated analysis is required. Controls were selected for use in determining the mitigated explosion consequences. For High-Rem transfers, three levels of control are required. Because only the FW in the immediate vicinity of the event was at risk, one level of control is required for Low-Rem transfers through the HPFP. The first level of control for High-Rem transfers will also serve as the single control for Low-Rem transfers.

The containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity were chosen as the first level of control to prevent an HPFP explosion. The controls supporting primary containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for High-Rem transfers is instrumentation to detect the release (e.g., conductivity probes) and equipment to stop the release (e.g., transfer isolation devices) was credited. The instrumentation will alert operators to the event and allow for actions to minimize flammable vapor accumulation. The HPFP structure provides a liquid waste containment function to support conductivity probe functionality.

The third level of control for High-Rem transfers is the HPFP structure. The controls supporting HPFP structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The HPFP structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement.

LDB Drain Cell Explosion (except Chemical Cleaning Transfers)

Because the unmitigated LDB Drain Cell explosion exceeds the Onsite EGs, mitigated analysis is required. For both High and Low-Rem transfers, three levels of control are required for the LDB Drain Cell. The first and third levels of control for High-Rem transfers will also serve as the first and third levels of control for all Low-Rem transfers. Additionally, to preclude potential

accident scenarios associated with MCU material in the LDB Drain Cell, one level of control is required.

The first level of control for High-Rem transfers is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a LDB Drain Cell explosion. The controls supporting primary containment integrity include (depending on the scenario) critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for High-Rem transfers is the instrumentation to detect the release (e.g., conductivity probes) and equipment to stop the release (e.g., transfer isolation devices). The LDBs and transfer line jacket provide a liquid waste containment function to support conductivity probe functionality. The LDB conductivity probes along the leak path to the LDB Drain Cell shall provide control room alarm following a primary containment waste release that could reach the LDB Drain Cell. The instrumentation will alert operators to the event and allow for actions to minimize flammable vapor accumulation.

The third level of control for High-Rem transfers is the LDB Drain Cell structure and transfer line jackets, draining to the drain cell. The controls supporting LDB Drain Cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The controls supporting transfer line jacket integrity include critical lift controls, structural integrity controls, and tank top/secondary containment loading controls. The LDB Drain Cell structure and transfer line jackets do not prevent the event, but do provide mitigation close to the immediate hazard through passive confinement.

The first level of control for Low-Rem transfers is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a LDB Drain Cell explosion. The controls supporting primary containment integrity include (depending on the scenario) critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations). This level of control also prevents potential MCU material from reaching the LDB Drain Cell. The core pipe (and controls supporting containment integrity) associated with the transfer lines from MCU to Tank 50 and from the Tank 50 VB to Tank 50 (via the C-1 Riser) prevents potential leakage of MCU material to the LDB Drain Cell via associated LDBs.

The second level of control for Low-Rem transfers is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]).

The third level of control for Low-Rem transfers is the LDB Drain Cell structure and transfer line jackets, draining to the drain cell. The controls supporting LDB Drain Cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The controls supporting transfer line jacket integrity include critical lift controls, structural integrity controls, and tank top/secondary containment loading controls. The LDB Drain Cell structure and transfer line jackets do not

prevent the event, but do provide mitigation close to the immediate hazard through passive confinement.

LDB Drain Cell Explosion (Chemical Cleaning Transfers)

Because the unmitigated LDB Drain Cell explosion exceeds the Onsite EGs, mitigated analysis is required. For Chemical Cleaning Transfers (or related vent/drain operations), three levels of control are required for the LDB Drain Cell.

The first level of control is the containment structure closest to the waste hazard (e.g., core pipe) and controls supporting primary containment integrity to prevent a LDB Drain Cell explosion. The controls supporting primary containment integrity include (depending on the scenario) critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

Also part of the first level of control is waste tank temperature monitoring and the Waste Tank Chemical Cleaning Program. Waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions. The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through designated transfer facilities (permits transfers that may leak from primary containment to the LDB Drain Cell). Additionally, the Waste Tank Chemical Cleaning Program ensures the Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.

The second level of control is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]).

The third level of control is the LDB Drain Cell structure and transfer line jackets, draining to the drain cell. The controls supporting LDB Drain Cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The controls supporting transfer line jacket integrity include critical lift controls, structural integrity controls, and tank top/secondary containment loading controls. The LDB Drain Cell structure and transfer line jackets do not prevent the event, but do provide mitigation close to the immediate hazard through passive confinement.

3.4.2.7.2 FREQUENCY DETERMINATION

The HA classifies Transfer Facility Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not

credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduces the probability of a Transfer Facility Explosion.

3.4.2.7.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below. The overall Transfer Facility Explosions ST is made up of an explosion ST and a Transfer Error ST. The following discussions pertain only to the explosion ST. Discussion of the derivation and calculation of the Transfer Error ST is provided in Section 3.4.2.9.

3.4.2.7.3.1 Source Term Inputs and Assumption

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Transfer Facility Explosions STs and are all taken from References 71 and 274, unless otherwise stated:

- Maximum sludge slurry transfer temperature less than or equal to 90°C
- The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, and Tank 51 Drain VB. Chemical Cleaning Transfers (or related vent/drain operations) that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell are also permitted. Additionally, the Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) ensures the Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA (at ≤ 60°C) and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.

3.4.2.7.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion (detonation or deflagration) model. The value of each of the terms is specific to the location being analyzed. As stated previously, the following discussions pertain only to the explosion ST.

Material at Risk

The characteristics of the MAR vary for the different Transfer Facility Explosions scenarios. For the transfer facilities associated with Tank 50/MCU, the waste stream involved is assumed to be Tank 50 Supernate. For the remaining (non-Tank 50/MCU related) transfer facilities, the waste stream involved is assumed to be Bounding Sludge Slurry to determine the bounding ST for each

scenario. The waste characteristics and inhalation dose potential on a per unit volume basis for the various streams is given in Section 3.4.1.5.1.

For the transfer facilities associated with Tank 50/MCU, the volume of the MAR for the explosion is all of the waste in the applicable transfer facility and assumes a detonation occurs at stoichiometric conditions for Isopar® L. Additionally, the AA calculates the consequences assuming a spill volume of 173,000 gallons (assumed 360 gpm spill rate over an 8-hour period).

For the remaining (non-Tank 50/MCU related) transfer facility explosion scenarios, the volume of the MAR for the explosion is all of the waste in the applicable transfer facility prior to the time of a leak plus any of the waste that leaks into the cell. The leakage is contained within the transfer facility structure and allows flammable vapors to accumulate until an explosion occurs. As the spill volume increases, the time to LFL or LEL becomes shorter; however, the consequences of an explosion become less. With less vapor space volume, less flammable vapor is available to explode and impart its energy on the waste and hence, less aerosolization of waste. The AA has calculated the worst consequences up to the largest assumed spill volume.

Excluding Tank 50/MCU related scenarios, the explosion ST varies depending on whether the LFL or LEL has been reached. For the scenarios, the ST varies greatly because of the various volumes. In the 10 days between termination of the leak and addressing the spill (e.g., ventilation operation, removal of spilled waste), the hydrogen concentration for HDB-8 never exceeds the LFL. The flammable vapor concentration calculation is discussed later.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1).

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.7.3.3 Flammable Vapor Concentration Models

For the transfer facilities associated with Tank 50/MCU analyses, a flammable vapor concentration of Isopar® L at stoichiometric conditions was used. For the remaining transfer facility analyses, the flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present for each of the

locations of concern. The hydrogen concentration and percent LFL at the time of the explosion are determined in Reference 71 using the flammable vapor concentration determination formulas described in Section 3.4.1.1.2. For Chemical Cleaning Transfer facilities, the Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) prevents corrosion induced hydrogen generation from contributing to the flammable vapor concentration, thus the values from Reference 71 remain valid for these transfer facilities.

3.4.2.7.3.4 Source Term Calculation

For the Tank 50/MCU related transfer facility analyses, the explosion STs were calculated in Reference 228 using the detonation model described in Section 3.4.1.1.2. To determine the overall scenario consequences for the various locations, the explosion STs were added to Transfer Error STs (discussed in detail in Section 3.4.2.9.3).

For the remaining transfer facility scenarios, the explosion STs for the various locations were calculated in Reference 71 using the deflagration and detonation models described in Section 3.4.1.1.2. To determine the overall scenario consequences for the various locations, the explosion STs were added to Transfer Error STs (calculated in Reference 60 and discussed in detail in Section 3.4.2.9.3). The 241-96H VB explosion has not been specifically analyzed within Reference 71, but it is approximately the same size as the FDB-3 explosion (approximately 256 ft^3/1,916 gallons, Ref. 216). High-Rem transfers are prohibited in 241-96H VB. However, the consequences of a Transfer Facility Explosion during a Low-Rem transfer through the 241-96H VB is equivalent to the Low-Rem consequences of a Transfer Facility Explosion in FDB-3 (Ref. 255). Therefore, the 241-96H VB consequences will be approximately the same as the FDB-3 detonation consequences for Low-Rem (Ref. 71, 255). Of all the locations of concern, the bounding Transfer Facility Explosion is an H-Area Catch Tank explosion followed by a Transfer Error.

3.4.2.7.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Transfer Facility Explosion event, applying DOE-EM Interim Guidance methodology (Ref. 255) are given in Table 3.4-7. Excluding Tank 50/MCU transfer facility analyses, these consequences are determined for any given transfer facility by adding the consequences from the Transfer Error (Ref. 60) and Transfer Facility Explosion (Ref. 71) calculations together with consideration given to DOE-EM Interim Guidance methodology (Ref. 255). For Tank 50/MCU transfer facility analyses, Reference 228 determined the consequences by adding the consequences from the Transfer Error and Transfer Facility Explosion.

For the Tank 50/MCU transfer facility analyses, the unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding Tank 50/MCU Transfer Facility Explosion scenario (Tank 50 VB explosion) do not challenge the Offsite EGs. For the remaining transfer facility scenarios, the unmitigated and mitigated Offsite consequences (≤ 0.54 rem) for the bounding Offsite Transfer Facility Explosion scenario (H-Area Catch Tank explosion) do not challenge the Offsite EGs.

For the Tank 50/MCU transfer facility analyses, the unmitigated and mitigated Onsite consequences (≤ 22 rem) for the bounding Tank 50/MCU Transfer Facility Explosion scenario (Tank 50 VB explosion) do not exceed the Onsite EGs. For the remaining transfer facility scenarios, the unmitigated Onsite consequences (> 100 rem) for the bounding Onsite Transfer Facility Explosion scenario (H-Area Catch Tank explosion) exceed the Onsite EGs. The mitigated Onsite consequences for the bounding Transfer Facility Explosion scenario (H-Area Catch Tank explosion) are zero because the event is prevented. The consequences of a Low-Rem Transfer Facility Explosion and a Transfer Facility Explosion associated with Chemical Cleaning Transfers would be less than 15% of the consequences of the bounding scenario, which assumed Bounding Sludge Slurry as the MAR. The unmitigated Onsite consequences (> 100 rem) for the bounding Low-Rem Transfer Facility Explosion and Chemical Cleaning Transfer Facility Explosion exceed the Onsite EGs. The mitigated Onsite consequences for the Low-Rem and Chemical Cleaning Transfer Facility Explosions are zero because the event is prevented. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.7.5. The consequences of a Transfer Facility Explosion event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.7.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Transfer Facility Explosions event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.7.5.1 Safety Class Controls

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following (applicable during Chemical Cleaning Transfers [or related vent/drain operations]):

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, and Tank 51 Drain VB. Chemical Cleaning Transfers (or related vent/drain operations) are also permitted in transfer paths that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell.
- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering transfer facilities outside of the intended transfer path.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.

- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.

Waste Tank Temperature Monitoring: Temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks to protect initial conditions for corrosion induced hydrogen generation rate assumptions.

3.4.2.7.5.2 Safety Significant Controls

Diversion Box: The DB structure provides airborne waste confinement following an explosion in the DB. The DB structure also provides liquid waste containment to support conductivity probe functionality (applicable to HDB-4, HDB-5, HDB-6, HDB-7 and HDB-8). The DB structure also supports ventilation system operation (applicable to HDB-6 and HDB-7).

Diversion Box Active Ventilation System: The DB active ventilation system shall provide a minimum flow through the DB to prevent accumulation of a flammable mixture of hydrogen (applicable to HDB-6 and HDB-7).

Diversion Box Conductivity Probes: The DB conductivity probes shall provide control room alarm following a primary containment waste release into the DB (applicable to HDB-4, HDB-5, HDB-6, HDB-7 and HDB-8).

Equipment Needed to Stop Transfers, Siphons, and Liquid Additions: The equipment needed to stop transfers, siphons, and liquid additions shall be available to respond to indications of a primary containment waste release.

H-Area Catch Tank Encasement: The H-Area Catch Tank Encasement and the ground cover over the Catch Tank Encasement provide airborne waste confinement following an explosion in the catch tank.

High Point Flush Pit: The HPFP structure provides airborne waste confinement following an explosion in the HPFP. The HPFP structure also provides liquid waste containment to support conductivity probe functionality.

High Point Flush Pit Conductivity Probe: The HPFP conductivity probe shall provide control room alarm following a primary containment waste release (applicable along the leak path between FTF and HTF).

LDB Conductivity Probes: The LDB conductivity probes shall provide control room alarm following a primary containment waste release (applicable along the leak path to the LDB Drain Cell).

LDB Drain Cell: The LDB Drain Cell structure provides airborne waste confinement following an explosion in the LDB Drain Cell.

Transfer Line Core Pipe: Transfer line integrity (e.g., core pipe, valves, jumpers, connectors, and associated gaskets) shall ensure primary waste containment.

Transfer Line Encasement: The transfer line encasements draining to the H-Area Catch Tank provide airborne waste confinement following a primary containment waste release.

Transfer Line Jacket and Leak Detection Box: The transfer line jacket and LDB structures provide liquid waste containment to support conductivity probe functionality (applicable along the leak path to the LDB Drain Cell). The transfer line jacket and LDB structures also provides airborne waste confinement following a transfer line core pipe waste release.

Valve Box: The VB structure provides airborne waste confinement following an explosion in the VB. The VB structure also provides liquid waste containment to support conductivity probe functionality (applicable to Tank 21 VB, Tank 22 VB, Tank 40 VB, Tank 40 Drain VB, Tank 42 VB, Tank 49 VB, Tank 51 VB, and Tank 51 Drain VB).

Valve Box Conductivity Probes: The VB conductivity probes shall provide control room alarm following a primary containment waste release into the VB (applicable to conductivity probes in the following VBs: Tank 21 VB, Tank 22 VB, Tank 40 VB, Tank 40 Drain VB, Tank 42 VB, Tank 49 VB, Tank 51 VB, and Tank 51 Drain VB).

3.4.2.8 Pump Pit and Pump Tank Explosion

3.4.2.8.1 SCENARIO DEVELOPMENT

3.4.2.8.1.1 Background

Waste handling in the CSTF requires multiple transfers of liquid solutions or slurries containing radioactive waste. Waste is transferred between various process areas (e.g., pump tanks, waste tanks) through transfer facilities (e.g., PPs). In addition to containing waste during transfers, the pump tanks normally contain a heel of waste or flush water. Because of this heel, flammable vapors can be a concern in pump tanks at all times. The PPs serve as a secondary containment to mitigate any pump tank (or connected piping) releases. If a leak occurs inside a PP, the leakage is contained within the containment structure of the pit. If not mitigated, the leaked waste could result in flammable vapors accumulating in the PP. For further detail on flammable vapor generation, refer to Section 3.4.1.5.3.

For further detail on the pump tanks and PPs (including pump tank and PP designs), refer to Section 2.4.4. The Pump Tank and PP Explosion events have the potential to evolve into Transfer Errors, and the Transfer Error consequences derived in Section 3.4.2.9 are used in determining the overall Pump Tank and PP Explosion consequences. Discussion of the derivation and calculation of the Transfer Error ST is provided in Section 3.4.2.9 and will not be discussed here.

3.4.2.8.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with PP and Pump Tank Explosions that have non-negligible risk. The locations of concern for an explosion are as follows: HPT-2, HPT-3, HPT-4, HPT-5, HPT-6, HPT-7, HPT-8, HPT-9, HPT-10, F-Area Pump Tank (FPT) FPT-1, FPT-2, FPT-3, HPP-2, HPP-3, HPP-4, HPP-5, HPP-6, HPP-7, HPP-8, HPP-9, HPP-10, FPP-1, FPP-2, and FPP-3.

In determining vapor space size, each PP is considered independent of other PPs. Process areas prohibited from being placed in a transfer path are stated in the Section 3.4.1.5.2. Events that could lead to an explosion in these areas were not analyzed since these process areas are isolated. A discussion of transfer path determination is provided in Section 5.4.2.

3.4.2.8.1.3 Unmitigated Accident Progression

The unmitigated accident progressions for the General Pump Pit, Chemical Cleaning Pump Pit, and Pump Tank Explosions are provided below.

General Pump Pit Explosion

- A small initial quantity of waste is present in the PP structure,
- Flammable vapors in the PP structure accumulate until the vapor space reaches an equilibrium hydrogen concentration (determined by the hydrogen release from any initial waste volume and atmospheric breathing),
- A transfer is in progress,
- A primary containment leak occurs (e.g., jumper failure or pump tank leaks) as described in the HA scenarios (The maximum assumed missing waste volume is 15,000 gallons [Section 3.4.1.5.2]),
- Waste accumulates in the PP structure,
- The initial leak is assumed to go undetected (e.g., no credit for leak detection instrumentation),
- Ventilation (other than atmospheric breathing) is not functional,
- Flammable gas is generated via radiolysis of the waste in the cell and release of dissolved hydrogen from the leaked material during the time of the leak (steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through transfer lines for which DBs or PPs are credited leak detection locations are prohibited),
- Additional flammable vapors are released for ≤ 10 days (the vapor is assumed to be at the same temperature as the spilled or transferred waste),
- Hydrogen is assumed to mix uniformly with the air in the vapor space (i.e., there is no stratification or pocketing),

- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

Chemical Cleaning Pump Pit Explosion

The following accident progression applies to the explosion locations of concern for PPs associated with Chemical Cleaning Transfers (or related vent/drain operations) (applicable to FPP-1, FPP-2, and HPP-3):

- A small initial quantity of waste is present in the PP structure,
- Flammable vapors in the PP structure accumulate until the vapor space reaches an equilibrium hydrogen concentration (determined by the hydrogen release from any initial waste volume and atmospheric breathing),
- A Chemical Cleaning Transfer or vent and drain is in progress,
- A primary containment leak occurs (e.g., jumper failure) as described in the HA scenarios (The maximum assumed missing waste volume is 15,000 gallons [Section 3.4.1.5.2]),
- Waste accumulates in the PP structure,
- The initial leak is assumed to go undetected (e.g., no credit for leak detection instrumentation),
- Ventilation (other than atmospheric breathing) is not functional,
- Flammable gas is generated via radiolysis of the waste in the cell and corrosion induced hydrogen,
- Hydrogen is assumed to mix uniformly with the air in the vapor space (i.e., there is no stratification or pocketing),

- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,
- The overpressure from the explosion causes cell covers to lift off of the cell (where applicable), ejects any installed HEPA filters, and/or creates other openings (vent paths) in the cell,
- The air expansion from the heat of the explosion causes air to be expelled from the cell. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the cell during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

Pump Tank Explosion

- Waste is present in pump tank,
- Flammable gas is generated via radiolysis of the waste. The pump tank vapor space is maintained at ≤ 25% of the LFL,
- A transfer is in progress,
- Ventilation fails,
- The waste transfer continues into the pump tank for 2 hours causing the pump tank to overflow into the PP,
- Dissolved hydrogen is released from the material transferred through the tank during the event (steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/gal-hr of waste through transfer lines for which DBs or PPs are credited leak detection locations are prohibited),
- Additional flammable vapors are generated via radiolysis of the waste in the pump tank and release of dissolved hydrogen from the material (trapped gas release within the pump tank is neglected [Ref. 307]),
- Flammable vapor accumulation continues for ≤ 10 days,
- No ignition source controls are credited and it is assumed that an ignition source is present and initiates an explosion at the maximum flammable vapor concentration during the event,
- An explosion occurs, if the flammable vapors have reached explosive levels,
- The explosion causes material to become airborne,

- The overpressure from the Pump Tank Explosion causes openings (vent paths) from the pump tank to atmosphere,
- The air expansion from the heat of the explosion causes air to be expelled from the pump tank. This expelled air carries with it the previously described material made airborne by the explosion,
- The airborne material that has escaped from the pump tank during the explosion is transported to Onsite and Offsite receptors,
- The explosion damages adjacent transfer lines/transfer facilities, thereby initiating a Transfer Error (progression discussed in Section 3.4.2.9).

3.4.2.8.1.4 Mitigated Accident Progression

General Pump Pit Explosion

The general PP flammable vapor concentration never reached the LFL during the event duration, and the General Pump Pit Explosion event consequences are zero. Because the unmitigated consequences of a General Pump Pit Explosion event do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.8.4), no mitigated analysis is required.

Chemical Cleaning Pump Pit Explosion

The Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) prevents corrosion induced hydrogen generation from contributing to the flammable vapor concentration in the PP during Chemical Cleaning Transfers (or related vent/drain operations). Thus the flammable vapor concentration analyses performed for the General Pump Pit Explosion applies to the Chemical Cleaning Pump Pit Explosion scenario. Therefore, the PP flammable vapor concentration does not reach the LFL during the event duration, and the Chemical Cleaning Pump Pit Explosion event consequences are zero.

The following SC controls from the Waste Tank Chemical Cleaning Program are required to protect the initial accident assumptions:

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FPP-1, FPP-2, and HPP-3.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1 and HPT-3.
- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks or transfer facilities outside of the intended transfer path.
- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.

- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.

Additionally, to protect the initial accident assumptions, waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This SC control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions.

Pump Tank Explosion

Since the unmitigated consequences of a Pump Tank Explosion can exceed the Onsite EGs, mitigated analysis is required. Since the Pump Tank Explosions exceed the EGs, two SS levels of control are required. Because the event involves an explosion, one additional SS level of control is required. The mitigated Pump Tank Explosion accident progression differs from the unmitigated accident progression in that pump tank ventilation is required on pump tanks of concern.

The PP/pump tank active ventilation system (including passive vents for HPT-2, HPT-3, HPT-4, HPT-5, HPT-6, FPT-1, FPT-2, and FPT-3) was chosen as the first level of control to prevent a Pump Tank Explosion. The PP/pump tank supports ventilation system operation. The PP/pump tank active ventilation system shall provide a minimum flow through the PP/pump tank to prevent accumulation of a flammable mixture of hydrogen, thereby preventing an explosion. The equipment needed to stop transfers is included in the first level of control because steam jetted transfers need to be stopped upon loss of ventilation to minimize dissolved hydrogen release. In addition, backup portable ventilation (with power supply) shall be installed and functional for pump tanks, which are receiving steam jetted transfers from a source with an inventory greater than 1,200 gallons (excluding HDB-8 Complex pump tanks and pump tanks receiving canyon transfers (Ref. 166)). This ensures that pump tank ventilation flow can be provided as required. The bounding response time for the restoration of pump tank ventilation flow is 14 minutes (Ref. 310). The receipt pump tanks for some organics transfers may exceed the routine 5% organic contribution (up to a 20% organic contribution). These pump tanks will have their required purge flow adjusted to account for the additional contribution of the organics for these particular organic transfers. The HDB-8 Complex pump tanks do not have passive vents, but the HDB-8 PVV System is supplied power via a diesel generator, independent of the normal power. Additionally, other diesel generators (non-credited) are available to provide power to purge systems for HTF process areas with flammable vapor concerns (e.g., waste tanks, pump tanks).

In addition to the first levels of control discussed above the following SC controls from the Waste Tank Chemical Cleaning Program are required to protect the initial accident assumptions for Chemical Cleaning Transfers:

- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1 and HPT-3.
- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks or transfer facilities outside of the intended transfer path.
- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.

Additionally, to protect the initial accident assumptions, waste tank temperature monitoring will ensure the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks. This SC control will ensure that the temperature of the transferred waste material is within initial conditions for corrosion induced hydrogen generation rate assumptions.

Although, the pump tanks are constructed of stainless steel, components associated with the pump tank may contain carbon steel. Therefore, the controls associated with the Waste Tank Chemical Cleaning Program and waste tank temperature monitoring prevents corrosion induced hydrogen generation from contributing to the flammable vapor concentration in the pump tank during Chemical Cleaning Transfers (or related vent/drain operations). These controls are considered SC to protect initial accident assumptions.

For the second level of control, the PP structure was credited. The controls supporting PP structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The PP structure does not prevent the event, but does provide mitigation close to the immediate hazard through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Pump Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

3.4.2.8.2 FREQUENCY DETERMINATION

The HA classifies PP and Pump Tank Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduces the probability of a PP and Pump Tank Explosion.

3.4.2.8.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.8.3.1 Source Term Inputs and Assumption

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the PP and Pump Tank Explosion STs and are all taken from References 71 and 274, unless otherwise stated:

- The Waste Tank Chemical Cleaning Program requires that Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FPP-1, FPP-2, and HPP-3. This program also ensures sufficient inhibitors are present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste during a vent and drain operation associated with a Chemical Cleaning Transfer. Additionally, the Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) ensures the Chemical Cleaning Transfer material contains less than or equal to 4 wt. % OA (at ≤ 60°C) and that acidic material within transfer facilities is neutralized, thus preventing corrosion induced hydrogen generation from contributing to the flammable vapor concentration.
- Pump tank vapor space volume at tank overflow = 121 ft^3
- Sludge amount in a pump tank is 1,260 gallons
- Maximum sludge slurry transfer temperature less than or equal to 90°C

3.4.2.8.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or intrinsic to the explosion (detonation or deflagration) model. The value of each of the terms is specific to the location being analyzed.

Material at Risk – Pump Pit Explosion

The waste stream used to determine the bounding ST for each scenario is Bounding Sludge Slurry. Explosion consequences for other streams were calculated in Reference 71 to demonstrate the decrease in consequences relative to the MAR. The waste characteristics and inhalation dose potential on a per unit volume basis for the various streams is given in Section 3.4.1.5.1.

The volume of the MAR for this event is all of the waste in the PP prior to the time of a leak plus any of the waste that leaks into the PP. The leakage is contained within the structure of the PP and allows flammable vapors to accumulate (if ventilation is not available) until an explosion occurs. As the spill volume increases, the time to LFL or LEL becomes shorter; however, the consequences of an explosion become less. With less vapor space volume, less flammable vapor is available to explode and impart its energy on the waste and hence, less aerosolization of waste. The AA has calculated the worst consequences up to the largest assumed spill volume.

The explosion ST varies depending on whether the LFL or LEL has been reached. In the 10 days between termination of the leak and addressing the spill (e.g., ventilation operation, removal of spilled waste), the hydrogen concentration in the PPs never reach the LFL. The flammable vapor concentration calculation is discussed later.

Material at Risk – Pump Tank Explosion

The MAR for this event is all of the waste in the pump tank prior to the start of the event plus any of the waste that is transferred into the pump tank (up to overflow). The pump tank vapor space is conservatively assumed to be sealed, which allows flammable vapors to accumulate (if ventilation is not available) until an explosion occurs. As pump tank volume increases, the time to LFL or LEL becomes shorter; however, the consequences of an explosion become less. With less vapor space volume, less flammable vapor is available to explode and impart its energy on the waste and hence, less aerosolization of waste. The AA has calculated the worst consequences in the 10-day event duration.

The explosion ST varies depending on whether the LFL or LEL has been reached. In the 10 days between event initiation and termination (e.g., ventilation operation, emptying the pump tank), the pump tank vapor space could become flammable. The flammable vapor concentration calculation is discussed later.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1).

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.8.3.3 Flammable Vapor Concentration Models

The flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present for each of the locations of concern. The hydrogen concentration and percent LFL at the time of the explosion are determined in Reference 71 using the flammable vapor concentration formulas described in Section 3.4.1.1.2. For Chemical Cleaning Transfer facilities, the Waste Tank Chemical Cleaning Program (with waste tank temperature monitoring controls prior to transfers) prevents corrosion induced hydrogen generation from contributing to the flammable vapor concentration, thus the values from Reference 71 remain valid for these transfer facilities.

3.4.2.8.3.4 Source Term Calculation

The explosion STs for the various locations were calculated in Reference 71 using the deflagration and detonation models described in Section 3.4.1.1.2. To determine the overall scenario consequences for the pump tanks, the Pump Tank Explosion STs were added to pump tank transfer error STs (calculated in Reference 60, and discussed in detail in Section 3.4.2.9.3). Because the PP flammable vapor concentration never reached the LFL during the event duration, the PP explosion ST and consequences were zero.

3.4.2.8.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding PP and Pump Tank Explosion events, applying DOE-EM Interim Guidance methodology (Ref. 255) are given in Table 3.4-7. These consequences are determined for any given PP and Pump Tank Explosion by adding the consequences from the Transfer Error (Ref. 60) and PP and Pump Tank Explosion (Ref. 71) calculations together.

The unmitigated and mitigated Offsite consequences (≤ 0.66 rem) for the bounding Offsite PP and Pump Tank Explosion scenario (pump tank explosion) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding Onsite PP and Pump Tank Explosion scenario (pump tank explosion) exceed the Onsite EGs. The mitigated Onsite consequences for the bounding Onsite PP and Pump Tank Explosion scenario (pump tank

explosion) are zero because the event is prevented. The consequences to the immediate vicinity worker are also zero because the event is prevented.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.8.5. The consequences of a PP and Pump Tank Explosion event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.8.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Pump Pit and Pump Tank Explosion event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression).

3.4.2.8.5.1 Safety Class Controls

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following (applicable during Chemical Cleaning Transfers [or related vent/drain operations]):

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FPP-1, FPP-2, and HPP-3.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1, HPT-3, and the waste tanks associated with the vent/drain path.
- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks, waste tanks, or transfer facilities outside of the intended transfer path.
- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.

Waste Tank Temperature Monitoring: Temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II

Acidic Chemical Cleaning Waste Tanks to protect initial conditions for corrosion induced hydrogen generation rate assumptions.

3.4.2.8.5.2 Safety Significant Controls

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Pump Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

Equipment Needed to Stop Transfers, Siphons, and Liquid Additions: The equipment needed to stop transfers, siphons, and liquid additions shall be available to respond to indications of a primary containment waste release.

HDB-8 Diesel Generator: The HDB-8 diesel generator supplies power to the HDB-8 PVV System upon loss of normal power.

HDB-8 PVV System: The HDB-8 PVV System shall provide a minimum flow through the HDB-8 Complex pump tanks to prevent accumulation of a flammable mixture of hydrogen.

Pump Pit: The PP structure provides airborne waste confinement following an explosion in the pump tank. The PP Structure also supports ventilation system operation.

Pump Pit/Pump Tank Active Ventilation System: The PP/pump tank active ventilation system shall provide a minimum flow through the pump tank to prevent accumulation of a flammable mixture of hydrogen.

Pump Tank: Pump Tank integrity supports ventilation system operation.

Pump Tank Backup Ventilation Systems Program: Backup portable ventilation (with power supply) shall be installed and functional for pump tanks which are receiving steam jetted transfers from a source with an inventory greater than 1,200 gallons (excluding HDB-8 Complex pump tanks and pump tanks receiving canyon transfers).

Pump Tank Passive Vents: The pump tank passive vents provide a flowpath between the pump tank vapor space and PP vapor space to extend the time to reach LFL in the pump tank. (not applicable to HPT-7, HPT-8, HPT-9, and HPT-10.)

3.4.2.9 Transfer Error/SMP Waste Release

3.4.2.9.1 SCENARIO DEVELOPMENT

3.4.2.9.1.1 Background

The Transfer Error/SMP Waste Release DBA includes a large number of events with slightly different accident progressions. These events are similar in that they could all lead to a release of waste from primary containment.

Waste handling in the CSTF requires multiple transfers of liquid solutions or slurries containing radioactive waste. Waste is transferred between various process areas (e.g., waste tanks, pump tanks, evaporator pots) and out of secondary containment sumps through core piping. The CSTF core piping consists of a variety of connected configurations. The term core pipe as used throughout this DBA includes all components that make up primary waste containment along the transfer path (e.g., core pipe, valves, jumpers, connectors, and other pressure retaining components).

Transfers typically have a secondary containment available to mitigate any primary containment releases. Most core piping is jacketed for secondary containment, but some sections of transfer lines may either be unjacketed (have no secondary containment at all) or have secondary containment provided by concrete encasements. Transfer systems details are provided in Section 2.4.4.

Transfers are categorized various ways (e.g., High-Rem transfers, Low-Rem transfers, Waste Transfers, Non-Waste Transfers) to assist in differentiating risk and to aide in control selection. The categories differ in various ways, such as transfer size and radiological content. High-Rem and Low-Rem transfers are defined in Section 3.4.1.5.1.

Certain activities are not considered to be waste transfers. These activities include, but are not limited to, removal of contaminated rainwater in-leakage from inactive locations. Transfers may be treated as non-waste transfers (i.e., do not have to be considered waste transfers) if the transfer stream can be demonstrated to meet the non-waste transfer criteria described in Section 3.4.1.5.1. Transfers to or from the CSTF have been evaluated against the receiving facility WAC or Safety Basis restrictions (Ref. 213, 314). Some waste streams have been shown not to be waste transfers nor require transfer controls (see exceptions for Tank 50 below). These waste streams include, but are not limited to, transfers from CSTF to the Saltstone Facility, transfers from Effluent Treatment Project (ETP) to Tank 50, transfers to Tank 50 with an inhalation dose potential less than or equal to Tank 50 Supernate (2.09E+05 rem/gal), and transfers of Evaporator Overheads to ETP.

For transfers from Tank 50 to the Saltstone Facility and transfers into Tank 50 (e.g., MCU to Tank 50), the Waste Tank Overflow scenario in this DBA was qualitatively judged to exceed the FW criteria in the immediate vicinity of the event. For this scenario, equipment to stop transfers is credited (this control is associated with transfer controls). However, for the remaining scenarios associated with transfer errors, no transfer controls were credited for transfers into and out of Tank 50 to the Saltstone Facility or transfers into Tank 50. Therefore, only those portions of the Transfer Control Program specified in this section apply to transfers into Tank 50, and those transfers need not be considered waste transfers.

During waste removal operations, waste may be inadvertently released as a result of other non-transfer operations (e.g., SMP operations). The SMP is used in waste tanks to suspend and mix waste. SMP system details are provided in Section 2.4.4.5 and Figure 3.7-2.

The Contingency Transfer System provides a means to remove accumulated waste from the annulus of a leaking waste tank and transfer the waste back to the primary side of the same waste tank. Each Contingency Transfer System is comprised of a portable submersible pump/motor

assembly, a portable generator, and associated support equipment. A flexible hose-in-hose transfer line is utilized to transfer the waste from the annulus to the vapor space of the leaking waste tank (through a tank top riser). Contingency Transfer System transfers shall have an inhalation dose potential less than or equal to 9.8E+07 rem/gal (see Section 3.4.1.5.2). In addition, siphon evaluations are not required for Contingency Transfer System transfers because the transfer will terminate in the vapor space of the primary waste tank. No potential for Waste Tank Overflow exists during a Contingency Transfer System transfer. Material balances are not required for Contingency Transfer System transfers.

3.4.2.9.1.2 Accident Initiators

A loss of primary containment or incorrect transfer of waste could result in a Transfer Error event or SMP Waste Release. Transfer Error/SMP Waste Release events encompass a broad range of activities that could lead to material release, including leaks, spills, sprays, and overflows. Table 3.3-17 identifies the HA events associated with Transfer Errors and SMP Waste Releases that have non-negligible risk. The events that evolve into Transfer Errors are, in many instances, the same initiators for explosion accidents. These explosion scenarios are covered in Sections 3.4.2.6, 3.4.2.7, 3.4.2.8, and 3.4.2.12. Releases into an evaporator cell due to an evaporator pot overflow, Evaporator System leak/break, or transfer jumper leak/break are covered in Section 3.4.2.3.

The secondary containments identified in the HA as potential Transfer Error/SMP Waste Release locations include waste tank annuli, DBs, VBs, drain VBs, PPs, catch tanks, HPFP, LDB Drain Cell, waste tank transfer pump/jet/SMP risers, transfer line jackets, transfer line encasements, LDBs, MLDBs, LPSs, and COPs. Some waste tank transfer pump/jet/SMP risers are open at the bottom or have large drains, which excludes them from being potential Transfer Error/SMP Waste Release locations. For these locations, a leak has been shown to not buildup and plug the drain holes. Siphoning/lifting/pump-outs of waste from the evaporator pot to an evaporator drop tank (with evaporator feed secured) is not considered a waste tank overflow initiator due to the evaporator pot maximum waste volume being less than 11,500 gallons (per Table 3.4-4). This maximum evaporator pot volume does not exceed the 15,000 gallons maximum missing waste volume. Flushwater VBs are considered an integral part of DBs and were not analyzed separately.

Process areas prohibited from being placed in a transfer path are stated in Section 3.4.1.5.2. Events that could lead to a Transfer Error in these areas were not analyzed since these process areas are isolated. A discussion of transfer path determination is provided in Section 5.4.2.

3.4.2.9.1.3 Unmitigated Accident Progression

For the purpose of this analysis, the Transfer Error/SMP Waste Release events are grouped into different scenarios. The different releases were analyzed assuming various leak rates and locations. The various scenarios (above-ground core pipe (including excavated pipes) release, SMP riser overflow, SMP column spill, SMP column spray, waste tank overflow, pump tank overflow, core pipe failure into a secondary containment (indoor spill or pressurized spray), and waste tank annulus spill due to core pipe failure) are discussed below. Refer to Figure 3.7-2 for the SMP accident scenarios.

Above-Ground Core Pipe Release

Initiators for an above-ground core pipe (including excavated pipes) release include corrosion (Microbiologically Induced Corrosion [MIC]), stress corrosion), water hammer, core pipe overpressurization (pump overspeed, line pluggage, closed valve), vehicle crash, crane and load impacts, siphon into non-contaminated system (during flushing, during hydro testing), operator error, material degradation (wall thinning, thermal stress, metal fatigue, ground vibration, IAL cathodic protection, brittle fracture, cycling), pushback into Flush Water System, external events (gas bottle missile, nearby fire/explosion), tornado/high wind, seismic, lightning, and contamination of non-contaminated system.

The general progression for all initiators, excluding the Tank 50 to Z-Area transfer line, is as follows:

- Above-ground core pipe (including excavated pipes) containment is lost
- Waste is released from above-ground core pipe (including excavated pipes) to the environment (outdoor spill)
- The release height is ≤ 3 meters
- The leak continues with up to 15,000 gallons of waste released
- Waste is made airborne as result of the outdoor free-fall spill
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 3 hours

The progression for the Tank 50 to Z-Area transfer line is as follows:

- Above-ground core pipe (including excavated pipes) containment is lost
- Waste is released from above-ground core pipe (including excavated pipes) to the environment (outdoor spill)
- The release height is ≤ 3 meters
- The leak continues for 8 hours, with up to 173,000 gallons of waste released
- Waste is made airborne as result of the outdoor free-fall spill
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 10 hours

SMP Riser Overflow

The SMP is deployed through a riser and extends above the waste tank top. Waste has the potential to be released from primary containment and overflow the SMP riser. Initiators for an SMP riser overflow include crane and load impacts, overpressurization, thermal stress, corrosion, water hammer, and seismic.

The general progression for SMP riser overflow is as follows:

- The SMP is operating
- Waste fills the flushwater piping
- Flush pipe inside SMP riser fails
- Waste overflows SMP riser and is released to the environment (outdoor spill)
- The release height is ≤ 3 meters
- The leak rate is ≤ 75 gpm (Ref. 209)
- Leak continues for up to 8 hours at the maximum leak rate (total spill size is approximately 36,000 gallons)
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 10 hours

SMP Column Spill

The SMP is deployed through a riser and extends above the waste tank top. Waste has the potential to be released from primary containment and spill from the column. The initiator for an above-ground spill from the SMP column is failure of the flush/motor pressure boundary. Possible causes for the boundary failure include vehicle crash, crane and load impacts, thermal stress, corrosion, water hammer, and seismic.

The general progression for the above-ground spill is as follows:

- SMP is operating
- SMP Flush/Motor pressure boundary fails, causing waste to enter the column and the column to pressurize
- Waste is released as spill from above-ground SMP column to the environment through cracks or joints in column
- The maximum release height is 25 feet
- The leak rate is ≤ 55 gpm, with the leak site being the column top based on the SMP design (Ref. 209)

- Leak continues for up to 8 hours at the maximum leak rate (total spill size is 26,400 gallons)
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 10 hours

SMP Column Spray

The SMP is deployed through a riser and extends above the waste tank top. Waste has the potential to be released from primary containment and spray from the column. The initiator for a spray from the SMP column is failure of the flush/motor pressure boundary. Possible causes for the boundary failure include vehicle crash, crane and load impacts, thermal stress, corrosion, water hammer, and seismic.

The general progression for the SMP column spray is as follows:

- SMP is operating
- SMP Flush/Motor pressure boundary fails, causing waste to enter the column and the column to pressurize
- Waste is released as spray from above-ground SMP column to the environment through cracks or joints in column
- The maximum release height is 25 feet
- The leak rate is 5.2 gpm (1.3 gpm pressurized spray, 3.9 gpm free-fall spill) (Ref. 60)
- Spray continues for up to 8 hours at the maximum leak rate
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 10 hours

Waste Tank Overflow

Initiators for a waste tank overflow are operator error, tornado/high wind, seismic, siphon into tank (from waste tank through the transfer system), limited liquid additions (e.g., flush water, CRW), and non-batch liquid addition (e.g., IW additions), and 242-16H Evaporator overheads receiver tanks overflow from a break in the evaporator overheads condenser. Initiators for a waste tank overflow involving siphons through the CRW System are covered in Section 3.4.2.15.

The general progression for all initiators is as follows:

- Waste is transferred into a waste tank
- Waste overflows the waste tank and is released to the environment (outdoor spill)
- The overflow continues, with up to 15,000 gallons of waste released (for Tank 50, the release is assumed to be followed by a liquid pool fire due to the potential presence of Isopar® L)
- Waste is made airborne for 8 hours as result of outdoor resuspension
- Workers in proximity of the spill are exposed to a shine dose
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 3 hours

Pump Tank Overflow

Initiators for a pump tank overflow are operator error, tornado/high wind, seismic (including II/I), siphon into a pump tank (from waste tank through the transfer system), and large liquid additions (e.g., flush water).

The general progression for all initiators is as follows:

- Waste is transferred into the pump tank
- Waste overflows the pump tank and is released to the PP (indoor spill)
- The overflow continues, with up to 15,000 gallons of waste released
- Waste is made airborne for one hour as result of the indoor free-fall spill
- Waste fills the PP, but does not overflow the PP (all PP volumes are greater than 15,000 gallons)
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 3 hours

Core Pipe Failure into a Secondary Containment (Indoor Spill or Pressurized Spray)

Initiators for a core pipe failure into a secondary containment are corrosion (MIC, stress corrosion), water hammer, crane and load impacts, missing jumper, siphon into non-contaminated system (during flushing, hydro testing), operator error, material degradation (wall thinning, thermal stress, metal fatigue, ground vibration, IAL cathodic protection, brittle fracture, cycling), pushback into Flush Water System, external events (gas bottle missile, nearby fire/explosion), tornado/high wind, seismic, lightning, PP flooding, and contamination of non-contaminated system.

The accident progression for core pipe failure into a secondary containment differs depending on whether the waste release is an indoor spill (with waste flowing into the secondary containment at a relatively high rate) or a pressurized leak into the secondary containment.

The general progression for indoor spill is as follows:

- Core pipe containment is lost
- Waste is released from the core pipe to a secondary containment
- The release continues, with up to 15,000 gallons of waste released
- The waste release is an indoor spill
- Waste is made airborne for one hour as result of the indoor free-fall spill
- Waste fills the secondary containment
- Waste overflows secondary containment (if box volume ≤ 15,000 gallons) and is released to the environment (outdoor spill)
- Waste is made airborne for 8 hours as result of indoor resuspension
- Waste is made airborne for 8 hours as result of outdoor resuspension (if box volume ≤ 15,000 gallons)
- Workers in proximity of the release are exposed to a shine dose (if box volume ≤ 15,000 gallons)
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 3 hours

The general progression for a pressurized spray, excluding the Tank 50 to Z-Area transfer line, is as follows:

- Core pipe containment is lost
- Waste is released from the core pipe to a secondary containment
- The release continues, with up to 1,872 gallons of waste released
- The leak rate is 5.2 gpm (1.3 gpm pressurized spray, 3.9 gpm free-fall spill) (Ref. 60)
- Waste is made airborne for 6 hours as result of the indoor free-fall spill
- Waste is made airborne for 6 hours as result of the pressurized venting
- Waste fills the secondary containment
- Waste overflows secondary containment (if box volume less than or equal to 1,872 gallons) and is released to the environment (outdoor spill)
- Waste is made airborne for 8 hours as result of indoor resuspension
- Waste is made airborne for 8 hours as result of outdoor resuspension (if box volume less than or equal to 1,872 gallons)

- Workers in proximity of the release are exposed to a shine dose (if box volume less than or equal to 1,872 gallons)
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 8 hours

The general progression for a pressurized spray for the Tank 50 to Z-Area transfer line is as follows:

- Core pipe containment is lost
- Waste is released from the core pipe to a secondary containment
- The release continues, with up to 2,496 gallons of waste released
- The leak rate is 5.2 gpm (1.3 gpm pressurized spray, 3.9 gpm free-fall spill) (Ref. 228)
- Waste is made airborne for 8 hours as result of the indoor free-fall spill
- Waste is made airborne for 8 hours as result of the pressurized venting
- Waste fills the secondary containment
- Waste overflows secondary containment (if box volume less than or equal to 2,496 gallons) and is released to the environment (outdoor spill)
- Waste is made airborne for 8 hours as result of indoor resuspension
- Waste is made airborne for 8 hours as result of outdoor resuspension (if box volume less than or equal to 2,496 gallons)
- Workers in proximity of the release are exposed to a shine dose (if box volume less than or equal to 2,496 gallons)
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 10 hours

Waste Tank Annulus Spill Due to Core Pipe Failure

Initiators for a waste tank annulus spill due to core pipe failure are corrosion (MIC, stress corrosion), water hammer, core pipe overpressurization, operator error, material degradation (wall thinning, thermal stress, metal fatigue, ground vibration, brittle fracture, cycling), and seismic.

The general progression for all initiators is as follows:

- Waste is being transferred through a core pipe traversing the waste tank annulus,
- Core pipe containment is lost,
- Waste is released from the core pipe into the waste tank annulus,

- The release continues, with up to 15,000 gallons of waste released,
- The waste release is an indoor spill,
- Waste is made airborne for one hour as result of the indoor free-fall spill,
- Waste is made airborne for 8 hours as result of indoor resuspension,
- Waste fills the annulus, but does not overflow the annulus (all annulus volumes are greater than 15,000 gallons,
- The Offsite exposure time for the release is 8 hours,
- The Onsite exposure time for the release is 3 hours.

3.4.2.9.1.4 Mitigated Accident Progression

The unmitigated consequences for Transfer Error events associated with Tank 50 to Z-Area transfers and receipt transfers into Tank 50 (from HDB-7 or ETP through the Tank 50 VB, MCU to Tank 50), hereafter referred to in this section as "Tank 50/MCU" transfers or analyses, do not challenge the Offsite or exceed the Onsite EGs, with the exception of the Waste Tank Overflow scenario. Therefore, mitigated analysis is only required for this scenario associated with Tank 50/MCU transfers.

The unmitigated consequences of some Transfer Error/SMP Waste Release events exceed the Onsite (but do not challenge the Offsite) EGs (as documented in Section 3.4.2.9.4). Because the EGs are exceeded, mitigated analysis is required. The mitigated accident progressions (and corresponding required controls) for the Transfer Error/SMP Waste Release events vary by the process area involved.

Above-Ground Core Pipe Release

For an above-ground core pipe (including excavated pipes) release during a High-Rem or Low-Rem transfer, two levels of control are required.

For all above-ground core pipe (including excavated pipes) release initiators, core pipe integrity and controls supporting containment integrity were chosen as the first level of control to prevent the event. The controls supporting core pipe containment integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and transfer controls (water hammer evaluations and pump speed evaluations). Additionally as a first level of control, the 242-16H Evaporator Feed Pump Backflow Prevention Devices provide containment of liquid waste to mitigate an above-ground radioactive material release or spill via the Flush Water System.

For High-Rem transfers, instrumentation to detect the release (i.e., ARM with control room notification) and equipment to stop the release were credited as the second level of control. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate

alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication).

For Low-Rem transfers, transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]) provide the second level of control.

SMP Riser Overflow

For an SMP Riser Overflow, two levels of control are required. The riser leak detection instrumentation (i.e., conductivity probe) interlocked to stop the SMP will serve as the first level of control to minimize the potential for riser overflow, unless the SMP riser is capable of free draining. If the SMP riser has been shown to be capable of free draining, the first level of control is the SMP riser drain (a passive design feature).

In either case, the waste tank SMP riser structure is required as part of the first level of control. The riser structure provides airborne waste confinement following a primary containment waste release into the riser, and also provides a containment function to support conductivity probe functionality or allows waste to drain back to the tank. Controls supporting the riser structure integrity are also required as the first level of control. The controls supporting riser structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

For the second level of control, instrumentation to detect the release (i.e., ARM with control room notification) and equipment to secure power to SMPs was credited. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication).

SMP Column Spill

For an SMP Column Spill, two levels of control are required. The SMP flush/motor pressure boundary was chosen as the first level of control to prevent a SMP column spill. The controls supporting pressure boundary integrity were also chosen as part of the first level of control. The controls supporting SMP flush/motor pressure boundary integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

For the second level of control, instrumentation to detect the release (i.e., ARM with control room notification) and equipment to secure power to SMPs was credited. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication).

SMP Column Spray

For an SMP Column Spray, two levels of control are required. The SMP flush/motor pressure boundary was chosen as the first level of control to prevent a SMP column spray. The controls supporting pressure boundary integrity were also chosen as part of the first level of control. The controls supporting SMP flush/motor pressure boundary integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

For the second level of control, instrumentation to detect the release (i.e., ARM with control room notification) and equipment to secure power to SMPs was credited. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication).

Waste Tank Overflow

For a waste tank overflow, two levels of control are required (except for Tank 50). Because only the FW in the immediate vicinity of the event was at risk during transfers into Tank 50, just one level of control is required. The first level of control will also serve as the single control during transfers into Tank 50.

For all waste tank overflow initiators, the first level of control is the waste tank High Liquid Level Conductivity Probe (HLLCP) to detect the tank level increase and equipment to stop the release (except as noted below). One of the HLLCP setpoint considerations (Tank Fill Limits Program) is to prevent tank overflow. The tank HLLCPs are set to alarm at least 15,000 gallons below the tank overflow level. The HLLCP instrumentation will alert operators to the event and allow for mitigation. Equipment to stop the release is also required as part of the first level of control for both waste or non-waste additions, except for:

- Batch transfers of less than 15,000 gallons (i.e., sending vessel is less than 15,000 gallons and does not have continuous makeup capability). The liquid source system shall be considered to have continuous makeup capability if the system has an automatic fill provision that is not electrically or mechanically isolated. The electrical or mechanical isolation shall contain two independent means of isolation (e.g., two isolation valves; one isolation valve and open disconnect for liquid source transfer pump). Liquid additions to the waste tank from the DWS do not have continuous makeup capability as described in Section 3.4.1.5.2.
- Siphons/lifts/pump-outs of the contents of an evaporator pot (assuming that evaporator feed pump is secured as required by the first level of control)
- Contingency Transfer System transfers

For the second level of control, the Transfer Control Program was chosen to prevent the event. This program will require pre-transfer verification of available tank space.

Waste tank overflow is considered not credible for Type I/II Chemical Cleaning Waste Tanks due to the following:

- Limited volume of waste (controls limit level to less than or equal to 63.8 inches for Type I and 64.8 inches for Type II)
- Liquid additions are limited (e.g., waste transfers from other waste tanks is prohibited), as discussed in Section 3.4.1.5.2
- A very large (greater than 100,000 gallons) undetected liquid addition (e.g., rainwater) would be required to initiate the event

Waste tank overflow is considered not credible for Closure Waste Tanks due to the following:

- Closure Waste Tanks are isolated (as discussed in Section 3.4.1.5.2) from waste transfers, CRW System (cooling coils and purge exhaust condenser), and Bearing Water System supply
- Liquid additions are limited, as discussed in Section 3.4.1.5.2
- A very large (greater than 100,000 gallons) undetected liquid addition (e.g., rainwater) would be required to initiate the event

Based on the above, no waste tank overflow controls are required for Type I/II Chemical Cleaning Waste Tanks, or Closure Waste Tanks.

Pump Tank Overflow

For a pump tank overflow, two levels of control are required. For pump tank overflows initiated by operator error, siphon into a pump tank, or large liquid addition, the first level of control includes the PP/pump tank active ventilation system with HEPA filter. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP structural integrity include HEPA filter efficiency testing controls (99.5% HEPA efficiency), critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

For the second level of control, the pump tank, instrumentation to detect the PP sump level increase (i.e., the PP sump conductivity probe), and equipment to stop the release is credited. The instrumentation will alert operators to the event and allow for mitigation. The controls supporting pump tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, connector installation controls, and tank top/secondary containment loading controls. The PP structure provides a liquid waste containment function to support conductivity probe functionality.

Core Pipe Failure into a Secondary Containment (Indoor Spill or Pressurized Spray)

For a core pipe failure into a secondary containment during a High-Rem transfer, two levels of control are required (Note: High-Rem waste transfers through the 241-96H VB are prohibited). For a core pipe failure into a secondary containment (except Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, Tank 51 Drain VB, HPFP, HDB-4, and HDB-5) during a Low-Rem transfer, two levels of control are required. Because only the FW in the immediate vicinity of the event was at risk during Low-Rem transfers into Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, Tank 51 Drain VB, HPFP, HDB-4, and HDB-5, just one level of control is required. The first level of control for High-Rem transfers will serve as the first level of control for Low-Rem transfers (except Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, Tank 51 Drain VB, HDB-4, and HDB-5). The first level of control for High-Rem transfers will also serve as the single control during Low-Rem transfers into Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, Tank 51 Drain VB, HPFP, HDB-4, and HDB-5.

Core pipe integrity and controls supporting core pipe integrity were chosen as the first level of control to prevent a core pipe failure into a secondary containment. The controls supporting core pipe integrity include (depending on the scenario) critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, and transfer controls (water hammer evaluations and pump speed evaluations).

The second level of control for High-Rem transfers through large secondary containments (greater than or equal to 15,000 gallons) is the secondary containment structure. The secondary containment structure provides containment of liquid waste and provides airborne waste confinement following a core pipe failure. The controls supporting secondary containment structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The PPs, large DBs (i.e., FDB-4, HDB-2, HDB-7, HDB-8), and the H-Area Catch Tank all have an available waste containment volume of over 15,000 gallons (For the H-Area Catch Tank, the encasements that lead to the catch tank were considered in determining the available waste containment volume). The second level of control for High-Rem transfers through small secondary containments (e.g., VBs, small DBs) is the secondary containment, the secondary containment leak detection instrumentation (i.e., conductivity probe), and equipment to stop the release. In the case of transfer pump/jet risers, leak detection instrumentation is not required if the riser is capable of free draining. For core pipe leaks that drain to the LDB Drain Cell, the credited leak detection is in the pathway to the LDB Drain Cell, not in the LDB Drain Cell. The instrumentation will alert operators to the event and allow for mitigation.

The second level of control for Low-Rem transfers through secondary containments (except Tank 21 VB, Tank 22 VB, Tank 40 Drain VB, Tank 51 Drain VB, HPFP, HDB-4, and HDB-5) is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]).

Waste Tank Annulus Spill Due to Core Pipe Failure

For a waste tank annulus spill due to core pipe failure, two levels of control are required. The first level of control for High-Rem transfers will also serve as the first level of control during Low-Rem transfers.

Core pipe integrity and controls supporting containment integrity were chosen as the first level of control to prevent a core pipe failure into a secondary containment. The controls supporting core pipe integrity and containment integrity include critical lift controls, structural integrity controls, corrosion controls, and transfer controls (water hammer evaluations and pump speed evaluations).

For Type I and Type II Waste Tanks during High-Rem transfers, the waste tank annulus structure, HEPA filter, and ductwork were credited as the second level of control to provide passive airborne waste confinement following a core pipe failure. If the ventilation system is operating (non-credited), Ventilation System Performance Monitoring is also credited to ensure that the HEPA filter is operating properly. For Type III/IIIA Waste Tanks, the second level of control during High-Rem transfers is the waste tank annulus leak detection instrumentation (i.e., conductivity probe) and equipment to stop the release. The instrumentation will alert operators to the event and allow for mitigation. The waste tank annulus structure also provides a liquid waste containment function to support conductivity probe functionality. The Waste Tank Annulus Ventilation System was not credited as a mitigative second level of control for Type III/IIIA Waste Tanks because the Type III/IIIA Waste Tank Annulus Ventilation System design could allow contamination to be purged unfiltered from the annulus.

For Type I, II, III/IIIA Waste Tanks during Low-Rem transfers, the second level of control is transfer controls (transfer monitoring and equipment to stop the release [e.g., transfer isolation devices]).

Waste tank annulus spill due to core pipe failure is not credible for Closure Waste Tanks since the tanks are isolated (as discussed in Section 3.4.1.5.2) from waste transfers. Therefore, no waste tank annulus spill controls are required for Closure Waste Tanks.

Waste tank annulus spill due to core pipe failure is not credible for Type I/II Chemical Cleaning Waste Tanks since waste transfers through a transfer line that traverses the annulus are prohibited (as discussed in Section 3.4.1.5.2). Therefore, no waste tank annulus spill controls are required for Type I/II Chemical Cleaning Waste Tanks.

3.4.2.9.2 FREQUENCY DETERMINATION

The HA classifies Transfer Error/SMP Waste Release events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.9.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.9.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Transfer Error STs and are all taken from References 60, 209, 228, and 242 unless otherwise stated:

- Secondary containments are closed (i.e., cell covers are in place, but small openings such as access or inspection ports may be open) when a waste transfer is in progress through the secondary containment. Secondary containments that have liquid drain/overflow communication (at equivalent level of less than 15,000 gallons) from the secondary containment involved with the waste transfer, shall also be closed (i.e., cell covers are in place, but small openings such as access or inspection ports may be open).
- The effective spill/splash height within a box is 3 meters or less. The spilling liquid is assumed to travel no more than 3 meters in the vertical direction before encountering an obstruction. Obstructions take the form of (1) equipment present in the box, (2) the side of the box when the spilling liquid undergoes sufficient horizontal displacement, or (3) the bottom of the box when the vertical distance from the point of release to the bottom is actually less than or equal 3 meters.
- The maximum spill/splash height for the SMP column spill scenario is 25 ft. Twenty-five feet represents the highest elevation above the waste tank riser such that the water connection manifold remains within the secondary containment provided by the riser.
- External water sources will be connected to the SMP only at (or below) the maximum pump speed of 500 revolutions per minute (rpm). The head developed by the pump at 500 rpm is insufficient to force waste out of the waste tank. Controls shall be established to ensure that if an external water source is connected to the SMP, that the SMP is operated at or below its maximum allowable speed. This speed (less than or equal to 500 rpm) shall be verified by manually reducing the speed at the VFD until the speed is at or below 500 rpm. This shall be independently verified prior to connecting an external water source to the pump. To ensure that the VFD speed is not modified during the time when the SMP is operating and the external water source is connected, an operator shall be stationed at the VFD. The primary role of this operator shall be verifying that the VFD speed is not altered. A lockable physical barrier may be installed which prevents VFD speed changes, in lieu of stationing an operator.

- The secondary containment conductivity probe setpoints assumed for mitigation are less than or equal to the initial waste (residual) values stated in Tables 3.4-1 and 3.4-3.
- For the above-ground leak of Evaporator Bottoms via the 242-16H Evaporator Flush Water System, the waste volume assumed is 480 gallons. This value is based on an assumed leak rate of one gpm through the backflow prevention devices over an 8-hour period.

3.4.2.9.3.2 Source Term Derivation

Unmitigated STs were derived for each of these cases using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The value of each of the terms is specific to the scenario being analyzed. The release mechanisms assumed also varied by scenario. The terms in the five-factor ST formula are discussed below, including discussion of scenario specific parameters.

Material at Risk

The MAR varies for the different Transfer Error/SMP Waste Release scenarios. The affected waste stream is assumed to be Bounding Sludge Slurry to determine the bounding ST for each scenario (except the above-ground radioactive material release or spill via the 242-16H Evaporator Flush Water System, which uses 242-16H Evaporator Bottoms, and Tank 50/MCU scenarios, which use Tank 50 Supernate). Consequences for other streams (e.g., Bounding Supernate) were calculated in Reference 60 to demonstrate the decrease in consequences relative to the MAR. The waste characteristics and inhalation dose potential on a per unit volume basis for the various streams is given in Section 3.4.1.5.1. The volume of waste involved for the different Transfer Error/SMP Waste Release scenarios is stated in the accident progressions.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

Different ARF and RF values were used for the various release mechanisms (Ref. 60, 228). The values are taken from Reference 14. The ARF/RF values used are:

- Free-Fall Spill ≤ 3 meters = 5.0E-05 / 0.8 (Indoor and Outdoor)
- Free-Fall Spill > 3 meters = Variable (calculated based on spill height)
- Pressurized Spray = 1.04E-04 / 1.0

The ARR and RF values used in the analysis are based on Reference 14. The ARR/RF values used are:

- For Indoor Resuspension (without ventilation) an ARR of 4.0E-08/hr and an RF of 1.0 was used
- For Indoor Resuspension (with ventilation) an ARR of 4.0E-07/hr and an RF of 1.0 was used
- For Outdoor Resuspension an ARR of 4.0E-06/hr and an RF of 1.0 was used

Leak Path Factor

For unmitigated calculations, the LPF is set equal to 1.0. For mitigated calculations, the LPF is applied based on whether or not the affected location has forced ventilation with HEPA filter. For locations that have forced ventilation, the LPF reflects a deposition of 1.0 and HEPA filtration of 99.5% for non-seismic scenarios. For locations without forced ventilation, atmospheric breathing rates are used for calculating the deposition LPF. The methodology for determining the LPF is documented in the LPF portion of Section 3.4.1.1.1.

3.4.2.9.3.3 Source Term Calculation

The basic ST methodology was applied to each scenario, with the ST formula applied separately for each of the four specific release mechanisms (free-fall spill, indoor resuspension, outdoor resuspension, pressurized venting). The Offsite and Onsite ST results for the different scenarios are documented in References 60 and 228.

3.4.2.9.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Transfer Error/SMP Waste Release events, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 60, 228, 255).

The unmitigated and mitigated Offsite consequences (≤ 0.43 rem) for the bounding Offsite Transfer Error scenario (above-ground pipe, including excavated pipes, break during a sludge slurry transfer) do not challenge the Offsite EGs (Ref. 60). The unmitigated and mitigated Offsite consequences (≤ 0.7 rem) for the bounding Offsite SMP Waste Release scenario (SMP Riser Overflow) do not challenge the Offsite EGs (Ref. 60). The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the above-ground release due to the 242-16H Evaporator Flush Water System pushback do not challenge the Offsite EGs (Ref. 60). The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding Tank 50 to Z-Area Transfer Error scenario do not challenge the Offsite EGs (Ref. 228).

The unmitigated Onsite consequences (> 100 rem) for the bounding Onsite Transfer Error/SMP Waste Release scenario (SMP Riser Overflow) exceed the Onsite EGs. The unmitigated and mitigated Onsite consequences (≤ 5 rem) for the above-ground release due to the 242-16H Evaporator Flush Water System pushback do not exceed the Onsite EGs (Ref. 60). The unmitigated and bounding mitigated Onsite consequences (≤ 23 rem) for the Tank 50 to Z-Area Transfer Error scenario do not exceed the Onsite EGs (Ref. 228, 255). The Onsite consequences

(≤ 13 rem) for the Onsite mitigated Transfer Error/SMP Waste Release scenario (pump tank overflow with sludge slurry transfer) do not exceed the Onsite EGs. The consequences of a Low-Rem Transfer Error would be less than 15% of the consequences of the bounding scenario, which assumed Bounding Sludge Slurry as the MAR. The unmitigated Onsite consequences (> 100 rem) for the bounding Low-Rem transfer error (above-ground transfer error with Low-Rem material) exceed the Onsite EGs. The mitigated Onsite consequences of a Low-Rem Transfer Error are zero since the event is prevented. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.9.5. The consequences of a Transfer Error/SMP Waste Release event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.9.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Transfer Error/SMP Waste Release event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Closure Waste Tanks.

3.4.2.9.5.1 Safety Significant Controls

242-16H Evaporator Feed Pump Backflow Prevention Devices: The 242-16H Evaporator Feed Pump Backflow Prevention Devices provide containment of liquid waste to mitigate an above-ground radioactive material release or spill via the Flush Water System.

Area Radiation Monitors: The ARMs provide control room notification of a primary containment waste release (applicable to above-ground core pipe, including excavation locations, during High-Rem transfers, and operating SMPs).

ARM Location Program: The ARM Location Program shall provide for proper placement of ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication) (applicable to above-ground core pipe, including excavation locations, during High-Rem transfers, and operating SMPs).

Diversion Box: The DB structure provides airborne waste confinement following a primary containment waste release into the DB. The DB structure for small (< 15,000 gallons) DBs also provide liquid waste containment to support conductivity probe functionality.

Diversion Box Conductivity Probes: The DB Conductivity Probes shall provide control room alarm following a primary containment waste release into the DB (applicable to small (< 15,000 gallons) DBs).

Equipment Needed to Stop Transfers, Siphons, SMP Operation, and Liquid Additions: The equipment needed to stop transfers, siphons, and liquid additions, and secure power to SMPs shall be available to respond to indications of a primary containment waste release, with the exception of batch transfers of less than 15,000 gallons (into waste tanks only), Contingency Transfer System transfers, and siphoning/lifting/pump-outs of the contents of an evaporator pot.

H-Area Catch Tank: The H-Area Catch Tank provides airborne waste confinement following a primary containment waste release. The H-Area Catch Tank also provides containment of liquid radioactive waste.

HDB-8 PVV System: The HDB-8 PVV System ensures that airborne releases within HDB-8 complex are mitigated via HEPA filtration.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions.

High Point Flush Pit: The HPFP structure provides airborne waste confinement following a primary containment waste release into the HPFP. The HPFP structure also provides liquid waste containment to support conductivity probe functionality.

High Point Flush Pit Conductivity Probe: The HPFP Conductivity Probe shall provide control alarm following a primary containment waste release into the HPFP.

LDB Drain Cell: The LDB Drain Cell structure provides airborne waste confinement following a primary containment waste release into the LDB Drain Cell.

Leak Detection Box, Modified Leak Detection Box, and Leak Probe Sleeve Conductivity Probes: The LDB, MLDB, and LPS Conductivity Probes shall provide control room alarm following a primary containment waste release. The HDB-8 LDBs and overflow lines use a common drain header leading to the HDB-8 and HPP-7 sumps. Since the sump conductivity probes are used to monitor for leakage into HDB-8 LDBs, the drain header must remain open and unplugged to ensure flow into the sumps.

Pump Pit: The PP structure provides airborne waste confinement following a primary containment waste release into the PP and supports ventilation system operation. The PP structure also provides liquid waste containment to support conductivity probe functionality.

Pump Pit Conductivity Probes: The PP Conductivity Probes shall provide control room alarm following a primary containment waste release into the PP.

Pump Pit/Pump Tank Active Ventilation System: The PP/Pump Tank Active Ventilation System ensures that airborne releases within the PP are mitigated via HEPA filtration.

Pump Tank: Pump Tank integrity shall ensure primary waste containment, airborne waste confinement, and support ventilation system operation.

SMP Flush/Motor Pressure Boundary: The SMP Flush/Motor Pressure Boundary prevents an SMP column release by preventing waste from entering the SMP column.

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to prevent waste tank overflow.

Transfer Control Program: Prior to initiation of a waste transfer, available tank space shall be verified.

Transfer Line Core Pipe: Transfer Line integrity (e.g., core pipe, valves, jumpers, connectors, and associated gaskets) shall ensure primary waste containment.

Transfer Line Jacket, Transfer Line Encasement, Leak Detection Box, Modified Leak Detection Box, and Leak Probe Sleeve: The Transfer Line Jacket, Transfer Line Encasement, LDB, MLDB, and LPS structures provides airborne waste confinement following a primary containment waste release. These structures also provide liquid waste containment to support conductivity probe functionality.

Type I and Type II Waste Tank Annulus: Type I and Type II Waste Tank Annulus structure (including ductwork up to and including HEPA filtration where installed) provides airborne waste confinement following a primary containment waste release into the annulus.

Type III and Type IIIA Waste Tank Annulus: The Type III and Type IIIA Waste Tank Annulus structure provides liquid waste containment to support conductivity probe functionality.

Type III and Type IIIA Waste Tank Annulus Conductivity Probes: The Type III and Type IIIA Waste Tank Annulus Conductivity Probes shall provide control room alarm following a primary containment waste release into the annulus.

Valve Box: The VB structure provides airborne waste confinement following a primary containment waste release into the VB. The VB structure also provides liquid waste containment to support conductivity probe functionality (includes Drain VBs).

Valve Box Conductivity Probes: The VB Conductivity Probes shall provide control room alarm following a primary containment waste release into the VB (includes Drain VBs).

Ventilation System Performance Monitoring: Ventilation System Performance Monitoring is required when HEPA filtration is credited as a control in an active ventilation system. Ventilation System Performance Monitoring shall ensure that the HEPA filter is operating properly, and capable of performing its credited function. Ventilation System Performance Monitoring checks the ventilation system and the downstream airborne activity periodically to ensure that HEPA filter plugging or breakthrough has not occurred. Monitoring of the downstream airborne activity is only required if the ventilation system condenser or reheater is not in service or is non-functional. Monitoring shall be performed prior to beginning the evolution to establish baseline conditions, and periodically thereafter. The required frequency of monitoring shall be adjusted based on the availability of equipment to remove moisture and condition the exhaust flow before passing through the HEPA filter.

Waste Tank Mixing Device Operation: Controls on SMP operation shall be established. These controls shall ensure that if an external water source is connected to the SMP, that the SMP is

operated at or below the maximum allowable pump speed of 500 rpm. This speed (less than or equal to 500 rpm) shall be verified by manually reducing the speed at the VFD until the speed is at or below 500 rpm. This shall be independently verified prior to connecting an external water source to the pump. To ensure that the VFD speed is not modified during the time when the SMP is operating and the external water source is connected, an operator shall be stationed at the VFD. The primary role of this operator shall be verifying that the VFD speed is not altered. A lockable physical barrier may be installed which prevents VFD speed changes, in lieu of stationing an operator.

Waste Tank Transfer Pump/Transfer Jet/SMP Riser: The Waste Tank Transfer Pump/Transfer Jet/SMP Riser structure provides airborne waste confinement following a primary containment waste release into the riser. The riser structure also provides liquid waste containment to support conductivity probe functionality. Some risers freely drain directly to the waste tank, precluding the need for riser leak detection capability.

Waste Tank Transfer Pump/Transfer Jet/SMP Riser Conductivity Probes: The Waste Tank Transfer Pump/Transfer Jet Riser Conductivity Probes shall provide control room alarm following a primary containment waste release into the riser. During SMP Operation, the Waste Tank/ SMP Riser Conductivity Probes shall be interlocked to shutdown the SMP following a primary containment waste release into the riser. (This control is not applicable to risers that have been shown to be free draining).

3.4.2.10 Aerosolization Events

3.4.2.10.1 SCENARIO DEVELOPMENT

3.4.2.10.1.1 Background

The amount of airborne material at any location containing liquid waste is related to the conditions of the waste (e.g., waste temperature, surface area, ventilation flow, and available vapor volume). In addition, anticipated normal operations and process upsets could disturb liquid waste and cause an increase in the airborne component of wastes in the CSTF. Some waste disturbances (e.g., normal waste transfers) can cause minor waste splashing but do not result in a significant increase in airborne material and are not considered accidents, as documented in the HA. Other intended and unintended waste disturbances (e.g., agitation, sparging, stripping, high pressure lancing operations at greater than 10,000 psi) could result in a more significant airborne material release due to increased splashing or spraying.

Various types of mixing and pumping devices are used to agitate waste inside of tanks and transfer waste from tank to tank. It is possible to generate aerosols as a result of pump failure, pump control failure, misalignment or mispositioning of the pump, or a break in the discharge path of a pump. Additionally, various equipment used to transfer and agitate the waste uses high-pressure steam and/or air sources. It is possible as a result of equipment malfunction or a break in a steam or air line that high-pressure steam or air will impinge on the liquid waste and generate aerosols.

3.4.2.10.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Aerosolization Events that have non-negligible risk.

3.4.2.10.1.3 Unmitigated Accident Progression

For the purpose of this analysis, the Aerosolization events are grouped into different scenarios. The different releases were analyzed assuming aerosolization causes and locations. Most of the Aerosolization events involve liquid jet impingement, steam jet impingement, or air jet impingement, which are primarily discussed in detail in Reference 157. Some of the HA events have both air and steam jets as potential aerosolization methods (e.g., air or steam sparging through the steam jet). These events are analyzed for both aerosolization mechanisms to ensure the bounding case is analyzed. The unmitigated accident progressions for the various scenarios are discussed below.

Pump Tank Aerosolization Due to Transfer Jet Failure

- Pump Tank transfer jet is in use
- Steam/air is introduced into the pump tank near the waste surface due to the jet discharge path being blocked (because of valve closure or salt pluggage) which causes steam/air to flow back through the suction leg
- Waste is aerosolized via steam/air jet impingement
- Suspended waste is released via ventilation system
- Steam/air is isolated to jet in 1 hour (2 hours post-seismic)

Pump Pit Sump Aerosolization Due to Steam Jet Failure

- The PP sump contains waste
- PP sump jet is in use
- Steam/air supply line to jet fails near the waste level (higher steam inlet pressure assumed for seismic case, due to failed regulators and relief valves)
- Waste is aerosolized via steam/air jet impingement
- Suspended waste is released via ventilation system
- Steam/air is isolated to jet in 1 hour (2 hours post-seismic)

Diversion Box Sump Aerosolization Due to Steam Jet Failure

- The DB sump contains waste

- DB sump jet is in use (applicable only to HDB-4, HDB-5, HDB-6, HDB-7, and HDB-8)
- Steam/air supply line to jet fails near the waste level (higher steam inlet pressure assumed for seismic case, due to failed regulators and relief valves)
- Waste is aerosolized via steam/air jet impingement
- Suspended waste is released via ventilation system (HDB-4 does not have an active purge ventilation system, HDB-5 does not have a ventilation system, release is through gaps in the cell covers)
- Steam/air is isolated to jet in 1 hour (2 hours post-seismic)

Waste Tank Aerosolization Due to Steam Jet Failure

- Waste Tank Transfer Jet is in use
- Steam/air is introduced into the waste tank near the waste surface due to either the jet discharge path being blocked (because of valve closure or salt pluggage) or due to the supply line to the jet having failed near the waste level (higher steam inlet pressure assumed for seismic case, due to failed regulators and relief valves)
- Waste is aerosolized via steam/air jet impingement
- Suspended waste is released via ventilation system
- Steam/air is isolated to jet in 2 hours (2 hours post-seismic)

Waste Tank Annulus Aerosolization Due to Steam Jet Failure

- The waste tank annulus contains waste
- Annulus Transfer Jet is in use
- Steam/air supply line to jet fails near the waste level (higher steam inlet pressure assumed for seismic case, due to failed regulators and relief valves)
- Waste is aerosolized via steam/air jet impingement
- Suspended waste is released via ventilation system
- Steam/air is isolated to jet in 1 hour (2 hours post-seismic)

Waste Tank Mixing Device Rooster Tailing

- Mixing device is in use
- Mixing device discharges above the waste level (for the SMP, both the flow discharge nozzles and motor cooling discharge nozzles are exposed)
- Waste is aerosolized via liquid jet impingement

- Suspended waste is released via ventilation system
- Event continues for 8 hours

Refer to Figure 3.7-2 for the SMP accident scenarios.

SMP Motor Cooling Discharge Nozzle Aerosolization

- SMP is in use
- SMP Motor Cooling Discharge Nozzles (weep holes) discharge above the waste level
- Waste is aerosolized via liquid jet impingement
- Suspended waste is released via ventilation system
- Event continues for 8 hours

Refer to Figure 3.7-2 for the SMP accident scenarios.

Pulse Tube Agitator Sparging Aerosolization

- Pulse Tube Agitator (PTA) is operating in FPT-1
- Unit remains in “Drive” too long and sparges waste
- Waste is aerosolized via air jet impingement
- Suspended waste is released via ventilation system
- Event continues for 8 hours

Pulse Tube Agitator Aspiration Aerosolization

- PTA is operating in FPT-1
- Unit remains in “Suction” too long and draws waste into the suction jet
- Waste is aerosolized via air jet impingement
- Suspended waste is released via ventilation system
- Event continues for 8 hours

Diaphragm Pump Aerosolization

- Diaphragm Pump is in use (maximum flow rate 150 gpm)
- Diaphragm Pump fails resulting in mixing of high pressure air and the pumped waste
- Waste is sparged via air jet impingement on the liquid

- After the liquid that is not aerosolized is introduced to the air chamber, it is pumped out the air exhaust line
- Waste is aerosolized via liquid jet impingement on the liquid
- Event continues until the maximum missing waste volume (15,000 gallons) is reached (1.67 hours)

Aerosolization in a Dry Sludge Tank

The following scenarios apply to dry sludge tanks and are only applicable to Closure Waste Tanks. A "dry sludge tank" is defined as a tank where there is no free-standing liquid. Peaks or mounds of sludge/salt that are above the liquid surface and sludge/salt that are exposed during waste removal operations are acceptable and shall not result in a waste tank being considered a "dry sludge tank."

One scenario considered is aerosolization of dry sludge by introduction of liquid to a tank containing dry sludge. Introduction of a liquid to a dry sludge tank introduces the possibility of exposing the assumed powder or aggregate surface of the dry sludge to aerodynamic forces that could result in resuspension and potential release of the powder/aggregate dry sludge material. This scenario was intended to address large liquid additions, in which the introduction of liquid was at a high enough velocity that it could create an area of turbulent air flow over the surface of the dry sludge. This type of large liquid addition scenario is not applicable to Closure Waste Tanks and was originally intended for rewetting activities associated with larger dry sludge volumes previously contained in some waste tanks at the CSTF. Small liquid additions (e.g., equipment flushes) are bounded by the "dropped object scenario" discussed later. Addition of liquid to Closure Waste Tanks (excluding cooling coil flushing/grouting) via the in-tank cooling coils is not credible since the tanks are isolated from the CRW System. In-tank cooling coil flushing/grouting that may be performed in Closure Waste Tanks are considered small liquid additions and are bounded by the "dropped object scenario".

Another scenario considered was the aerosolization potential due to inadvertent operation of the steam jet (primary or annulus) in a dry sludge tank. Addition of steam and air to Closure Waste Tanks via transfer jet is not credible since the primary and annulus transfer jet gang valve is isolated from the steam and air supply.

Another scenario of concern is aerosolization of dry sludge by dropping an object onto the surface of the dry sludge. This would be any event scenario in which an object (large enough and heavy enough) is dropped onto the dry sludge surface from a height such that the forces from the impact on the dry sludge are large enough to result in the suspension of some of the sludge material into the tank atmosphere. The size of the object dropped onto the sludge surface is limited by the fact that the object would have to be dropped through an open riser on the top of the waste tank.

3.4.2.10.1.4 Mitigated Accident Progression

The unmitigated consequences of some Aerosolization events exceed the Offsite and Onsite EGs (as documented in Section 3.4.2.10.4). Because the EGs are exceeded, mitigated analysis is required. The mitigated accident progressions (and corresponding required controls) for the Aerosolization events vary by process area involved.

For Closure Waste Tanks, the applicable Aerosolization events are precluded by the following:

- Air and steam to any waste tank primary or annulus jet are isolated (Waste Tank Aerosolization Due to Steam Jet Failure, Waste Tank Annulus Aerosolization Due to Steam Jet Failure, Aerosolization in a Dry Sludge Tank [Steam Jet Operation Scenario])
- Waste tank mixing device operation or column pressurization is prohibited as discussed in Section 3.4.1.5.2 (Waste Tank Mixing Device Rooster Tailing, SMP Motor Cooling Discharge Nozzle Aerosolization)
- Liquid additions are limited and the CRW System is isolated, as discussed in Section 3.4.1.5.2 (Aerosolization in a Dry Sludge Tank [Large Liquid Addition Scenario])

For Type I/II Chemical Cleaning Waste Tanks, the applicable Aerosolization events are precluded by the following:

- Air and steam to any waste tank primary or annulus jet are isolated (Waste Tank Aerosolization Due to Steam Jet Failure, Waste Tank Annulus Aerosolization Due to Steam Jet Failure)

Pump Tank Aerosolization Due to Transfer Jet Failure

This event is prevented by the Pump Tank Transfer Jet Control Program (isolating the transfer jet when not in use) and through the Transfer Control Program (steam jet flowpath controls) which is the first level of control. The Transfer Control Program requires independent verification of jet discharge path valve position and evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The jet discharge path valve position verification applies to any valve with the potential to block transfer jet flow (including 3-way valves) such that the transfer jet steam/air is not allowed to transfer waste from the tank (i.e., the steam/air is directed into the tank). The evaluation shall be performed for jet transfers out of the pump tank that has the potential for salt solids formation and will include the amount of time the transfer may be suspended before flushing is required. The PP structure, controls supporting PP confinement integrity, and PP/pump tank active ventilation with HEPA filter provide a mitigative second level of control. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Pump Pit Sump Aerosolization Due to Steam Jet Failure

This event is prevented through PP sump jet jumper integrity (there are no discharge valves to isolate) and controls supporting PP sump jet jumper integrity. The controls supporting PP sump jet jumper integrity include critical lift controls, structural integrity controls, corrosion controls, and connector installation controls. The PP structure, controls supporting PP confinement integrity, and PP/pump tank active ventilation with HEPA filter provide a mitigative second level of control. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Diversion Box Sump Aerosolization Due to Steam Jet Failure

This event is prevented through DB sump jet jumper integrity (applicable only to HDB-4, HDB-5, HDB-6, HDB-7, and HDB-8) and controls supporting DB sump jet jumper integrity. The controls supporting DB sump jet jumper integrity include critical lift controls, structural integrity controls, corrosion controls, and connector installation controls. The DB structure, controls supporting DB confinement integrity, and active ventilation with HEPA filter provide a mitigative second level of control. The DB structure also supports ventilation system operation. Not all DBs with sump jets have a ventilation system. HDB-4 only has a passive HEPA filter vent and will credit only the filter, vent piping, and DB confinement. HDB-5 has no ventilation system and will credit only the DB confinement. The controls supporting DB confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Waste Tank Aerosolization Due to Steam Jet Failure

This event is prevented through transfer jet and piping integrity inside Type I, II, III, IIIA and IV Waste Tanks, the controls supporting transfer jet and piping integrity, and through the Transfer Control Program. The controls supporting piping integrity include critical lift controls, structural integrity controls, corrosion controls, and transfer controls (water hammer evaluations). The Transfer Control Program requires independent verification of jet discharge path valve position and evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The jet discharge path valve position verification applies to any valve with the potential to block transfer jet flow (including 3-way valves) such that the transfer jet steam/air is not allowed to transfer waste from the tank (i.e., the steam/air is directed into the tank). The evaluation shall be performed for jet transfers out of a salt tank and will include the amount of time the transfer may be suspended before flushing is required. The waste tank confinement, controls supporting waste tank confinement integrity, and active ventilation with HEPA filter provide a mitigative second level of control for Type I, II, III, IIIA and IV Waste Tanks. The waste tank structure also supports ventilation system operation. The controls supporting waste

tank confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Waste Tank Annulus Aerosolization Due to Steam Jet Failure

This event is prevented through annulus jet and piping integrity and controls supporting annulus jet and piping integrity. The controls supporting annulus jet and piping integrity include critical lift controls, structural integrity controls, corrosion controls, and transfer controls (water hammer evaluations). The second level of control is mitigation via the waste tank annulus confinement, controls supporting waste tank annulus confinement integrity, and the Transfers From Waste Tank Annuli Program, which will ensure that negative pressure HEPA filtered ventilation is in place prior to waste transfers out of the tank annulus via a jetted transfer (steam or air). The controls supporting annulus confinement integrity include critical lift controls, structural integrity controls, corrosion controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Waste Tank Mixing Device Rooster Tailing

SMP operation in a Type IV Waste Tank has not been analyzed for seismic effects. Therefore, SMP operation is prohibited in a Type IV Waste Tank. For Type I, II, III, IIIA, and IV Waste Tanks, the Waste Tank Mixing Device Operation Program prevents waste aerosolization during waste tank mixing device operation. The waste tank confinement, controls supporting waste tank confinement integrity, and waste tank active ventilation with HEPA filter provide a mitigative second level of control. The waste tank structure also supports ventilation system operation. The controls supporting waste tank confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

SMP Motor Cooling Discharge Nozzle Aerosolization

SMP operation in a Type IV Waste Tank has not been analyzed for seismic effects. Therefore, SMP operation is prohibited in a Type IV Waste Tank. For Type I, II, III, and IIIA Waste Tanks, the waste tank confinement, controls supporting waste tank confinement integrity, and waste tank active ventilation with HEPA filter provide the first level of control. The waste tank structure also supports ventilation system operation. The controls supporting waste tank confinement integrity include HEPA filter efficiency testing controls (99.5% HEPA efficiency), critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly. Instrumentation to detect

the release (i.e., ARM with control room notification) and equipment to stop the release were credited as the second level of control. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication).

Pulse Tube Agitator Sparging Aerosolization

The FPT-1 PTA Liquid Level Interlock prevents this event by ensuring a minimum liquid cover over the potential sparging location. The suction pipe is not assumed to leak; therefore, all sparging would be out the discharge nozzle, which is at the bottom of the pipe, making the liquid level an effective control. The PP structure, controls supporting PP confinement integrity, and PP/pump tank active ventilation system with HEPA filter provide a mitigative second level of control. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Pulse Tube Agitator Aspiration Aerosolization

The PTA Air Supply PRVs (suction side) are set at 58 psig or less to prevent this event and provide a first level of control. The PP structure, controls supporting PP confinement integrity, and PP/pump tank active ventilation system with HEPA filter provides a mitigative second level of control. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Diaphragm Pump Aerosolization

The unmitigated consequences of the Diaphragm Pump Aerosolization event do not challenge the Offsite EGs. The unmitigated consequences of the Diaphragm Pump Aerosolization event exceed the Onsite EGs. This event is mitigated by prohibiting the use of a diaphragm pump for High-Rem transfers.

Aerosolization in a Dry Sludge Tank (Dropped Object Scenario)

The unmitigated consequences of the Dropped Object in a Dry Sludge Tank Aerosolization scenario (Closure Waste Tanks) do not challenge the Offsite or exceed the Onsite EGs.

3.4.2.10.2 FREQUENCY DETERMINATION

The HA classifies Aerosolization events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.10.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.10.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Aerosolization event STs. Inputs and assumptions associated with Dry Sludge Tank Aerosolization scenarios apply only when the tank is considered a "dry sludge tank." The inputs and assumptions are all taken from References 157, 242, and 263 unless otherwise stated.

- Dropped object size for Type I Closure Waste Tanks is 23 inches (Ref. 263).
- Dropped object size for Type II Closure Waste Tanks is 25 inches (Ref. 263).
- Dropped object size for Type IV Closure Waste Tanks is 39 inches (Ref. 263).
- Dropped object height for Type I Closure Waste Tanks is 38 feet (Ref. 263).
- Dropped object height for Type II Closure Waste Tanks is 32 feet (Ref. 263).
- Dropped object height for Type IV Closure Waste Tanks is 53 feet (Ref. 263).
- Steam or air jet sparging can only occur in DBs and PPs that have installed steam jets (Ref. 157). PPs FPP-1 and HPP-1 and DBs FDB-1, FDB-2, FDB-3, FDB-4, FDB-5, FDB-6, HDB-2, and HDB-3 either have a pump or drain for removing residual liquid waste from their sumps. Therefore, these structures do not have steam jets.
- The air discharge line for the PTA consists of a straight line of pipe with an internal diameter of 0.46 inches and a length of 2.69 inches, with two entrance and two exit losses (Ref. 157).
- The thermal energy transfer from the steam to the liquid waste is not included separately in steam jet aerosolization. The overheating events are described elsewhere (Section 3.4.2.13). Adding these two events together would produce higher doses, but would be overly conservative since it would result in double counting some of the energy. The aerosolization scenario uses an entrainment model, which essentially assumes the steam jet blows through the liquid, carrying the droplets formed with the jet. It is not a sparging scenario where significant heat is transferred from the steam to the liquid. In aerosolization, steam interaction with the liquid waste is mechanical (i.e., kinetic energy transfer). As modeled, only about

33 BTU/pound mass (lbm) is available as thermal energy and for subsequent heat up of the waste. However, some of this energy is used in the head loss in the piping, leaving an estimated 22 BTU/lbm of energy actually available to heat up the vapor, tank walls, or liquid waste, which could result in a maximum dose increase of approximately 20%. However, the conservatism used in the analysis more than compensate for not including this energy transfer term in the aerosolization model. In particular, the calculation (Ref. 157) assumes particles created, which are less than or equal to 20 µm are respirable (normally consider particles are less than or equal to 10 µm are respirable) to account for potential evaporation of the particles during transport through the air. Additionally, the calculation uses the efficiency of entraining 50 µm particles to ensure all particles ≤ 20 µm are modeled as being entrained. The entrainment efficiency of 50 µm particles is a factor of approximately 40 higher than the entrainment efficiency of 20 µm particles and a factor of > 500 than the entrainment efficiency of 10 µm particles. Given these two and the other areas of conservatism in the analysis, it would be overly restrictive and result in unrealistic results to double count the energy by adding the two phenomena together.

3.4.2.10.3.2 Source Term Derivation

Unmitigated STs were derived for each of these scenarios using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The value of each of the terms is specific to the scenario being analyzed. The release mechanisms assumed also varied by scenario (Ref. 157, 263).

Material at Risk

The MAR varies for the different aerosolization scenarios as described below:

- The MAR for the aerosolization from steam/air jet scenarios in a waste tank is Bounding Sludge Slurry or Slurried Type IV Tank Waste, as determined by the waste tank type
- The MAR for the aerosolization from steam/air jet scenarios in a waste tank annulus is Bounding Supernate
- The MAR for the aerosolization from a mixing device operation/malfunction in a waste tank is Bounding Sludge Slurry or Slurried Type IV Tank Waste, as determined by the waste tank type
- The MAR for the aerosolization from SMP Motor Cooling Discharge Nozzle Aerosolization is Bounding Sludge Slurry
- The MAR for the aerosolization from steam/air jet scenarios in a pump tank, PP, or DB is Bounding Sludge Slurry
- The MAR for the aerosolization from a diaphragm pump failure scenario is Bounding Sludge Slurry
- The MAR for the aerosolization/sparging due to the PTA is Bounding Sludge Slurry

- The MAR for the Dropped Object in a Dry Sludge Tank Aerosolization scenarios (Closure Waste Tanks) is Type I/II Tank Sludge Solids or Type IV Tank Sludge Solids

The waste characteristics and inhalation dose potential on a per unit volume basis for these streams are given in Section 3.4.1.5.1.

For the Dropped Object in a Dry Sludge Tank Aerosolization scenario for Closure Waste Tanks, the waste inventory associated with a 12-inch mound and applicable area of influence (dependent on tank type) is included as the MAR. This scenario is assumed to affect the solid aggregate layer (dried sludge) of the dry sludge.

The inputs (e.g., dropped object height/size, mound size) used for determining the consequences for the Dropped Object in a Dry Sludge Tank Aerosolization scenario for Closure Waste Tanks may not reflect the maximum values on an individual input basis that could occur for this scenario. However, the combined aspects of these inputs provide a reasonably conservative consequence for this scenario.

The volume of waste involved in the other aerosolization scenarios varies, but is not ST limiting (e.g., the ST is limited by the duration of the event only, since waste material is assumed available for release during the entire event).

Damage Ratio

The DR for the case of impact by falling object for Closure Waste Tanks is set to 1.0 since the assumed waste material mound area is the same size as the area of influence by the falling object.

The DR is assumed to be one for all other (non-dry sludge) aerosolization scenarios.

Airborne Release Fraction/Respirable Fraction

Different ARF and RF values were used for the various aerosolization scenarios.

Liquid Jet Aerosolization Scenarios

Reference 14 provides estimates of the bounding ARF and RF for the venting of pressurized liquid below the liquid surface. However, the values in Reference 14 are based on experiments using a commercial spray nozzle that is designed to produce small droplets and under flow conditions that are not comparable to the conditions that would be present in the scenarios analyzed here. Therefore, the ARF and RF from Reference 14 for the venting of pressurized liquid is not considered to appropriately model the situation under consideration in this analysis.

Reference 157 determined the aerosol production rate per gallon of liquid in a jet for the soluble and insoluble radionuclides. These aerosol production rates are effectively the ARFs for the production of soluble and insoluble dry aerosols. These values are used for the mixing device liquid jet aerosolization scenarios. The ARFs for the mixing device aerosolization scenarios are

3.91E-03 mg/gal for soluble radionuclides in the slurry and 3.58 mg/gal for insoluble radionuclides for Bounding Sludge Slurry. For Slurried Type IV Tank Waste, the values are 1.02E-05 mg/gal for soluble radionuclides in the slurry and 1.19 mg/gal for insoluble radionuclides. The RF for all cases is 0.4.

Steam/Air Jet Aerosolization Scenarios

The accident stressor that has the potential to generate respirable aerosols of radioactive material in the steam/air jet aerosolization scenarios is related to the interaction of a high-pressure steam/air jet with a liquid. There are no applicable values for this accident stress in Reference 14. Therefore, a specific model is developed to determine the ARR and RF for steam/air jet impingement on the liquid waste.

The aerosolization process involved in steam/air jet impingement on liquid can be thought of as an entrainment process. Liquid droplets are entrained in the steam/air flow by the interaction of the steam/air jet with the liquid surface. The interaction of the steam/air jet with the liquid will transfer energy from the kinetic energy of the steam/air jet to the liquid. The kinetic energy transferred from the steam/air jet to the liquid is utilized in the formation of droplets of the liquid. Since the energy of small spherical droplets is equal to the surface energy, and the surface energy is the product of the surface area of the droplet and the surface tension of the liquid, the amount of kinetic energy transferred from the steam/air jet to the liquid will appear as an increase in the surface area of droplets. For a given droplet diameter, the increase in surface area can be used to determine the volume and mass of droplets generated. The mass of droplets of a given size generated per unit mass flow of the steam/air is defined as the entrainment ratio. Therefore, the entrainment ratio is essentially the ARR x RF for a steam/air jet impingement scenario.

The mass flowrate is used to determine the ARR x RF. The location of the steam/air jet and the liquid with which it interacts do not impact the mass flowrate. Only the physical properties of the steam/air system and the steam/air line have an impact. The ARR/RF values are calculated in Reference 157 for the various steam/air jet aerosolization scenarios.

Dry Sludge Scenarios (Closure Waste Tanks)

As discussed earlier, there is one accident scenario and its related induced stresses considered for dry sludge Closure Waste Tanks. The accident scenario, impact by a falling object, occurs as a result of the event scenario of dropping an object on the dry sludge surface. This scenario is assumed to affect a solid aggregate layer (dried sludge) of the dry sludge. For this scenario, Reference 263 specified ARF and RF values that are applicable to the specific event scenario and accident stresses, as discussed below.

ARF and RF Values for Aggregate Solids

Brittle materials (e.g., glass, aggregate such as mechanically compacted UO_2, concrete, limestone) can be fragmented when impacted or crushed. The dry sludge is assumed to behave as an aggregate. Therefore, it is susceptible to fragmentation from impact. Reference 14 documents an empirical correlation based on experimental data for the respirable ARF due to

impact of a hard object on a hard, unyielding surface. Note that implicit in this correlation is the assumption that the object being dropped onto the surface is at least as hard (i.e., dense) as the surface material being impacted. The correlation is intended to be an indicator of the energy density imparted into the material by the falling object. This correlation is:

$$ARF \times RF = A \times \rho \times g \times h$$

Where:

A = empirical correlation, 2E-11 cm^3 per g-cm^2 /s^2

ρ = specimen density, g/cm^3

g = gravitational acceleration, 980 cm/s^2 at sea level

h = fall height, cm

Reference 14 notes that use of this correlation to estimate the ARF × RF value is considered very conservative, and may be excessively so if large debris from substantial heights is considered. This conservatism is due to various factors including the fact that the majority of the particles generated due to fragmentation of the material by impact will be too large to become airborne or be respirable. However, in this case, relatively small objects are considered as potential objects dropped onto the dry sludge surface so the conservatism in the correlation should not be excessive.

Leak Path Factor

The LPF is a measure of how much of the respirable airborne material is released to the atmosphere. There are physical removal processes that occur that will remove some of the airborne material from the air stream. A principal process for particulate removal is deposition. Since deposition is an aerosol removal process that does not depend on any engineered features other than the physical presence of the structure into which the aerosol is released, it may be credited in the unmitigated analysis. A simplified model for estimating the amount of particulate removed due to deposition is provided in References 159 and 263. The model determines the LPF as a function of the deposition velocity of the aerosol, the air exchange rate of the area into which the aerosol is released, and the volume and surface area of the area into which the aerosol is released. The formula from References 159 and 263 for the LPF due to deposition is provided in Section 3.4.1.1.1.5. Using the physical parameters (given as ST inputs), a deposition LPF for each location can be determined. The calculation of the deposition LPF for the waste tanks is documented in References 157 and 263. HEPA efficiencies are 99.5% for selected aerosolization scenarios (Ref. 157). All other unmitigated LPFs are assumed to be 1.0.

3.4.2.10.3.3 <u>Source Term Calculation</u>

The basic ST methodology was applied to each scenario. The unmitigated and mitigated ST calculations for the dry sludge tank aerosolization scenarios are documented in Reference 263.

The unmitigated and mitigated ST calculations for the other aerosolization scenarios are documented in Reference 157.

3.4.2.10.4 CONSEQUENCE ANALYSIS

3.4.2.10.4.1 Consequences by Aerosolization Scenario

The unmitigated and mitigated consequences for the Dry Sludge Tank Aerosolization events are documented in Reference 263. The unmitigated consequences for other Aerosolization events are documented in Reference 157. The seismic and non-seismic scenario consequences given below are based on the applicable assumed conditions (e.g., 370-psig steam for the seismic Aerosolization events, 171-psig steam for the non-seismic Aerosolization events). The individual scenario consequences are as follows:

Pump Tank Aerosolization Due to Transfer Jet Failure

The unmitigated Offsite consequences of this event (≤ 9.9 rem) do not challenge the Offsite EGs. The mitigated Offsite consequences of this event are zero since this event is prevented.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs. The mitigated Onsite consequences of this event are zero since this event is prevented.

Pump Pit Sump Aerosolization Due to Steam Jet Failure

The unmitigated Offsite consequences of this event (> 25 rem) exceed the Offsite EGs for both the seismic and non-seismic cases. The mitigated Offsite consequences of this event are zero since this event is prevented.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for both the seismic and non-seismic cases. The mitigated Onsite consequences of this event are zero since this event is prevented.

Diversion Box Sump Aerosolization Due to Steam Jet Failure

The unmitigated Offsite consequences of this event (≤ 15.3 rem) do not challenge the Offsite EGs for the non-seismic case. The unmitigated Offsite consequences of this event (> 25 rem) exceed Offsite EGs for the seismic case. The mitigated Offsite consequences of this event are zero since this event is prevented.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for both the seismic and non-seismic cases. The mitigated Onsite consequences of this event are zero since this event is prevented.

Waste Tank Aerosolization Due to Steam Jet Failure

For Type I, II, III, IIIA Waste Tanks, the unmitigated Offsite consequences of this event are ≤ 23 rem for the non-seismic case and > 25 rem for the seismic case. These consequences challenge or exceed the Offsite EGs. For Type IV Waste Tanks, the unmitigated Offsite consequences of this event (≤ 0.4 rem) do not challenge the Offsite EGs in either the seismic or non-seismic cases. The mitigated Offsite consequences of this event in Type I, II, III, IIIA, and IV Waste Tanks are zero since this event is prevented.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for both the seismic and non-seismic cases. The mitigated Onsite consequences of this event are zero since this event is prevented.

Waste Tank Annulus Aerosolization Due to Steam Jet Failure

The unmitigated Offsite consequences of this event (≤ 5 rem) do not challenge the Offsite EGs in any waste tank for either the non-seismic or seismic case. The mitigated Offsite consequences of this event are zero since this event is prevented.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for both the seismic and non-seismic cases. The mitigated Onsite consequences of this event are zero since this event is prevented.

Waste Tank Mixing Device Rooster Tailing

The unmitigated Offsite consequences of this event (≤ 5 rem for four SMPs with flow discharge nozzles and motor cooling discharge nozzles exposed, ≤ 3.7 rem for four quad-volute slurry pumps) do not challenge the Offsite EGs in any waste tank. The Offsite consequences (unmitigated and mitigated) for slurry pumps that are not quad-volute (e.g., standard, single nozzle) and CSMPs are bounded by the consequences for the quad-volute slurry pumps.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for Type I, II, III, IIIA, and IV Waste Tanks. The mitigated Onsite consequences of this event in Type I, II, III, IIIA, and IV Waste Tanks are zero because this event is prevented.

SMP Motor Cooling Discharge Nozzle Aerosolization

The unmitigated Offsite consequences of this event (≤ 0.1 rem for four SMPs) do not challenge the Offsite EGs in any waste tank.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs for Type I, II, III, and IIIA Waste Tanks. The mitigated Onsite consequences of the bounding SMP Motor Cooling Discharge Nozzle Aerosolization (Type I Waste Tank) are ≤ 10.5 rem.

Pulse Tube Agitator Sparging Aerosolization

The unmitigated Offsite consequences of this event (≤ 8.3 rem) do not challenge the Offsite EGs.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs. The mitigated Onsite consequences of this event are zero since this event is prevented.

Pulse Tube Agitator Aspiration Aerosolization

The unmitigated Offsite consequences of this event (≤ 1.6 rem) do not challenge the Offsite EGs.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs. The mitigated Onsite consequences of this event are zero since this event is prevented.

Diaphragm Pump Aerosolization

The unmitigated Offsite consequences of this event (≤ 0.1 rem) do not challenge the Offsite EGs.

The unmitigated Onsite consequences of this event (> 100 rem) are above the Onsite EGs. The mitigated Onsite consequences of this event (≤ 70 rem) do not exceed the Onsite EGs.

Aerosolization in a Dry Sludge Tank (Dropped Object Scenario)

The unmitigated Offsite consequences of this event (≤ 0.01 rem) do not challenge the Offsite EGs.

The unmitigated Onsite consequences of this event (≤ 6 rem for Closure Waste Tanks) do not exceed the Onsite EGs.

3.4.2.10.4.2 Consequence Summary

The unmitigated and mitigated consequences of the bounding Aerosolization event are given in Table 3.4-7 (Ref. 157, 255, 263).

The unmitigated Offsite consequences (> 25 rem) of the bounding Aerosolization scenario (Pump Pit Sump Aerosolization Due to Steam Jet Failure) exceed the Offsite EGs. The mitigated Offsite consequences (≤ 8.3 rem) of the bounding Aerosolization scenario (Pulse Tube Agitator Sparging Aerosolization) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding Onsite aerosolization scenarios (Pump Pit Sump Aerosolization Due to Steam Jet Failure) exceed the Onsite EGs. The mitigated Onsite consequences (≤ 70 rem) of the bounding Aerosolization scenario (Diaphragm Pump Aerosolization) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to standard design practices for transfer

system configuration, site radiological programs, Emergency Response Program, waste tank structure/location, and the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.10.5. The consequences of an Aerosolization event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.10.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of an Aerosolization event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Closure Waste Tanks.

3.4.2.10.5.1 Safety Class Controls

Diversion Box Sump Steam Jet: DB Sump Steam Jet integrity shall provide air/steam containment to prevent waste aerosolization (applicable only to HDB-4, HDB-5, HDB-6, HDB-7, and HDB-8).

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Pump Pit Sump Steam Jet: PP Sump Steam Jet integrity shall provide air/steam containment to prevent waste aerosolization.

Pump Tank Transfer Jet Control Program: Pump Tank Transfer Jets shall be manually isolated from steam and air while not in use to prevent Aerosolization events.

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Transfer Control Program: To prevent Aerosolization events, the Transfer Control Program shall require independent verification of jet discharge path valve position. The Transfer Control Program shall also require evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The evaluation shall be performed for jet transfers out of a salt tank and will include the amount of time that the transfer may be suspended before flushing is required.

Waste Tank Annulus Jet and Piping: The transfer jet and piping integrity in Type I, Type II, Type III, and Type IIIA Waste Tank annuli shall provide air/steam containment to prevent waste aerosolization.

Waste Tank Transfer Jet and Piping: The primary transfer jet and piping integrity in Type I, Type II, Type III, Type IIIA, and Type IV Waste Tanks shall provide air/steam containment to prevent waste aerosolization.

3.4.2.10.5.2 Safety Significant Controls

Area Radiation Monitors: The ARMs provide control room notification of a primary containment waste release (applicable to SMP Operation).

ARM Location Program: The ARM Location Program shall provide for proper placement of ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication) (applicable to SMP Operation).

Diversion Box: The DB structure (including HEPA filtration) provides airborne waste confinement following waste aerosolization in the DB and supports ventilation system operation. The HDB-4 structure includes the Passive Vent path up to and including the HEPA filter. (applicable to HDB-4, HDB-5, HDB-6, HDB-7, and HDB-8) (Note: HDB-5 does not have a HEPA filter).

Diversion Box Active Ventilation System: The DB Active Ventilation System ensures that airborne releases within the DB are mitigated via HEPA filtration. (applicable to HDB-6 and HDB-7.)

Equipment Needed to Secure Power to SMPs: The equipment needed to secure power to SMPs shall be available to respond to indications of a primary containment release and limit waste releases.

FPT-1 PTA Liquid Level Interlock: The FPT-1 PTA Liquid Level Interlock shall ensure a minimum liquid cover over the potential sparging location to prevent waste aerosolization during PTA operation.

HDB-8 PVV System: The HDB-8 PVV System ensures that airborne releases within HDB-8 complex are mitigated via HEPA filtration.

PTA Air Supply Pressure Relief Valves: The PTA Air Supply PRVs (suction side) shall prevent waste aerosolization by limiting pressure to less than 58 psig during PTA operation.

Pump Pit: The PP structure (including HEPA filtration) provides airborne waste confinement following waste aerosolization in the PP and supports ventilation system operation.

Pump Pit/Pump Tank Active Ventilation System: The PP/Pump Tank Active Ventilation System ensures that airborne releases within the PP are mitigated via HEPA filtration.

Pump Tank: Pump Tank integrity supports ventilation system operation.

Transfers From Waste Tank Annuli Program: Procedures shall be established governing waste transfers out of the waste tank annulus, including verification that a negative pressure ventilation

system with HEPA filter shall be installed and operating prior to transferring waste from a waste tank annulus via a jetted transfer (steam or air).

Ventilation System Performance Monitoring: Ventilation System Performance Monitoring is required when HEPA filtration is credited as a control in an active ventilation system. Ventilation System Performance Monitoring shall ensure that the HEPA filter is operating properly, and capable of performing its credited function. Ventilation System Performance Monitoring checks the ventilation system and the downstream airborne activity periodically to ensure that HEPA filter plugging or breakthrough has not occurred. Monitoring of the downstream airborne activity is only required if the ventilation system condenser or reheater is not in service or is non-functional. Monitoring shall be performed prior to beginning the evolution to establish baseline conditions, and periodically thereafter. The required frequency of monitoring shall be adjusted based on the availability of equipment to remove moisture and condition the exhaust flow before passing through the HEPA filter.

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank structure (including HEPA filtration) provides airborne waste confinement following waste aerosolization in the waste tank and supports ventilation system operation.

Waste Tank Annulus: The Type I, Type II, Type III, and Type IIIA Waste Tank Annulus structure provides airborne waste confinement following waste aerosolization in the annulus.

Waste Tank Mixing Device Operation: Waste Tank Mixing Devices Operation in Type I, II, III, IIIA, and IV Waste Tanks shall be controlled such that the waste tank mixing device discharge is sufficiently below the waste surface to prevent a waste aerosolization accident during these activities. As a minimum, this program shall account for the maximum allowable speed of the waste tank mixing device versus waste tank mixing device submergence to ensure sufficient inventory remains above the waste tank mixing device discharge (i.e., rpm versus level).

Waste Tank Purge Ventilation System: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank Active Ventilation Systems ensure that airborne releases within the waste tank are mitigated via HEPA filtration.

3.4.2.11 Waste Tank Explosion

3.4.2.11.1 SCENARIO DEVELOPMENT

3.4.2.11.1.1 Background

The radioactive aqueous wastes stored in the waste tanks may release flammable vapors into the waste tank vapor space. Hydrogen released during the radiolytic decomposition of water from waste is the primary flammable vapor of concern. For Type I/II Acidic Chemical Cleaning Waste Tanks, corrosion induced hydrogen generation is an additional significant contributor to flammable vapor concentration. Additionally for Tank 50, Isopar® L is a potential contributor to the flammable vapor concentration. Dissolved hydrogen and small quantities of flammable

organics may also be released from the waste. Hydrogen can also become trapped in the saltcake and/or sludge layers and be released. For further details on flammable vapor generation/release refer to Section 3.4.1.5.3. Since the waste tanks have an air atmosphere, quantities of oxygen sufficient to allow an explosion are assumed available. For the purpose of this scenario, no ignition source controls are credited and it is assumed that an ignition source is present.

The Waste Tank Explosion analysis for Waste Tank 48 is contained in Chapter 18.

For further detail on the waste tanks, refer to Section 2.4.1.

3.4.2.11.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with a Waste Tank Explosion that have non-negligible risk. For the purpose of this analysis, the tank explosion events have been grouped into two main categories: waste tank bulk vapor space explosions and waste tank pump column explosions. These two categories were further divided based on the MAR. Tank 50 and Type IV Waste Tank bulk vapor space explosions were analyzed separately from all other waste tanks, which contain a higher activity material. Two different pump columns (one representing the slurry pumps used on the Type I/II/III/IIIA/IV Waste Tanks and one representing the SMPs used on the Type I/II/III/IIIA Waste Tanks) were modeled for the waste tank pump column explosion event. The pump column explosion scenarios bound similar Waste Tank Explosions involving smaller vapor spaces (e.g., flammable vapor accumulation in a smaller piece of in-tank equipment) and bound other slurry pump types in use at the CSTF. Additionally, Waste Tank vapor space explosions were analyzed for both non seismic and seismic cases.

3.4.2.11.1.3 Unmitigated Accident Progression – Waste Tank Explosion (Non-Seismic)

- Flammable vapors released into the waste tank vapor space. Flammable vapor sources include:
  - radiolytic decomposition of water from the liquid waste
  - release of trace organic compounds
  - release of dissolved hydrogen due to tank heatup or receipt of a steam jet transfer
  - release of trapped hydrogen from sludge or saltcake
  - hydrogen releases associated with potential acid additions during 242-16H Evaporator chemical cleaning
  - corrosion induced hydrogen [Type I/II Acidic Chemical Cleaning Waste Tanks or waste tanks receiving Chemical Cleaning Transfers or related vent/drain operations]
  - Isopar® L vapor (Tank 50 only) due to evaporation
- Waste tank ventilation or atmospheric breathing removes flammable vapors from the waste tank vapor space
- Waste Tank Purge Ventilation System fails

- Flammable vapors accumulate in the waste tank vapor space
- Flammable vapor purge failure is undetected (by either ventilation surveillance and/or hydrogen monitoring) or ventilation cannot be restored prior to the vapor space reaching 100% of the LFL (CLFL for Tank 50)
- Flammable vapor concentration reaches the LFL (CLFL for Tank 50)
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the waste tank vapor space deflagrate or detonate (depending on when the ignition source occurs relative to the flammable vapor concentration)

3.4.2.11.1.4 Unmitigated Accident Progression – Waste Tank Explosion (Seismic)

- Flammable vapors released into the waste tank vapor space (see flammable vapor sources listed above) and the waste tank vapor space has an initial hydrogen concentration at the safety analysis value
- Seismic event causes Waste Tank Purge Ventilation System to fail
- Trapped hydrogen from sludge or saltcake is released
- Flammable vapors accumulate in the waste tank vapor space (radiolytic hydrogen accumulates and only atmospheric breathing is assumed to remove flammable vapors from the waste tank vapor space)
- Flammable vapor concentration reaches the LFL
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the waste tank vapor space deflagrate or detonate (depending on when the ignition source occurs relative to the flammable vapor concentration)

No unmitigated consequences were calculated for Type I/II/III/IIIA Waste Tank Explosions, except for Tank 50. The unmitigated consequences of these explosions are assumed to exceed the Offsite and Onsite EGs (as documented in Section 3.4.2.11.4). Since the EGs are exceeded, mitigated analysis is required.

Unmitigated consequences were calculated for explosions in Tank 50 and Type IV Waste Tanks. These consequences do not challenge the Offsite, but exceed the Onsite EGs. Therefore, mitigated analysis is performed for Tank 50 and Type IV Waste Tank Explosions.

Unmitigated consequences were calculated for explosions in Closure Waste Tanks. Prior to grouting in a Closure Waste Tank, there is no potential for the vapor space to reach 100% of the LFL, given only atmospheric breathing and a hydrogen generation rate less than or equal to 0.5 ft^3/hr. The grout level will eventually reduce the vapor space volume in the waste tank such that an equilibrium hydrogen concentration of greater than 100% of the LFL may occur (Ref. 284). The time required to reach LFL once that grout level is achieved would be long enough such that a failure to monitor for hydrogen or purge the vapor space is not credible. Reference 281 determined that prior to reaching a waste tank level with a time to LFL of less than 10 days, that an explosion in a Closure Waste Tank undergoing the grouting process is not

credible. At the point the time to LFL reaches less than 10 days, an explosion is considered credible due to the limited time to respond. However, the grout level will have covered the highest known historical waste level in all tank types and the associated consequences of this explosion do not challenge the Offsite or exceed the Onsite EGs (Ref. 281). Therefore, mitigated analysis is not required for Closure Waste Tank explosions.

3.4.2.11.1.5 Unmitigated Accident Progression – Pump Column (Slurry Pump, SMP) Explosion

- Bearing water (slurry pump) fails or is isolated to pump. Seal leakage allows waste to enter the pump column. SMP column pressure boundary failure or flush/motor pressure boundary failure allows waste to enter the column
- Flammable vapors accumulate in the pump column
- Pump column is not ventilated and flammable vapor concentration continues to increase
- Flammable vapor concentration reaches stoichiometric conditions
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the pump column detonate
- The column vents to the outside atmosphere, but no catastrophic failure of the pump column occurs (Ref. 61, 205, 225); thus, this scenario does not propagate into additional events (e.g., Tank Explosion, Tank Wall Failure, Waste Tank Siphon/Pump-Out)
- Material aerosolized from detonation is released to the environment

Refer to Figure 3.7-2 for the SMP accident scenarios.

The unmitigated consequences of the Slurry Pump Column Explosion (applying DOE-EM Interim Guidance methodology, Ref. 255) do not challenge the Offsite or exceed the Onsite EGs. The Slurry Pump Column Explosion event has been evaluated by assuming the MAR for the Slurry Pump Column Explosion is supernate for Type I/II/III/IIIA Waste Tanks. A leak will not permit sludge solids to leak into the pump column due to the viscous properties of the sludge (similar to the assumption used in the Waste Tank Annulus Explosion [see Section 3.4.2.12]). Any significant sludge solids leaked into the pump column past the lower seal assembly would settle at the bottom of the column since there is no credible mixing mechanism within the column that would cause solids to be retained in suspension. Assuming Bounding Supernate (Tank 50 Supernate for Tank 50), the consequences of a quad-volute Slurry Pump Column Explosion in a Type I/II/III/IIIA Waste Tank do not challenge the Offsite or exceed the Onsite EGs, and no controls are required. The Slurry Pump Column Explosion for a Type IV Waste Tank has been evaluated by assuming the MAR for the Slurry Pump Column Explosion is Slurried Type IV Tank Waste. Assuming Slurried Type IV Tank Waste, the consequences of a quad-volute Slurry Pump Column Explosion in a Type IV Waste Tank do not challenge the Offsite or exceed the Onsite EGs, and no controls are required.

The unmitigated consequences of the SMP Column Explosion do not challenge the Offsite EGs but exceed the Onsite EGs (as documented in Section 3.4.2.11.4). Therefore, mitigated analysis is required for SMP Column Explosion. Analysis was not performed for Isopar® L related explosions in SMP columns; however, SMP operation in Tank 50 is prohibited. SMP operation in a Type IV Waste Tank has not been analyzed for seismic effects. Therefore, analysis was not performed for SMP Column Explosions in Type IV Waste Tanks. SMP operation is prohibited in a Type IV Waste Tank.

3.4.2.11.1.6 Mitigated Accident Progression

No unmitigated consequences were calculated for Waste Tank Explosions (except Tank 50 and Type IV waste tanks). Because the unmitigated consequences of Type I/II/III/IIIA Waste Tank Explosions (excluding Tank 50), are assumed to exceed the Offsite EGs, two levels of control (one SC and one SS) are required. Because the event involves an explosion, one additional SS level of control is required. Since an explosion in Tank 50 and a Type IV Waste Tank exceeds the Onsite EGs, but does not challenge the Offsite EGs, three SS levels of control are required.

The mitigated Waste Tank Explosion accident progression differs from the unmitigated accident progression in that continuous purge by the waste tank ventilation system is required on waste tanks of concern. For the non-seismic case, loss/failure of ventilation is detected and flammable vapor purge restored prior to reaching the LFL, thereby preventing the accident. For the seismic case, the strategy is discussed in the Controls Addressing Release of Trapped Gas During a Seismic Event subsection.

The mitigation required varies depending upon tank conditions and activities. The control requirements are separated into the following categories/subsections (with an overall summary of the functions provided below each subsection):

- Routine Flammability Controls
- Controls for Type I/II Acidic Chemical Cleaning Waste Tanks
- Controls for Waste Tanks Undergoing Planned Gas Release Activities
- Controls Addressing Release of Trapped Gas During a Seismic Event
- Waste Tank Quiescent Time Program
- SMP Column Explosion

The control requirements for Waste Tank Explosion are summarized in Table 3.4-9.

Routine Flammability Controls

This subsection does not apply to Type I/II Acidic Chemical Cleaning Waste Tanks (see Controls for Type I/II Acidic Chemical Cleaning Waste Tanks subsection). Once the waste of a Type I/II Acidic Chemical Cleaning Waste Tank has been neutralized (i.e., pH is greater than or equal to 7) and the tank made a Type I/II Non-Acidic Chemical Cleaning Waste Tank, the waste

tank may be reclassified (Rapid Generation Tank, Slow Generation Tank, Very Slow Generation Tank) and the Routine Flammability Controls apply.

The Flammability Control Program is part of the first level of control and performs the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks (each function is described in detail below):

- Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification.
- Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification as described below) for the tank vapor space to reach the LFL (CLFL for Tank 50).
- Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50 and Very Slow Generation Tanks). The hydrogen concentration LFL limit shall account for potential organics.

Waste tanks are classified (waste tank flammability classification) by the Flammability Control Program according to the time it takes to reach 100% of the LFL following a loss of ventilation by the following criteria (for atmospheric breathing, see Section 3.4.1.5.5):

- Rapid Generation Tanks – Waste tanks that meet one of the following, whichever is more limiting (i.e., provides the lowest time to 100% of the LFL):
  - (Excluding Tank 50) Determined to go from the hydrogen concentration safety analysis value (nominally 25%) to 100% of the LFL in less than 28 days following a loss of ventilation. Classification based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions (from trace organics and radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Excluding Tank 50) Determined to go from 25% to 100% of the LFL in less than 28 days following a loss of ventilation. Classification based on the actual waste contents and vapor space volume, flammable vapor contributions (from trace organics, spontaneous liberation trapped gas release from slurried sludge, and radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Tank 50) Determined to go from 60% to 100% of the CLFL in less than 28 days following a loss of ventilation. Classification based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions (from radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Tank 50) Determined to go from 60% to 100% of the CLFL in less than 28 days following a loss of ventilation. Classification based on the actual waste contents and vapor space volume, flammable vapor contributions (from spontaneous liberation trapped gas release from slurried sludge and radiolytic hydrogen generation), and considers atmospheric breathing only.

- Slow Generation Tanks – Waste tanks (excluding Very Slow Generation Tanks) that meet one of the following, whichever is more limiting (i.e., provides the lowest time to 100% of the LFL):
  - (Excluding Tank 50) Determined to go from the hydrogen concentration safety analysis value (nominally 25%) to 100% of the LFL in greater than or equal to 28 days following a loss of ventilation. Classification based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions (from trace organics and radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Excluding Tank 50) Determined to go from 25% to 100% of the LFL in greater than or equal to 28 days following a loss of ventilation. Classification based on the actual waste contents and vapor space volume, flammable vapor contributions (from trace organics, spontaneous liberation trapped gas release from slurried sludge, and radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Tank 50) Determined to go from 60% to 100% of the CLFL in greater than or equal to 28 days following a loss of ventilation. Classification based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions (from radiolytic hydrogen generation), and considers atmospheric breathing only.
  - (Tank 50) Determined to go from 60% to 100% of the CLFL in greater than or equal to 28 days following a loss of ventilation. Classification based on the actual waste contents and vapor space volume, flammable vapor contributions (from spontaneous liberation trapped gas release from slurried sludge and radiolytic hydrogen generation), and considers atmospheric breathing only.
- Very Slow Generation Tanks – Waste tanks that meet both of the following:
  - Determined to never reach 100% of the LFL (CLFL for Tank 50). Classification based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions (from Isopar® L [Tank 50 only], trace organics, and radiolytic hydrogen generation), and considers atmospheric breathing only.
  - Determined to never reach 100% of the LFL (CLFL for Tank 50). Classification based on the actual waste contents and vapor space volume, flammable vapor contributions (from Isopar® L [Tank 50 only], trace organics, spontaneous liberation trapped gas release from slurried sludge, and radiolytic hydrogen generation), and considers atmospheric breathing only.

The waste tank HLLCP and Tank Fill Limits Program are part of the first level of control, to protect the level used in calculating the time to LFL by the Flammability Control Program.

Waste tanks for which the time to reach 100% of the LFL (CLFL for Tank 50) has the potential to fluctuate above and below one of the waste tank flammability classification criteria may remain classified at the higher flammability classification. For example, waste tanks for which

the time to reach 100% of the LFL (CLFL for Tank 50) has the potential to fluctuate above and below 28 days may remain classified as Rapid Generation Tanks.

For Tank 50, with respect to the waste tank flammability classifications discussed above, waste temperature controls are required to protect the flammable vapor contribution from Isopar® L and trace organics (less than or equal to 5%). For Tank 50, periodic waste temperature monitoring is also credited as part of the first level of control. Maintaining the average bulk waste temperature in Tank 50 less than or equal to 43°C will ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions (< 60%) for the contribution to the Tank 50 steady state CLFL (Ref. 224, 286). When Tank 50 is classified as a Rapid Generation Tank or Slow Generation Tank, the steady state CLFL (flammable vapor safety analysis value used above for waste tank flammability classification) is maintained less than or equal to 60% due to contributions from hydrogen (less than or equal to 3.8% of the LFL), trace organics (less than or equal to 5%), and Isopar® L.

The waste tank flammability classification does not include the effect of trapped hydrogen releases (discussed in detail in Section 3.4.1.5.3) from a seismic event or planned releases from operational activities (e.g., free supernate removal over saltcake/sludge, sludge agitation, saltcake interstitial liquid removal, or bulk saltcake dissolution). Controls pertaining to these events/activities are addressed in the Controls for Waste Tanks Undergoing Planned Gas Release Activities subsection.

The waste tank flammability classification does include the effect of trapped hydrogen releases due to spontaneous liberation events (discussed in detail in Section 3.4.1.5.3) for waste tanks that contain slurried sludge. Routine Flammability Controls and the Waste Tank Quiescent Time Program (Spontaneous Liberation Protection) ensure these waste tanks maintain the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification. The waste tank flammability classification considers waste tanks that contain slurried sludge, and conservatively assumes 100% instantaneous release from the slurried sludge layer (even though spontaneous liberation does not result in an instantaneous/full release). These controls are adequate to ensure spontaneous liberation events would not be a concern in these waste tanks (also see Waste Tank Quiescent Time Program subsection). For these waste tanks (excluding Tank 50), use of an initial hydrogen concentration of 25% of the LFL is considered acceptable for spontaneous liberation analysis (versus use of the hydrogen concentration safety analysis value). For waste tanks which require continuous purge by the waste tank ventilation system (Rapid Generation Tanks, Slow Generation Tanks), the ventilation system is adequate to maintain the radiolytic hydrogen concentration less than 25% of the LFL. For Tank 50, the flammable vapor safety analysis value (60% of the CLFL) is used.

The Flammability Control Program is also credited with ensuring that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the waste tank vapor space to reach the LFL (CLFL for Tank 50). Ensuring that it takes a minimum of seven days for the tank's vapor space to reach 100% of the LFL (CLFL for Tank 50) provides adequate time to respond to a loss of ventilation. The seven days allows time to detect the loss of flow and either restore ventilation or provide alternate ventilation. No credit is taken in the first level of control for any ventilation equipment

other than the installed ventilation. Additionally, diesel generators (non-credited) are available to provide power to purge systems for HTF process areas with flammable vapor concerns, such as the waste tanks. The assumption that purge capability could be obtained and installed in seven days, if required, is based on the following:

- The equipment required to assemble any required ventilation system is readily available Onsite and/or Offsite and can be obtained within four days by the on-duty facility staff (personnel meeting the TSR minimum staffing requirements).
- Staffing needed to install and operate any required ventilation system can be at the CSTF and ready to operate the ventilation system within three days.

It is recognized that some tanks may have less than seven days to reach the LFL (CLFL for Tank 50) following a seismic event and a limited number of waste tanks could reach the LFL (CLFL for Tank 50) within a very short time following a seismic event (under bounding conditions due to the release of trapped hydrogen). For additional information, refer to Controls Addressing Release of Trapped Gas During a Seismic Event subsection.

During chemical cleaning of the 242-16H Evaporator, inadvertent addition of nitric acid could occur to a waste tank, causing a potential increase in hydrogen generation. Isolation valves and administrative controls (242-16H Evaporator Chemical Cleaning Program) are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no increase in hydrogen generation rate occurs during chemical cleaning operations due to inadvertent acid addition.

During Type I/II Acidic Chemical Cleaning Waste Tank operations or Chemical Cleaning Transfers, inadvertent addition of OA could occur to a waste tank, causing a potential increase in hydrogen generation. OA will be added to a Type I/II Waste Tank via a dedicated transfer path. Controls are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no increase in hydrogen generation rate occurs during Type I/II Acidic Chemical Cleaning Waste Tank operations or Chemical Cleaning Transfers due to inadvertent acid addition to a non-Chemical Cleaning Tank.

In addition to the first levels of control discussed in this subsection, the following SC controls from the Waste Tank Chemical Cleaning Program are required for waste tanks that are receiving Chemical Cleaning Transfers (or related vent/drain operations) to protect the initial accident assumptions:

- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering waste tanks outside of the intended transfer path.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain operation shall only be permitted to the waste tanks associated with the vent/drain path.

- Prior to transfer initiation of a Chemical Cleaning Transfer (or related vent/drain operations), verification shall be performed to ensure that sufficient inhibitors are present in the applicable receipt waste tank to ensure neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers (or related vent/drain operations), at least one waste tank mixing device shall be operating in the applicable receipt waste tank to ensure adequate mixing and neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers, acidic waste shall enter the receipt tank via a flowpath that is below the waste tank liquid level.

The controls associated with the Waste Tank Chemical Cleaning Program prevent corrosion induced hydrogen generation from contributing to the flammable vapor concentration in the receipt waste tank during Chemical Cleaning Transfers (or related vent/drain operations). These controls are considered SC to protect initial accident assumptions.

On waste tanks that can reach 100% of the LFL (based on the waste tank flammability classification), continuous purge by the waste tank ventilation system is required as part of the first level of control. Ventilation is required on all Rapid Generation Tanks and Slow Generation Tanks (excluding Tank 50) to provide sufficient purge flow rate through the tank to maintain the tank bulk vapor space less than or equal to 25% of the LFL. The flow rate determination shall account for dissolved hydrogen release from steam jetted transfers (excluding Tanks 40 and 51 when classified as an ESP Sludge Slurry Waste Tank) and radiolytic hydrogen generation. Steam jetted transfers into ESP Sludge Slurry Waste Tanks are prohibited; therefore, dissolved hydrogen release can be discounted. For Tank 50 (when classified as a Rapid Generation Tank or Slow Generation Tank), ventilation is required to provide sufficient purge flow rate through the tank to maintain the hydrogen concentration in the waste tank bulk vapor space to less than or equal to 3.8% of the LFL. The Tank 50 flow rate determination shall account for radiolytic hydrogen generation. Contributions from trace organics and Isopar® L are accounted for in the assumed initial flammable vapor safety analysis value of 60% of the CLFL for Tank 50. Steam jetted transfers into Tank 50 are prohibited; therefore, dissolved hydrogen release can be discounted.

Providing sufficient purge ventilation for Rapid Generation Tanks and Slow Generation Tanks (as described above) will ensure that the tank bulk vapor space is maintained less than or equal to the hydrogen concentration safety analysis value (or 3.8% of the LFL for Tank 50) and protect the initial hydrogen concentration to ensure that the minimum time to LFL (CLFL for Tank 50) associated with the waste tank flammability classification is protected (i.e., seven days and 28 days, respectively).

Continuous purge by the waste tank ventilation system is also required as part of the first level of control for Very Slow Generation Tanks when receiving a steam jetted transfer. As the waste tank flammability classification does not account for dissolved hydrogen release from steam jetted transfers, ventilation is required on Very Slow Generation Tanks (under this condition) to ensure that the minimum time to LFL is maintained accounting for the dissolved hydrogen contribution.

To satisfy the flammability safety functions of the ventilation system, a minimum ventilation flow rate is required for Rapid Generation Tanks and Slow Generation Tanks. Very Slow Generation Tanks are shown by calculation to never reach 100% of the LFL (considering atmospheric breathing only). Therefore, no forced ventilation is required on Very Slow Generation Tanks, under static conditions, since atmospheric breathing will prevent the tank vapor space from reaching LFL. Since atmospheric breathing is not sufficient to account for dissolved hydrogen release from steam jetted transfers, continuous purge by the waste tank ventilation system (at a flow rate equal to that for a Slow Generation Tank) is required when receiving a steam jetted transfer into a Very Slow Generation Tank.

For Tank 50, Reference 224 demonstrates that a minimum flow rate of 45 scfm is adequate to protect the initial hydrogen concentration within the tank vapor space (less than or equal to 3.8% of the LFL accounting for the radiolytic hydrogen generation). Although 45 scfm will protect the initial hydrogen concentration in Tank 50 regardless of waste tank flammability classification, the minimum ventilation flow rate for Tank 50 will be 72 scfm when classified as a Rapid Generation Tank and 45 scfm when classified as a Slow Generation Tank. The 72 scfm and 45 scfm flow rates for Tank 50 do not account for hydrogen released from steam jetted transfers; therefore, steam jetted transfers into Tank 50 are prohibited.

For the remaining waste tanks, Reference 2 calculates a minimum flow rate of 72 scfm for Rapid Generation Tanks, and Reference 146 calculates a minimum flow rate of 45 scfm for Slow Generation Tanks. For Tanks 40 and 51, when classified as an ESP Sludge Slurry Waste Tank, the minimum ventilation flow is 188 scfm (Ref. 2). These values (72, 188, and 45 scfm) are derived using bounding conditions with respect to tank level, radiolytic hydrogen generation rate, and dissolved hydrogen release from steam jetted transfers and will maintain the hydrogen concentration to less than or equal to 25% of the LFL. The 188 scfm flowrate for Tanks 40 and 51 (when classified as an ESP Sludge Slurry Waste Tank) does not account for hydrogen released from steam jetted transfers; therefore, steam jetted transfers into ESP Sludge Slurry Waste Tanks are prohibited. For spontaneous liberation events and other activities (sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal) on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function minimizes the potential for reaching a flammable vapor concentration by providing a continuous purge of the tank vapor space. For Very Slow Generation Tanks, a minimum flow rate of 45 scfm is sufficient to account for dissolved hydrogen release from steam jetted transfers.

The ventilation system and waste tank design configuration (in conjunction with the high diffusivity of hydrogen) ensure that the tank ventilation system is able to provide bulk purging of the tank vapor space. For Routine Flammability Controls, installed flow indication is required only on the ventilation systems for Rapid Generation Tanks. For Very Slow Generation Tanks (when receiving a steam jetted transfer) and Slow Generation Tanks, the nominal capacity of the installed ventilation system is much larger than the flow required to maintain the tank below LFL (CLFL for Tank 50); therefore, flow measurement is not required. Per References 146 and 224 (for Tank 50 only), the required ventilation flow rate for Slow Generation Tanks is 45 scfm. This rate is calculated in Reference 146 assuming an “empty” Type IV Waste Tank producing radiolytic hydrogen at a rate which would cause the vapor space to go from 25% to 100% of the LFL in 28 days and receiving dissolved hydrogen at the maximum assumed rate from a steam

jetted transfer. Based on a nominal flow capacity of 150 scfm or greater for the installed ventilation systems, it is judged that when the ventilation system is operating, the system is supplying the required flow. This same judgment is applicable to Very Slow Generation Tanks when receiving a steam jetted transfer, as these waste tanks also require ventilation flow rate of 45 scfm. Typically ventilation is operated on Very Slow Generation Tanks, whenever available. Therefore, it is considered unlikely that a Very Slow Generation Tank with a high equilibrium hydrogen concentration (above 60% LFL) would have an operational ventilation system that was not placed into service until just before receipt of a steam jetted transfer. Thus, the hydrogen concentration would typically be well below its equilibrium value at the start of the steam jetted transfer.

Excluding Tank 50, periodic hydrogen monitoring is provided as a second level of control for Rapid Generation Tanks and Slow Generation Tanks to verify the waste tank hydrogen concentration is less than or equal to the hydrogen concentration safety analysis value. The hydrogen monitoring will alert operators to the event and allow for response (e.g., restore ventilation or provide alternate ventilation). For activities not exceeding the Gas Release Criteria discussed below (Controls for Waste Tanks Undergoing Planned Gas Release Activities), the hydrogen concentration safety analysis value shall be established by the Flammability Control Program. The hydrogen concentration safety analysis values shall be on an individual tank basis and shall consider any proposed activities having the potential to release trapped gas (e.g., sludge agitation, bulk saltcake dissolution, saltcake interstitial liquid removal). Excluding Tank 50, the mitigative confinement capability of the waste tank structure provides a third level of control for Rapid Generation Tanks and Slow Generation Tanks. The waste tank structure also supports ventilation system operation for Rapid Generation Tanks and Slow Generation Tanks. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

The confinement capability of the waste tank structure provides a second level of control for Tank 50 and Very Slow Generation Tanks. The waste tank structure also supports ventilation system operation for Tank 50 (when classified as a Rapid Generation Tank or Slow Generation Tank) and Very Slow Generation Tanks (when receiving a steam jetted transfer). The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control for Tank 50 and Very Slow Generation Tanks is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

Controls for Type I/II Acidic Chemical Cleaning Waste Tanks

This subsection only applies to Type I/II Acidic Chemical Cleaning Waste Tanks.

As a first level of control, continuous purge by the waste tank ventilation system is required on Type I/II Acidic Chemical Cleaning Waste Tanks. For these waste tanks, the time to LFL may be three days and the Flammability Control Program does not calculate the time to LFL but does ensure these tanks are classified (waste tank flammability classification) as Chemical Cleaning

Tanks. A Chemical Cleaning Tank is a waste tank (containing un-neutralized OA) that has the potential to go from 25% (safety analysis value) to 100% of the LFL in three days following a loss of ventilation. Once the waste of a Type I/II Acidic Chemical Cleaning Waste Tank (Chemical Cleaning Tank) has been neutralized (i.e., pH is greater than or equal to 7) and the tank made a Type I/II Non-Acidic Chemical Cleaning Waste Tank, the waste tank may be reclassified (Rapid Generation Tank, Slow Generation Tank, Very Slow Generation Tank) and the Routine Flammability Controls apply.

For Type I/II Acidic Chemical Cleaning Waste Tanks, the flammable vapor accumulation rate includes the effects of radiolytic production, corrosion induced hydrogen generation, and trapped gas release from the 10,000 gallons of sludge in the waste tank (accounting for atmospheric breathing) (see Section 3.4.1.5.5). During acidic spray washing activities on Type I/II Acidic Chemical Cleaning Waste Tanks, flammable vapor accumulation rate does not include the effects of corrosion induced hydrogen generation from the sprayed wetted surface area of the tank wall/internals (above the liquid level) since the acid does not remain in contact with vertical tank surfaces for longer than 48 hours (Ref. 246).

Ventilation is required on Chemical Cleaning Tanks to prevent flammable vapor accumulation and protect the initial hydrogen concentration within the tank vapor space. To satisfy the flammability safety function of the ventilation system, a minimum ventilation flow rate is required. For Chemical Cleaning Tanks, Reference 246 demonstrates a minimum flow rate of 110 scfm is adequate, accounting for the radiolytic and corrosion induced hydrogen generation (and trapped gas release from 10,000 gallons of sludge), to protect the initial hydrogen concentration of 25% of the LFL and provide at least three days to LFL following a loss of ventilation. The minimum flow rate of 110 scfm is based on the vapor space volume protected by the waste tank HLLCP setpoint initial conditions (≤ 63.8 inches for Type I and ≤ 64.8 inches for Type II). The 110 scfm flow rate for Type I/II Acidic Chemical Cleaning Waste Tanks does not account for hydrogen released from steam jetted transfers, since steam jetted transfers into or out of Type I/II Acidic Chemical Cleaning Waste Tanks are prohibited.

The ventilation system and waste tank design configuration (in conjunction with the high diffusivity of hydrogen) ensure that the tank ventilation system is able to provide bulk purging of the tank vapor space. Installed flow indication is required on the ventilation systems for Chemical Cleaning Tanks.

Also part of the first level of control for Chemical Cleaning Tanks is periodic waste tank temperature monitoring (during waste tank mixing device operation) and the Waste Tank Chemical Cleaning Program. Periodic waste tank temperature monitoring will ensure the average bulk waste temperature in Type I/II Acidic Chemical Cleaning Waste Tanks less than or equal to 60°C during waste tank mixing device operation. The Waste Tank Chemical Cleaning Program will require that, prior to waste tank mixing device operation, sufficient water has been added to the waste tank to ensure the OA content in the waste tank (once mixed) will be less than or equal to 4 wt. %. These controls will ensure that the waste tank conditions are within initial conditions for application of the assumed corrosion induced hydrogen generation rate.

In addition to the controls stated above, during acidic spray washing activities on Type I/II Acidic Chemical Cleaning Waste Tanks, liquid additions shall be limited to those from batch

sources less than or equal to 8,000 gallons total volume that do not have a continuous makeup capability. The liquid source system shall be considered to have continuous makeup capability if the system has an automatic or manual fill provision that is not electrically or mechanically isolated. The electrical or mechanical isolation shall contain two independent means of isolation (e.g., two isolation valves; one isolation valve and open disconnect for liquid source transfer pump). This control ensures that in place of the HLLCP, which is not functional during acidic spray washing, the fill limit initial conditions for flammability are not exceeded.

Periodic hydrogen monitoring is provided as a second level of control for Chemical Cleaning Tanks to verify the waste tank hydrogen concentration is less than or equal to the hydrogen concentration safety analysis value. The hydrogen monitoring will alert operators to the event and allow for response (e.g., restore ventilation or provide alternate ventilation). The hydrogen concentration safety analysis value shall be 25% of the LFL.

The mitigative confinement capability of the waste tank structure provides a third level of control for these tanks. The waste tank structure also supports ventilation system operation. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

Post-NPH controls for Waste Tank Explosions on Type I/II Acidic Chemical Cleaning Waste Tanks are discussed further in Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19.

Trapped gas release from sludge agitation, free supernate removal, or spontaneous liberation in Type I/II Acidic Chemical Cleaning Waste Tanks is accounted for in the flammability analysis for this subsection (Controls for Type I/II Acidic Chemical Cleaning Waste Tanks) since the analysis (Ref. 246) used maximum values for the sludge content (sludge volume, gas bubble volume, hydrogen percentage in trapped gas) for deriving the ventilation flow rate requirement. Trapped gas release from activities associated with bulk saltcake dissolution and saltcake interstitial liquid removal are not accounted for since bulk saltcake dissolution and saltcake interstitial liquid removal activities in Type I/II Acidic Chemical Cleaning Waste Tanks are prohibited. Therefore, controls stated in the Controls for Waste Tanks Undergoing Planned Gas Release Activities subsection do not apply to Type I/II Acidic Chemical Cleaning Waste Tanks.

Controls for Waste Tanks Undergoing Planned Gas Release Activities

This subsection does not apply to Type I/II Acidic Chemical Cleaning Waste Tanks (refer to Controls for Type I/II Acidic Chemical Cleaning Waste Tanks subsection). Information in this subsection pertaining to bulk saltcake dissolution and saltcake interstitial liquid removal activities does not apply to Type I/II Non-Acidic Chemical Cleaning Waste Tanks. Bulk saltcake dissolution and saltcake interstitial liquid removal activities in Type I/II Non-Acidic Chemical Cleaning Waste Tanks are prohibited.

Certain operational activities have the potential to release significant amounts of trapped hydrogen or have the potential to be flammable transient concern. This subsection describes the controls required to address trapped gas releases related to the following planned operational activities:

- Free Supernate Removal: Free supernate removal is the process of removing liquid from above the solids layers (saltcake and/or sludge) in a waste tank. Removing the supernate reduces the hydrostatic head over the gas trapped within the solids, causing the gas to expand. The increased volume of gas is released. At the same time, the tank vapor space volume is increasing due to the liquid removal that caused the reduction in hydrostatic pressure. For activities involved with free supernate removal over saltcake (including pumping liquid from a well in the saltcake), the activity is considered free supernate removal provided the Bulk Saltcake Layer has Supernate Coverage. See Section 3.4.1.5.3 for further discussion on Bulk Saltcake Layer and Supernate Coverage. Free supernate removal may also initiate spontaneous liberation of trapped gas (see Section 3.4.1.5.3).
- Sludge Agitation: Sludge agitation is the process of mixing sludge using waste tank mixing devices. Agitating the sludge releases the trapped hydrogen in the sludge.
- Bulk Saltcake Dissolution: Bulk saltcake dissolution is the process of dissolving saltcake by adding liquid to a waste tank and/or mixing of liquid within a waste tank (via waste tank mixing devices, Mixing Eductors, or transfer pumps associated with waste tank recirculation). Dissolving the saltcake with or without mixing releases the trapped hydrogen in the saltcake. Saltcake well mining is also considered a bulk saltcake dissolution activity. Saltcake well mining is the process of dissolving saltcake, usually to allow insertion of equipment such as a pump for saltcake interstitial liquid removal. Hydrogen that is trapped in the saltcake will be released.
- Saltcake Interstitial Liquid Removal: Saltcake interstitial liquid removal is the process of removing interstitial liquid from bulk saltcake, with the liquid level in the waste tank at or below the Bulk Saltcake Layer, by pumping liquid from a well in the saltcake. Pumping liquid from a well in the saltcake where the Bulk Saltcake Layer has Supernate Coverage is not considered saltcake interstitial liquid removal (but is considered a free supernate removal activity). See Section 3.4.1.5.3 for further discussion on Bulk Saltcake Layer and Supernate Coverage. Removing saltcake interstitial liquid will release trapped hydrogen from the saltcake where the interstitial liquid is removed and reduce the hydrostatic head on the remaining trapped gas, causing an additional hydrogen release.

Since free supernate removal has the potential to release significant amounts of hydrogen, additional controls (in addition to the Routine Flammability Controls) are required during these activities. The controls below are an additional first level of control (to the Routine Flammability Controls), with the second and third levels of control the same as stated in the Routine Flammability Controls subsection.

For tanks undergoing free supernate removal activities, the Gas Release Program is credited as a first level of control with ensuring that free supernate removal activities will be within

hydrogen release rate limits to maintain the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification (and associated minimum ventilation flow rate requirements). During free supernate removal activities on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function (in conjunction with the Gas Release Program) maintains the minimum time to LFL defined by the waste tank flammability classification and associated minimum ventilation flow rate requirements.

An engineering evaluation shall be performed prior to the free supernate removal activity (using the methodology of Section 3.4.1.5.3) and shall consider the combined contents of the waste tank (saltcake, settled sludge, and slurried sludge). The engineering evaluation shall verify that the release of hydrogen due to the activity is within limits for the associated waste tank type and waste tank flammability classification (Ref. 308). Flammability classification of a waste tank may be reclassified, based on the engineering evaluation, to meet the associated criteria. The limits derived for free supernate removal activities maintain the waste tank flammability classification for time to LFL (CLFL for Tank 50), but do not necessarily protect the hydrogen concentration safety analysis values established by the Flammability Control Program. However, excluding Very Slow Generation Tanks, the hydrogen concentration does not exceed 60% of the LFL during the free supernate removal activity (Ref. 308).

Reference 308 determined the limits for Rapid Generation Tanks and Slow Generation Tanks assuming the initial hydrogen concentration in the tank vapor space was at equilibrium hydrogen concentration conditions due to ventilation system operation (or 2.5% of the LFL, whichever was higher). In order to protect these assumed initial conditions, the Gas Release Program is credited with ensuring the waste tank bulk vapor space hydrogen concentration is less than or equal to 2.5% of the LFL.

As indicated in Section 3.4.1.5.3.5, free supernate removal can cause a spontaneous liberation event. There has only been one such incident recorded (Ref. 253). The waste tank flammability classification protects the time to LFL, considering spontaneous liberation (instantaneous, 100% trapped gas release starting at 25% of the LFL) under static conditions. As previously noted, spontaneous liberation events that have actually occurred were neither instantaneous nor 100% releases. Also, the controls described above ensure the waste tank bulk vapor space hydrogen concentration is less than or equal to 2.5% of the LFL prior to free supernate removal, as opposed to the 25% starting point for waste tank flammability classification. Reference 308 analyzed bounding postulated hydrogen releases from hydrostatic head reduction, without considering the amount or type of waste necessary to produce that hydrogen release. For example, the bounding hydrogen release limit for Type III/IIIA Rapid Generation Tanks is determined at a solids layer height of 105 inches. Reference 312 calculates bounding hydrogen release values for saltcake, settled sludge, and slurried sludge. Using these bounding values, it can be seen that any amount of settled sludge or saltcake with a combined height of 105 inches can only release about half of the calculated limit, even with a bounding percent hydrogen in the bubble gas (H_{mix}) and supernate density. A significant quantity of slurried sludge (in excess of 90 inches) is required to reach the calculated hydrogen release limit. This quantity of slurried sludge would require the waste tank to be in the Waste Tank Quiescent Time Program (Spontaneous

Release Protection). Reference 308 performed a sensitivity case intended to show the effect of a postulated spontaneous liberation event in conjunction with free supernate removal. For the case analyzed, the time to LFL (waste tank flammability classification) is protected. Additionally, Reference 312 shows that for waste tank conditions similar to the sensitivity case analyzed in Reference 308, the hydrogen release limits to protect 60% of the LFL are also met. Based on this discussion, and the conservative nature of the limits generated in Reference 308, the controls described above are considered sufficient to prevent a waste tank explosion from a spontaneous liberation event in conjunction with free supernate removal.

Trapped gas releases associated with flammable transients from mechanically disturbing waste (e.g., waste tank mixing device operation), bulk saltcake dissolution (e.g., saltcake well mining, water additions), and saltcake interstitial liquid removal activities have been analyzed in References 69, 195, and 309. Water additions injected below the saltcake surface at a rate greater than 300 gpm have not been analyzed for flammable transients. Based on this analysis, the following controls are required to ensure flammable transients are not a safety hazard. For waste tanks that do not contain saltcake or sludge, these controls are not applicable. The levels of control below shall be included as part of the levels of control associated with the Routine Flammability Controls subsection or Controls for Waste Tanks Undergoing Planned Gas Release Activities subsection when mechanically disturbing waste (e.g., waste tank mixing device operation), bulk saltcake dissolution (e.g., saltcake well mining, water additions), or saltcake interstitial liquid removal activities invoke controls from those subsections.

Waste tank level limitations (per Reference 309) are credited as a first level of control to ensure adequate vapor space volume for flammable transients. The waste tank level limitations are dependent upon the content of the waste tank (saltcake, settled sludge, or slurried sludge), waste tank mixing device operation/location, and percent hydrogen in the bubble gas (H_{mix}).

The vapor space volume protected by the waste tank HLLCP setpoint and maximum fill limit (see Table 3.4-2) permitted by Tank Fill Limits Program is sufficient to protect flammable transients for the following waste tank conditions (Ref. 309):

- waste tanks that do not have an operating waste tank mixing device
- waste tank mixing device operation in a waste tank containing only slurried sludge (with respect to solids layers in the tank) and the specific waste tank mixing device (planned for operation) has been operated within (less than or equal to) 180 days

For waste tank mixing device operations (stated below), the Gas Release Program is credited with protecting the vapor space volume by limiting the actual waste tank level within the requirements of Reference 309. The Gas Release Program is sufficient to protect flammable transients during waste tank mixing device operation for the following waste tank conditions:

- waste tanks containing saltcake, settled sludge, or any combination of saltcake, settled sludge, or slurried sludge (with respect to solids layers in the tank)
- waste tanks containing only slurried sludge (with respect to solids layers in the tank) and the mixing device has not been operated within 180 days

With the waste tank level limitations in place, Reference 309 indicates that the potential flammable transients in the tank vapor space are short-lived (less than three minutes for bounding waste tank conditions; less than two minutes for typical waste tank conditions). The model (Ref. 309) used to develop the waste tank level limitations and time at risk for flammable transients did not account for active ventilation within the waste tank vapor space or convective mixing from the temperature gradient within the waste tank. Based on this conservative approach with the model, the very limited time at risk for flammable transients, and low probability of an ignition source being present with the vapor space above 100% of the LFL, this event is considered to be prevented by the controls stated above.

The confinement capability of the waste tank structure provides a second level of control for flammable transients. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control for flammable transients is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

For tanks undergoing planned sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities (or combinations thereof), the Gas Release Program is credited with determining if the waste tank will exceed the Gas Release Criteria stated below. The engineering evaluation for release of hydrogen due to the activity shall use the methodology of Section 3.4.1.5.3 (considering the affected solids layers) and be based on an assumed initial hydrogen concentration (which will be protected by the Gas Release Program), the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program), flammable vapor contributions as stated below, and considers atmospheric breathing only (see Section 3.4.1.5.5).

Release of hydrogen due to planned sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities does not exceed the Gas Release Criteria when the activity does not cause the waste tank vapor space to:

- Become flammable in less than seven days for a Rapid Generation Tank (due to flammable vapor contributions from Isopar® L [Tank 50 only], trace organics, trapped gas release, and radiolytic hydrogen generation)
- Become flammable in less than 28 days for a Slow Generation Tank (due to flammable vapor contributions from Isopar® L [Tank 50 only], trace organics, trapped gas release, and radiolytic hydrogen generation)
- Become flammable for a Very Slow Generation Tank (due to flammable vapor contributions from Isopar® L [Tank 50 only], trace organics, trapped gas release, and radiolytic hydrogen generation)
- Exceed 60% of the LFL (due only to trapped gas release)

Sludge agitation activities in Type I/II Non-Acidic Chemical Cleaning Waste Tanks that could exceed the Gas Release Criteria above are not permitted. Sludge agitation, bulk saltcake

dissolution, and saltcake interstitial liquid removal activities in Tank 50 that could exceed the Gas Release Criteria above are not permitted. Liquid additions to the waste tank from the DWS are less than the total calculated volume that causes the vapor space to exceed the Gas Release Criteria above (see Section 3.4.1.5.2).

Tanks may be reclassified, based on the engineering evaluation, to meet the above criteria. For example, an evaluation determines that, for a Slow Generation Tank, the assumed trapped gas release from the planned sludge agitation results in reaching 50% of the LFL and the subsequent radiolytic hydrogen production causes the tank to reach the LFL in 25 days. This tank would be required to have the controls described below for sludge agitation (e.g., interlocks) unless it is reclassified as a Rapid Generation Tank (with associated Routine Flammability Controls and Gas Release Program).

In order to protect assumed initial conditions in the engineering evaluation, the Gas Release Program is credited with ensuring the waste tank bulk vapor space hydrogen concentration is less than or equal to the initial value assumed in the hydrogen release engineering evaluation.

Some planned activities have the potential to release insignificant amounts of hydrogen (excluding spontaneous liberation events, see discussion below) and no hydrogen release evaluation is required. The activities listed below are divided into three categories: sludge agitation, saltcake dissolution, and saltcake interstitial liquid removal. The activities are considered insignificant hydrogen release activities for the specific category identified, but may be considered a significant hydrogen release activity for a different category (or may be considered free supernate removal or a flammable transient concern as described above). Examples of these insignificant hydrogen release activities include the following (Ref. 307):

- Sludge Agitation (activity applies to settled sludge or slurried sludge, unless otherwise indicated)
  - Rotation of waste tank mixing device turntables
  - Limited duration operation (less than or equal to five minutes) of a waste tank mixing device for operational/maintenance testing (does not apply to a waste tank containing slurried sludge)
  - Sludge sampling
  - Sample rinsing
  - Inserting/removing tank components below the sludge layer
  - Riser mining in a sludge tank
  - Air blowing transfer jets that have a suction below the sludge layer
  - Operating transfer pumps or jets that have a suction below the sludge layer
  - Transfers into the waste tank (regardless of downcomer location)
  - Waste sparging (air or steam)
  - Flushing of transfer pumps or jets

- Flushing of ventilation system components (e.g., demister, reheater) and level monitoring equipment (e.g., reel tape)
- Filling purge condenser seal leg

Sludge agitation activities stated above (performed in slurried sludge) may cause a spontaneous liberation event; however, no hydrogen release evaluation is required for the activity. Routine Flammability Controls and the Waste Tank Quiescent Time Program (Spontaneous Liberation Protection) ensure waste tanks maintain the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification. These controls are adequate to ensure spontaneous liberation events would not be a concern in these waste tanks.

- Saltcake Dissolution
  - Bearing water leaks from pressurized pump columns (e.g., slurry pump, telescoping transfer pump) during transfers into a waste tank
  - Limited duration operation (less than or equal to five minutes) of a waste tank mixing device or transfer pump (waste tank recirculation) for operational/maintenance testing
  - Transfers out of a salt tank (including transfers with a siphon break on the transfer pump/jet discharge line)
  - Recirculation to the feed tank from the 242-16H evaporator feed pump
  - Evaporator operations associated with concentrated waste being transferred (siphoning/lifting/pump-outs) to the evaporator drop tank (including concurrent transfers)
  - Transfers into a salt tank with exposed salt on cooling coils / exposed salt on waste tank wall (height and base in inches not feet)
  - Flushing of equipment in a salt tank
  - Flushing of ventilation system components (e.g., demister, reheater) and level monitoring equipment (e.g., reel tape)
  - Salt sampling
  - Sample rinsing
  - Removing tank components below the saltcake layer
  - Filling purge condenser seal leg
- Saltcake Interstitial Liquid Removal
  - Limited duration operation (less than or equal to five minutes) of a transfer pump for operational/maintenance testing
  - Transfers out of a tank that expose salt peaks/mounds (height and base in inches not feet)

- Transfers out of a tank that expose salt on cooling coils

In general, if activities in waste tanks disturb a localized region of sludge, disturb a limited quantity of saltcake, or remove interstitial liquid from a limited quantity of saltcake, then these activities are judged to result in an insignificant hydrogen release.

For tanks which do not exceed the Gas Release Criteria specified above, only Routine Flammability Controls and the Gas Release Program (Gas Release Criteria evaluation and initial hydrogen concentration protection) are required.

For tanks exceeding the Gas Release Criteria specified above, the following controls (in addition to the Routine Flammability Controls) are required to ensure that the waste tanks do not exceed 60% of the LFL and that the minimum time to the LFL requirements are protected. The control strategy (based on the guidance provided by NFPA 69 [Ref. 194]) is as follows:

As a first level of control, continuous purge by the waste tank ventilation system with local flow indications and ventilation low flow interlocks are required. The minimum ventilation flow rate shall be 72 scfm (188 scfm for Tanks 40 and 51), regardless of waste tank flammability classification, to minimize the potential for reaching a flammable vapor concentration. The ventilation low flow interlocks shall ensure the waste tank mixing devices, saltcake interstitial liquid removal, and bulk saltcake dissolution activities are stopped on ventilation low flow conditions. Depending on the activity being performed, the interlock will perform the following when low ventilation flow occurs:

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

The Flammability Control Program is also credited as part of the first level of control and shall determine the hydrogen concentration safety analysis value for each waste tank. The hydrogen concentration safety analysis value shall be based on the percent LFL (not to exceed 60%) that, considering radiolytic hydrogen generation, ensures the minimum required time to the LFL is met for the waste tank flammability classification (e.g., seven days for a Rapid Generation Tank). The Flammability Control Program shall establish this safety analysis value based on the vapor space volume protected by the waste tank HLLCP setpoint (and Tank Fill Limits Program).

Additionally, the Gas Release Program is also credited as part of the first level of control with controlling the associated activity (sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal) to limit the planned release of trapped gas. The Gas Release Program ensures the activity is controlled to maintain the waste tank bulk vapor

space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification. The Gas Release Program supplements the ventilation system as the purge flow rates (72 and 188 scfm) may not be sufficient to limit the waste tank flammable vapor concentration to below assumed values for trapped gas releases. Thus, the Gas Release Program addresses this vulnerability by controlling the activity to limit the amount of trapped gas released (based on the minimum ventilation flow rate requirements).

For the second level of control, continuous hydrogen monitoring with a high hydrogen concentration interlock is required. Depending on the activity being performed, the interlock will perform the following when high hydrogen concentration occurs:

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

The mitigative confinement capability of the waste tank structure provides a third level of control for these tanks. The waste tank structure also supports ventilation system operation. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

Controls Addressing Release of Trapped Gas During a Seismic Event

This subsection does not apply to Type I/II Acidic Chemical Cleaning Waste Tanks (refer to Controls for Type I/II Acidic Chemical Cleaning Waste Tanks subsection).

Waste tank controls addressing the release of trapped gas during seismic events vary, depending on the ongoing activities and properties of the waste (e.g., saltcake, settled sludge, or slurried sludge). For tanks undergoing sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities, the Gas Release Program is credited with determining if the waste tank will exceed the applicable Gas Release Criteria (and protecting assumed initial conditions for hydrogen concentration in the engineering evaluation). For control sets stated below requiring the Waste Tank Quiescent Time Program, see the Waste Tank Quiescent Time Program subsection for additional information.

For waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) that contain only sludge, the controls stated below are adequate to prevent the event. For the remaining waste tanks, the controls stated below may not prevent the tank vapor space from

reaching LFL due to trapped gas release during a seismic event. Therefore, Offsite and Onsite consequences are attributed to this scenario in the mitigated Waste Tank Explosion analysis.

Tank 50 is not permitted to be involved in activities that exceed the Gas Release Criteria described in the Controls for Waste Tanks Undergoing Planned Gas Release Activities subsection. For Tank 50, the following three levels of control are required. The Waste Tank Quiescent Time Program (Seismic Release Protection) in conjunction with the Event Response Program (operator response) is the first level of control for Tank 50 following the Seismic event. Operator response includes the following: 1) secure waste tank liquid transfers, 2) secure waste tank mixing devices, 3) secure transfer pumps associated with waste tank recirculation, and 4) restore primary purge ventilation or install/and operate portable ventilation. Actions 1, 2, and 3 will stop sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste (or waste containing Isopar® L) is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. It is assumed that the average bulk waste temperature for Tank 50 is within limits prior to the Seismic event; however, Actions 2 and 3 prevent additional heat input to the waste. The confinement capability of the waste tank structure provides a second level of control for Tank 50. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control for Tank 50 is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank 50 Explosion event and response to the event to minimize the potential release/personnel exposure.

For the remaining waste tanks, the controls addressing the release of trapped gas during seismic events vary, depending on the ongoing activities and the ability of the waste tank vapor space to exceed the Gas Release Criteria.

For waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) <u>which are involved</u> in activities that have the potential to cause the tank vapor space to exceed the Gas Release Criteria, the following three levels of control are required. The Waste Tank Quiescent Time Program (Seismic Release Protection) is the first level of control following the Seismic event. Also part of the first level of control are the waste tank ventilation low flow interlocks and Gas Release Program. The ventilation low flow interlocks shall ensure the waste tank mixing devices, saltcake interstitial liquid removal, and bulk saltcake dissolution activities are stopped on ventilation low flow conditions (as previously described in Controls for Waste Tanks Undergoing Planned Gas Release Activities). The Gas Release Program ensures that the associated activity is controlled (to limit the planned release of trapped gas) to maintain the waste tank bulk vapor space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification. For the second level of control, a high hydrogen concentration interlock is required. The high hydrogen concentration interlock shall ensure the waste tank mixing devices, saltcake interstitial liquid removal, and bulk saltcake dissolution activities are stopped on high hydrogen concentration in the tank vapor space (as previously described in Controls for Waste Tanks Undergoing Planned Gas Release Activities). The mitigative confinement capability of

the waste tank structure provides a third level of control. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

For waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) which are not involved in activities that have the potential to cause the tank vapor space to exceed the Gas Release Criteria, the following three levels of control are required. The Waste Tank Quiescent Time Program (Seismic Release Protection) in conjunction with the Event Response Program (operator response) is the first level of control following the Seismic event. Operator response includes the following: 1) secure waste tank liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), 2) secure waste tank mixing devices, 3) secure transfer pumps associated with waste tank recirculation, 4) restore primary purge ventilation or install/operate portable ventilation (prioritized on a time to LFL basis), and 5) perform manual hydrogen monitoring upon loss of ventilation. Actions 1, 2, and 3 will stop sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. The mitigative confinement capability of the waste tank structure provides a second level of control. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

For waste tanks that are not under the Waste Tank Quiescent Time Program (Seismic Release Protection) which are involved in activities that have the potential to cause the tank vapor space to exceed the Gas Release Criteria, the following three levels of control are required. The first level of control is the waste tank ventilation low flow interlocks and Gas Release Program. The ventilation low flow interlocks shall ensure the waste tank mixing devices, saltcake interstitial liquid removal, and bulk saltcake dissolution activities are stopped on ventilation low flow conditions (as previously described in Controls for Waste Tanks Undergoing Planned Gas Release Activities). The Gas Release Program ensures that the associated activity is controlled (to limit the planned release of trapped gas) to maintain the waste tank bulk vapor space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification. For the second level of control, a high hydrogen concentration interlock is required. The high hydrogen concentration interlock shall ensure the waste tank mixing devices, saltcake interstitial liquid removal, and bulk saltcake dissolution activities are stopped on high hydrogen concentration in the tank vapor space (as previously described in Controls for Waste Tanks Undergoing Planned Gas Release Activities). The mitigative confinement capability of the waste tank structure provides a third level of control. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

For waste tanks that are not under the Waste Tank Quiescent Time Program (Seismic Release Protection) which are not involved in activities that have the potential to cause the tank vapor space to exceed the Gas Release Criteria, the following three levels of control are required. The first level of control for these waste tanks is the Event Response Program (operator response) following the Seismic event. Operator response includes the following: 1) secure waste tank liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), 2) secure waste tank mixing devices, 3) secure transfer pumps associated with waste tank recirculation, and 4) restore primary purge ventilation or install/operate portable ventilation (prioritized on a time to LFL basis). Actions 1, 2, and 3 will stop sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. The mitigative confinement capability of the waste tank structure provides the second level of control. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

The Flammability Control Program is inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring the following:

- Only seven waste tanks can reach LFL in less than 24 hours (assuming no ventilation and including the effects of post-seismic trapped gas release)
- Only 14 waste tanks can reach LFL in less than seven days including:
  - Effects of post-seismic trapped gas release, assuming no ventilation
  - Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

In determining the post-seismic time to LFL, the engineering evaluation shall use the methodology of Section 3.4.1.5.3 and shall consider the solids layers (saltcake, settled sludge, and slurried sludge) available for trapped gas release within the waste tank. The evaluation shall be based on the actual waste contents and vapor space volume, flammable vapor contributions (from trace organics, trapped gas release from affected solids layers, and radiolytic hydrogen generation), and considers atmospheric breathing only (see Section 3.4.1.5.5). The evaluation shall use an assumed initial hydrogen concentration of 2.5% of the LFL or radiolytic hydrogen equilibrium concentration accounting for minimum ventilation flow (based on waste tank flammability classification [atmospheric breathing for Very Slow Generation Tanks]), whichever is higher. Use of an initial hydrogen concentration of 2.5% of the LFL (or radiolytic hydrogen

equilibrium concentration, whichever is higher) is considered acceptable for this seismic risk categorization/prioritization (versus use of the hydrogen concentration safety analysis value). For waste tanks which require continuous purge by the waste tank ventilation system (e.g., Rapid Generation Tanks, Slow Generation Tanks), the ventilation system will typically maintain the radiolytic hydrogen concentration less than 2.5% of the LFL as evidenced by numerous years of waste tank operations. Additionally, this control is primarily used for risk characterization and establishing response prioritization of waste tanks for seismically induced loss of ventilation events.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent waste tanks from becoming flammable in seven days following a seismic event are maintained functional and available (see Section 5.5.2.13).

Although not part of the credited controls scheme, programmatic controls shall be established to ensure that a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks (more than 14) to have the potential to become flammable in less than seven days following a seismic event. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

Waste Tank Quiescent Time Program

This subsection does not apply to Type I/II Acidic Chemical Cleaning Waste Tanks (refer to Controls for Type I/II Acidic Chemical Cleaning Waste Tanks subsection). This subsection describes the criteria/methodology for the Waste Tank Quiescent Time Program (when required, as stated in Routine Flammability Controls subsection or Controls Addressing Release of Trapped Gas During a Seismic Event subsection).

The Waste Tank Quiescent Time Program is applicable to waste tanks that contain slurried sludge. This program is also applicable to waste tanks that contain settled sludge, if the waste tank was placed under the Seismic Release Protection portion of the program. This condition could occur in these waste tanks if the slurried sludge became settled sludge (i.e., meets requirements of Section 3.4.1.5.3) due to lack of sludge agitation (e.g., waste tank has infinite quiescent time).

The Waste Tank Quiescent Time Program provides different safety functions dependent upon whether the waste tank has completed full sludge inventory initial trapped gas depletion via mixing operations (Seismic Release Protection) or the waste tank contains a slurried sludge layer as a direct result of sludge agitation via waste tank mixing devices or receipt of slurried sludge via a transfer (Spontaneous Liberation Protection). The Waste Tank Quiescent Time Program is credited with controlling the waste tanks to ensure:

- Waste tanks under the Seismic Release Protection portion of the program will not reach 100% of the LFL (CLFL for Tank 50) (due to trapped gas release from the settled sludge / slurried sludge and subsequent radiolytic hydrogen production) in less than seven days following a seismic event.

- Waste tanks under the Spontaneous Liberation Protection portion of the program will maintain the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification (see Routine Flammability Controls subsection).

  This portion of the program protects spontaneous liberation events in these waste tanks, and is not credited to mitigate/prevent Waste Tank Explosion events (post-seismic). The credited controls that mitigate seismically-induced explosions are discussed in Controls Addressing Release of Trapped Gas During a Seismic Event subsection.

Waste tanks under the Waste Tank Quiescent Time Program are controlled to ensure that the applicable criteria (Seismic Release Protection and/or Spontaneous Liberation Protection) are not exceeded, by one or both of the following methods:

- Periodically operate waste tank mixing devices in the applicable sludge layer to limit the amount of trapped gas that can be released.
- Maintain waste tank configuration (e.g., waste level, slurried sludge level) to limit the amount of trapped gas that can be released and ensure adequate waste tank vapor space volume.

The Waste Tank Quiescent Time Program is credited with determining and tracking waste tanks required to be in the Waste Tank Quiescent Time Program (Seismic Release Protection and Spontaneous Liberation Protection). Waste tanks are placed under the Seismic Release Protection portion of the Waste Tank Quiescent Time Program after successful initial full inventory sludge mixing (i.e., hydrogen depletion). Initial sludge mixing is achieved upon completion of an adequate number of fully inserted waste tank mixing devices operating (with the turntable operating) for a cumulative period of 10 days. At this point, operation of the waste tank mixing devices will not result in any additional trapped hydrogen release from sludge disturbance. For waste tanks that contain a saltcake layer beneath the sludge layer, the same criteria applies for placing the waste tank under the Seismic Release Protection portion of the program; however, saltcake level must be considered for determining depth of "fully inserted" waste tank mixing devices and completion of full inventory sludge mixing (i.e., saltcake level would be considered the waste tank bottom for relationship of waste tank mixing devices). Additionally, waste tanks will be placed under the Seismic Release Protection portion of the Waste Tank Quiescent Time Program if the waste tank initially contains no sludge (even if saltcake is present), but receives slurried sludge via a transfer. Waste tanks will remain in the Seismic Release Protection portion of the program until the program is no longer applicable due to waste tank conditions (e.g., Type I/II Acidic Chemical Cleaning Waste Tanks, Closure Waste Tanks, settled sludge / slurried sludge layers removed). As discussed previously, waste tanks will remain in the Seismic Release Protection portion of the program even if the slurried sludge within the waste tank becomes settled sludge.

Waste tanks are placed under the Spontaneous Liberation Protection portion of the Waste Tank Quiescent Time Program when the waste tank contains a slurried sludge layer as a direct result of sludge agitation via waste tank mixing devices or receipt of slurried sludge via a transfer (including waste tanks in the Seismic Release Protection portion of the Waste Tank Quiescent

Time Program). Waste tanks will remain in the Spontaneous Liberation Protection portion of the program until the program is no longer applicable due to waste tank conditions (e.g., Type I/II Acidic Chemical Cleaning Waste Tanks, Closure Waste Tanks, slurried sludge layer becomes settled sludge, slurried sludge layer removed). Waste tanks may be removed from the Spontaneous Liberation Protection portion of the program if the slurried sludge within the waste tank becomes settled sludge (i.e., meets requirements of Section 3.4.1.5.3).

The Waste Tank Quiescent Time Program shall perform the following to determine applicability of waste tanks to the Seismic Release Protection and/or Spontaneous Liberation Protection portion(s) of the program:

- Evaluation of sludge slurry transfers to waste tanks to determine if the transfer warrants placing the waste tank (due to slurried sludge receipt) in the applicable portion(s) of the program.
- Evaluation of waste tank mixing device operation in waste tanks containing sludge to determine if the operation warrants placing the waste tank (due to sludge agitation) in the applicable portion(s) of the program.

For waste tanks in the Waste Tank Quiescent Time Program, trapped gas release is only considered from the applicable sludge layers (settled sludge / slurried sludge for Seismic Release Protection; slurried sludge for Spontaneous Liberation Protection). Other solids layers above (saltcake) or below (saltcake and/or settled sludge) the applicable sludge layer are not controlled as part of the Waste Tank Quiescent Time Program. However, the Flammability Control Program considers all the solids layers (saltcake, settled sludge, and slurried sludge) in the waste tank when determining/tracking the post-seismic trapped gas release time to reach LFL.

An integral part of this program (Seismic Release Protection and Spontaneous Liberation Protection) is to determine the maximum time that the settled sludge / slurried sludge (as applicable) can remain undisturbed and still not retain sufficient hydrogen to cause the tanks vapor space to exceed the applicable criteria if a hydrogen release event were to occur (e.g., earthquake). This time, referred to as the quiescent time, is calculated based upon the following conservative inputs and assumptions:

- The quiescent time is the time from the end of the last successful hydrogen depletion operation (waste tank mixing device operation) or the time that the program became applicable to the start of the next hydrogen depletion operation.

  For waste tanks that receive transfers of slurried sludge that cause the waste tank to be placed in the Seismic Release Protection and/or Spontaneous Liberation Protection portion(s) of the program, the quiescent time starts at the end of the transfer.

  For waste tanks that are undergoing initial sludge agitation using waste tank mixing devices (Spontaneous Liberation Protection), the quiescent time starts from the end of successful sludge agitation for an affected sludge layer. Successful sludge agitation occurs upon completion of an adequate number of waste tank mixing devices operating within acceptable times/speeds (with the turntable operating) for a cumulative period of 10 days. At this point, the affected sludge layer within the zone

of influence of the waste tank mixing devices (i.e., based on tank cross sectional area and sludge disturbance depth as defined in Section 3.4.1.5.3.6 for settled sludge agitation) is considered slurried sludge. If sludge agitation is stopped prior to completion of successful sludge agitation, the quiescent time does not start (and the sludge may still be considered settled sludge) for that sludge layer. This allowance is meant to address process upsets which may occur while mixing a sludge layer that require significant recovery efforts (e.g., failure of a waste tank mixing device during slurrying), and is not intended to be used for operational convenience to avoid treating the sludge layer being mixed as slurried sludge. Additionally, this provision is valid as long as waste tank mixing devices are not lowered. Should any waste tank mixing device be lowered, the affected sludge layer within the zone of influence of the waste tank mixing devices (based on the mixing device location prior to lowering, as described above) shall be considered slurried sludge.

- The hydrogen generation rate equations in Section 3.4.1.1.2 are used to determine the amount of hydrogen generated during the quiescent time. In determining the time to LFL (CLFL for Tank 50) or quiescent time for waste tanks in the Waste Tank Quiescent Time Program, the engineering evaluation shall use the methodology of Section 3.4.1.5.3. The evaluation shall be based on the actual waste contents and vapor space volume, flammable vapor contributions (from Isopar® L [Tank 50 only], trace organics, trapped gas release from settled sludge / slurried sludge [as applicable], and radiolytic hydrogen generation), and considers atmospheric breathing only (see Section 3.4.1.5.5). Evaluations for Seismic Release Protection shall consider trapped gas release from settled sludge and slurried sludge. Evaluations for Spontaneous Liberation Protection shall consider trapped gas release from slurried sludge. The evaluation shall use an assumed initial hydrogen concentration of 25% of the LFL or radiolytic hydrogen equilibrium concentration for Very Slow Generation Tanks, whichever is higher (for Tank 50, the initial hydrogen concentration is 3.8% of the LFL).

  For waste tanks in the Waste Tank Quiescent Time Program, use of an initial hydrogen concentration of 25% of the LFL (or radiolytic hydrogen equilibrium concentration for Very Slow Generation Tanks, whichever is higher) is considered acceptable for seismic or spontaneous liberation analysis (versus use of the hydrogen concentration safety analysis value). For waste tanks which require continuous purge by the waste tank ventilation system (e.g., Rapid Generation Tanks, Slow Generation Tanks), the ventilation system is adequate to maintain the radiolytic hydrogen concentration less than 25% of the LFL. Very Slow Generation Tanks do not require continuous purge by the waste tank ventilation system and the initial hydrogen concentration may exceed 25% of the LFL. Therefore, use of the waste tank specific radiolytic hydrogen equilibrium concentration may need to be applied for these waste tanks. Additionally, the waste tank flammability classification considers waste tanks that contain slurried sludge (for Spontaneous Liberation Protection), and conservatively assumes 100% instantaneous release from the slurried sludge layer (even though spontaneous liberation does not result in an instantaneous/full release).

- The quiescent time is the allowable time between waste tank mixing device operation such that the hydrogen released from the settled sludge / slurried sludge (as applicable) does not cause the waste tank vapor space to exceed the following criteria:
  - Reach LFL (CLFL for Tank 50) in less than seven days post-seismic (due to flammable vapor contributions described above) for Seismic Release Protection
  - Reach LFL (CLFL for Tank 50) in less than seven days for a Rapid Generation Tank (due to flammable vapor contributions described above) for Spontaneous Liberation Protection
  - Reach LFL (CLFL for Tank 50) in less than 28 days for a Slow Generation Tank (due to flammable vapor contributions described above) for Spontaneous Liberation Protection
  - Reach LFL (CLFL for Tank 50) for a Very Slow Generation Tank (due to flammable vapor contributions described above) for Spontaneous Liberation Protection
- The percent of the hydrogen generated during the quiescent time that is retained in the slurried sludge is described in the Trapped Gas Release discussion in Section 3.4.1.5.3.

Retained gas is released when adequate mixing occurs. The following addresses the requirements for declaring hydrogen depletion success for a given tank sector (e.g., waste tank mixing device run times/speeds, number of waste tank mixing devices required). These requirements apply to waste tanks if the entire sludge layer or entire tank contents are slurried sludge (once the program becomes applicable to a waste tank). Empirical trapped gas release data from the waste tank under consideration or an engineering evaluation utilizing effective cleaning radius (using actual waste tank mixing device parameters) may be evaluated to permit operation other than that described below and still claim adequate mixing occurs to deplete the trapped hydrogen inventory in the tank or slurried sludge layer.

- For Tank 50, Reference 240 demonstrates that adequate solids mixing of the tank occurs after successful completion of a 4 hour pump run at maximum allowable speed with three slurry pumps (assuming two of the three pumps are the quad-volute slurry pumps and the Tank 50 solids content is less than or equal to 20 wt. %). Thus, the trapped gas inventory in the tank can be removed with three slurry pumps operating in this manner that ensures adequate mixing. For this waste tank, it has been demonstrated by Reference 240 that a single slurry pump (standard or quad-volute) is capable of depleting approximately 33% of the retained hydrogen inventory in the tank. Therefore, for operational slurry pump configurations outside that described above (two quad-volute pumps and one standard pump), the effect of a non-operational pump is that it could leave up to 33% of the tank contents inadequately mixed, retaining the trapped gas inventory.
- For the remaining waste tanks, operational experiences (and analysis performed in Reference 296 for CSMPs) have demonstrated that adequate mixing occurs after successful completion of slurry pump/CSMP operation for an 8-hour period at

maximum allowable speed with evidence of adequate sludge mixing (e.g., camera inspection, motor loading within acceptable ranges). For a waste tank, it has been demonstrated that a single slurry pump/CSMP is capable of depleting at least 25% of the retained hydrogen inventory in the tank or slurried sludge layer. Thus, the trapped gas inventory in the tank or slurried sludge layer can be removed with four slurry pumps or CSMPs operating in a manner that ensures adequate mixing. Likewise, the effect of a non-operational pump is that it could leave up to 25% of the tank or slurried sludge layer contents inadequately mixed, retaining the trapped gas inventory. CSMP information is conservatively based on CSMP flow rates and the calculated effective cleaning radius performed in Reference 296. For SMPs, Reference 212 demonstrates that a single SMP operated for an 8-hour period at maximum allowable speed theoretically has sufficient mixing capability to deplete at least 50% of the retained hydrogen inventory in the tank or slurried sludge layer. Reference 212 also demonstrates the trapped gas inventory in the tank or slurried sludge layer can be removed with two or three SMPs (depending on waste tank type and SMP riser location) operating in a manner that ensures adequate mixing. The effect of a non-operational SMP is that it could leave up to 50% of the tank or slurried sludge layer contents inadequately mixed, retaining the trapped gas inventory (regardless of whether two or three SMPs are required for 100% depletion).

As discussed in Section 3.4.1.5.3, it is recognized under certain waste tank conditions during a process upset associated with typical initial sludge agitation processing plans, only a portion of the sludge layer may become slurried sludge within a waste tank. Additionally, cases could occur where the entire sludge layer may not be actually mixed (e.g., due to limited number of waste tank mixing devices operated in the sludge layer), but the layer is considered slurried sludge based on inputs in Section 3.4.1.5.3 for settled sludge agitation. For example, time based operation of only one SMP (or two slurry pumps/CSMPs) is assumed to cause the entire sludge layer (100% cross sectional area) to become slurried sludge. However, the entire sludge layer would not actually be mixed as the settled sludge agitation input is a conservative maximum value for sludge disturbance. The requirements for declaring hydrogen depletion success (stated above), assume an entire layer or entire tank contain slurried sludge (or contain sludge that was actually mixed) and would not be applicable to these scenarios. Should this situation occur (where only a portion of a sludge layer is considered slurried sludge or a portion of the sludge layer is actually mixed), an engineering evaluation shall be completed to determine the requirements for hydrogen depletion for this waste tank. The evaluation shall consider the location of the waste tank mixing device(s) used for hydrogen depletion in relationship to the area of slurried sludge (or portion of the sludge layer that is actually mixed), and determine the resulting trapped gas depletion/retention percentage.

SMP Column Explosion

This event is prevented by the SMP Column Pressure Boundary and SMP Flush/Motor Pressure Boundary, which serves as the first level of control. These pressure boundaries are designed to prevent waste from entering the column thus preventing an SMP Column Explosion.

Instrumentation to detect the release (i.e., ARM with control room notification) was credited as the second level of control. The instrumentation will alert operators to the event and allow for mitigation. The ARM Location Program is credited for ensuring the proper placement of the ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication). The ARM is credited with mitigating the SMP Column Explosion only during SMP operation, based on the higher risk of an ignition source being present at this time.

The third level of control is the waste tank structure. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The Emergency Response Program is also part of the third level of control. This program governs personnel evacuation following the SMP Column Explosion event and response to the event to minimize the potential release/personnel exposure. The immediate vicinity worker risk is eliminated by the pressure boundaries credited as the first level of control for the Onsite worker.

3.4.2.11.2 FREQUENCY DETERMINATION

The HA classifies Waste Tank Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL significantly reduces the probability of a Waste Tank Explosion.

3.4.2.11.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.11.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Waste Tank Explosion STs and are all taken from References 2, 206, 246, and 268 unless otherwise stated:

- For Type I/II Acidic Chemical Cleaning Waste Tanks, the maximum temperature of the vapor space and waste in the tank is 75°C
- The slurry pump column volume is 55 ft^3 (Types I, II, III, IIIA, and IV Waste Tanks). This volume is associated with a quad-volute slurry pump
- The SMP pump column volume is 66 ft^3
- The maximum settled sludge depth in waste tanks with no saltcake above the settled sludge is 90 inches

- The maximum settled sludge depth in waste tanks with saltcake below the settled sludge is 50 inches (for the saltcake depth, 40 inches of saltcake was used in the analysis as saltcake depths greater than this value will not contribute to the amount of trapped gas released)

3.4.2.11.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion (detonation or deflagration) model. The value of each of the terms is specific to the location being analyzed.

Material at Risk

The MAR varies for the different Waste Tank Explosion scenarios as described below:

- The MAR for a Type I, II, III, IIIA Slurry Pump Column Explosion (excluding Tank 50) is Bounding Supernate
- The MAR for an SMP Column Explosion is Bounding Sludge Slurry
- The MAR for Type I, II, III, or IIIA Waste Tank Explosion (excluding Tank 50 and waste tanks not under the Waste Tank Quiescent Time Program [Seismic Release Protection] [seismic]) is Bounding Sludge Slurry
- The MAR for seismic Waste Tank Explosions on waste tanks not under the Waste Tank Quiescent Time Program (Seismic Release Protection) (which are not performing gas release activities, but have the potential to exceed the Gas Release Criteria) is Bounding Supernate (Ref. 58)
- The MAR for a Tank 50 Waste Tank Explosion or Slurry Pump Column Explosion is Tank 50 Supernate
- The MAR for a Type IV Waste Tank Explosion or Type IV Waste Tank Slurry Pump Column Explosion is Slurried Type IV Tank Waste

The waste characteristics and inhalation dose potential on a per unit volume basis for the various streams is given in Section 3.4.1.5.1.

The volume of MAR for the Waste Tank and Pump Column Explosions is all of the waste in the waste tank or pump column prior to the explosion.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1).

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.11.3.3 Flammable Vapor Concentration Models

For the Tank 50 analyses, a flammable vapor concentration of Isopar® L at stoichiometric conditions was used. For the remaining waste tanks, the flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present for each of the locations of concern. The hydrogen concentration and percent LFL at the time of the explosion are determined in References 2 and 268 using the flammable vapor concentration formulas described in Section 3.4.1.1.2.

3.4.2.11.3.4 Explosion (Deflagration/Detonation) Source Term

For the Tank 50 analyses, a detonation is assumed to occur and the TNT equivalent model is used. The mass of liquid (ST) made airborne by the detonation is set equal to the mass of TNT that produces the same energy as is produced by the combustible gas mixture consumed during the detonation. A stoichiometric mixture for Isopar® L is assumed in the analyses.

For the remaining waste tanks, the ST is dependent on whether a deflagration or detonation occurs. If the hydrogen concentration is between the LFL and the LEL, a deflagration is assumed to occur. If the hydrogen concentration is at LEL or above, a detonation is assumed to occur. If the hydrogen concentration is below the LFL, no event will occur. The explosion is modeled in the ST calculation using either the detonation model or deflagration model, depending on whether the LFL or LEL has been reached (discussed further in Section 3.4.1.1.2).

3.4.2.11.3.5 Type IV Waste Tank Source Term Calculation

Unmitigated Waste Tank Explosion consequences were calculated for Type IV Waste Tanks. The analysis (Ref. 2) that was performed assumed a Type IV Waste Tank filled to the overflow point with Slurried Type IV Tank Waste. A bounding, fixed hydrogen generation rate of 2.6E-06 ft^3/gal-hr was used. The effect of atmospheric breathing was also included. The analysis added hydrogen to the equilibrium hydrogen concentration calculated at each level to account for trapped gas release. Parametric analysis was performed varying the amount of trapped hydrogen released and tank level. A model was developed to analyze the effects of a detonation or deflagration of the hydrogen gas at calculated conditions within the tank. Doses were calculated as a function of tank level, to obtain the maximum dose. The unmitigated Type IV Waste Tank Explosion consequences are based on a reasonably conservative value of

8,000 ft^3 of hydrogen for trapped gas contribution. This value of trapped hydrogen equates to approximately 110 inches of sludge in the waste tank utilizing conservative assumptions from Section 3.4.1.5.3 for slurried sludge (trapped gas bubble gas volume, hydrogen percent in trapped gas). Typically, Type IV waste tanks contain sludge levels significantly below this value.

3.4.2.11.3.6 Pump Column Detonation Source Term Calculation (Excluding Tank 50 and Type IV Waste Tanks)

For the waste tank pump column explosion analyses (Ref. 2, 206), two different pump columns were identified for consideration. The first pump identified is a quad-volute slurry pump used in sludge slurry tanks with an assumed column volume of 55 ft^3. The second is an SMP used in the sludge slurry tanks with an assumed column volume of 66 ft^3. The analysis using these two pump types is bounding for the other pump types used in the CSTF.

The SMP pump columns are assumed to contain slurry material representative of the sludge slurry found in the waste tanks. The slurry pump column is assumed to contain material representative of the supernate found in the waste tanks with a residual amount of sludge collected at the bottom of the slurry pump column. The hydrogen concentration is assumed to reach stoichiometric conditions, providing the most conservative calculation. In this scenario, it is assumed that when the explosion occurs, a seal (slurry pump) to the outside atmosphere fails or the column is vented (SMP) and the contents of the pump column are released to the atmosphere. The ST is calculated using the detonation model, discussed further in Section 3.4.1.1.2.

3.4.2.11.3.7 Tank 50 Pump Column Detonation Source Term Calculation

For the Tank 50 pump column explosion analyses (Ref. 226), a quad-volute slurry pump is used with an assumed column volume of 55 ft^3. The pump columns are assumed to contain Tank 50 Supernate material. The Isopar® L concentration is assumed to reach stoichiometric conditions, providing the most conservative calculation. In this scenario, it is assumed that when the explosion occurs, a seal to the outside atmosphere fails and the contents of the pump column are released to the atmosphere. The ST is calculated using the detonation model, discussed further in Section 3.4.1.1.2.

3.4.2.11.3.8 Type IV Waste Tank Pump Column Detonation Source Term Calculation

For the Type IV Waste Tank pump column explosion analyses (Ref. 2), an Advance Design Mixer Pump (ADMP) was used with an assumed column volume of 90 ft^3. The ADMP is no longer used and is grouted in place; however, the column volume of 90 ft^3 is more conservative than the 55 ft^3 volume of the quad-volute slurry pump column, and bounds the Slurry Pump Column Explosion scenario for the Type IV Waste Tank. The pump columns are assumed to contain Slurried Type IV Tank Waste. The hydrogen concentration is assumed to reach stoichiometric conditions, providing the most conservative calculation. In this scenario, it is assumed that when the explosion occurs, a seal to the outside atmosphere fails and the contents of the pump column are released to the atmosphere. The ST is calculated using the detonation model, discussed further in Section 3.4.1.1.2.

3.4.2.11.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Waste Tank Explosion event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 2, 206, 226, 255, 268).

The unmitigated and mitigated Offsite consequences for the Tank 50 Explosion (≤ 0.1 rem) and Type IV Waste Tank Explosion (≤ 1.5 rem) do not challenge the Offsite EGs. For the remaining waste tanks, the Waste Tank Explosion unmitigated consequences are assumed to be greater than 25 rem to the Offsite receptor. For waste tanks that have the potential for the tank vapor space to reach LFL due to trapped gas release during a seismic event, the mitigated Offsite consequences for Waste Tank Explosions (≤ 2.1 rem) do not challenge the Offsite EGs. These consequences also bound the mitigated Offsite consequences associated with Waste Tank Explosions due to flammable transients (Ref. 307). For the remaining waste tanks, the mitigated Offsite consequences are zero because the event is prevented.

Waste Tank Explosions result in unmitigated consequences of greater than 100 rem to the Onsite receptors. For waste tanks that have the potential for the tank vapor space to reach LFL due to trapped gas release during a seismic event, the mitigated Onsite consequences for Waste Tank Explosions are assumed to be greater than 100 rem to the Onsite receptors. For the remaining waste tanks, the mitigated Waste Tank Explosion Onsite consequences are zero because the event is prevented. Also for these remaining waste tanks, the consequences to the immediate vicinity worker are also zero because the event is prevented.

The unmitigated and mitigated Offsite consequences (≤ 0.15 rem) for the bounding pump column explosion (SMP Column Explosion) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding pump column explosion scenario (SMP Column Explosion) exceed the Onsite EGs. The mitigated Onsite consequences for the SMP Column Explosion are zero because the event is prevented. The unmitigated and bounding mitigated Onsite consequences (≤ 36 rem) for the Slurry Pump Column Explosion scenario (Type I/II/III/IIIA, except Tank 50) do not exceed the Onsite EGs. The unmitigated and mitigated Onsite consequences (≤ 8 rem) for the Type IV Waste Tank Slurry Pump Column Explosion scenario do not exceed the Onsite EGs. The immediate vicinity worker risk due to an SMP Column Explosion is judged not to exceed the applicable Onsite EGs due to the SMP Column Pressure Boundary, SMP Flush/Motor Pressure Boundary, ARMs, waste tank structure, and Emergency Response Program. The immediate vicinity worker risk for other pump column (non-SMP) explosions is also judged not to exceed the applicable Onsite EGs because of the waste tank structure.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.11.5. The consequences of the Waste Tank Explosion events following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.11.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Waste Tank Explosion event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Closure Waste Tanks.

3.4.2.11.5.1 Safety Class Controls

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

Acidic Spray Washing Controls: During acidic spray washing activities on Type I/II Acidic Chemical Cleaning Waste Tanks, liquid additions shall be limited to those from batch sources less than or equal to 8,000 gallons total volume that do not have a continuous makeup capability.

Event Response Program: Procedures shall be established governing required actions following a Seismic event. These procedures shall require the following operator actions:

1) Secure waste tank liquid transfers (excluding evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs).

2) Secure waste tank mixing devices.

3) Secure transfer pumps associated with waste tank recirculation.

4) Restore primary purge ventilation or install/operate portable ventilation systems on waste tanks, prioritized on a time to LFL (CLFL for Tank 50) basis.

5) Perform manual hydrogen monitoring of waste tanks (excluding Tank 50) under the Waste Tank Quiescent Time Program (Seismic Release Protection) upon loss of ventilation.

The portable ventilation systems are not required to be functionally classified as SC equipment. Additional information regarding portable ventilation system requirements can be found in Section 5.5.2.13.

Flammability Control Program: The Flammability Control Program provides the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

1) Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification. For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tanks shall be classified as Chemical Cleaning Tanks and the time to LFL (three days) is not calculated.

2) Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50, Very Slow Generation Tanks, and Type I/II Acidic Chemical Cleaning Waste Tanks). The hydrogen concentration LFL limit shall account for potential organics.

3) Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the tank vapor space to reach the LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks).

4) Determine, track, and ensure that only seven waste tanks can reach LFL in less than 24 hours assuming no ventilation and including the effects of post-seismic trapped gas release.

5) Determine, track, and ensure that only 14 waste tanks can reach LFL in less than seven days including:

   - Effects of post-seismic trapped gas release, assuming no ventilation

   - Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

   Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks to have the potential to become flammable in less than seven days. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

Gas Release Program: The Gas Release Program shall require the following to protect hydrogen concentration assumptions in the waste tank bulk vapor space during waste tank mixing device operation, bulk saltcake dissolution, saltcake interstitial liquid removal, or free supernate removal activities: (For Type IV Waste Tanks and Tank 50 this control is required to be SS only)

1) Prior to initiating sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities, determine if the activity will cause the waste tank to exceed the Gas Release Criteria stated in Section 3.4.2.11.1.

2) Prior to initiating sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities, controls shall be established to ensure the waste tank bulk vapor space hydrogen concentration is less than or equal to the initial value assumed in the hydrogen release engineering evaluation.

3) For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the activity shall be controlled to maintain the waste tank bulk vapor space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification.

4) Prior to initiating free supernate removal activities (excluding Very Slow Generation Tanks), controls shall be established to ensure the waste tank bulk vapor space hydrogen concentration is less than or equal to 2.5% of the LFL.

5) Prior to initiating free supernate removal activities, ensure that the resultant free supernate hydrogen release rate is within limits to maintain the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification (and associated minimum ventilation flow rate requirements).

6) Prior to operation of a waste tank mixing device in a waste tank containing only slurried sludge (for a mixing device that has not been operated within 180 days), ensure the waste tank level is within limits to ensure adequate vapor space volume for flammable transients.

7) Prior to operation of a waste tank mixing device in a waste tank containing saltcake, settled sludge, or any combination of saltcake, settled sludge, or slurried sludge, ensure the waste tank level is within limits to ensure adequate vapor space volume for flammable transients.

For Items 6 and 7, these controls are required to be SS only.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. For

Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCPs provide control room alarm following a waste tank high level condition (with maximum levels less than or equal to 63.8 inches [Type I] and 64.8 inches [Type II]) to protect assumed initial tank conditions for determination of flammability control requirements (e.g., minimum ventilation flow) for waste tanks classified as a Chemical Cleaning Tank. (For Type IV Waste Tanks and Tank 50 this control is required to be SS only)

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions, excluding Type I/II Acidic Chemical Cleaning Waste Tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following (applicable for waste tanks that are receiving Chemical Cleaning Transfers [or related vent/drain operations]):

- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering waste tanks outside of the intended transfer path.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain operation shall only be permitted to the waste tanks associated with the vent/drain path.
- Prior to transfer initiation of a Chemical Cleaning Transfer (or related vent/drain operations), verification shall be performed to ensure that sufficient inhibitors are present in the applicable receipt waste tank to ensure neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers (or related vent/drain operations), at least one waste tank mixing device shall be operating in the applicable receipt waste tank to ensure adequate mixing and neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers, acidic waste shall enter the receipt tank via a flowpath that is below the waste tank liquid level.

Waste Tank Chemical Cleaning Program: Controls shall be established to ensure that prior to waste tank mixing device operation, sufficient water has been added to the waste tank to ensure the OA content in the waste tank (once mixed) will be less than or equal to 4 wt. % (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Purge Ventilation System (excluding Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks): The Waste Tank Purge Ventilation System for Rapid Generation Tanks and Slow Generation Tanks shall provide sufficient purge flow rate through the tank to maintain the tank bulk vapor space less than or equal to 25% of the LFL (accounting for dissolved hydrogen release from steam jetted transfers [excluding Tanks 40 and 51 when classified as an ESP Sludge Slurry Waste Tank] and radiolytic hydrogen generation). This function will ensure that the tank bulk vapor space is maintained less than or equal to the hydrogen concentration safety analysis value and protect the initial hydrogen concentration to ensure that the minimum

time to LFL associated with the waste tank flammability classification is protected. For Very Slow Generation Tanks during receipt of a steam jetted transfer, the ventilation system shall provide sufficient purge flow rate through the tank (accounting for dissolved hydrogen release) to ensure that the minimum time to LFL associated with the waste tank flammability classification is protected. During free supernate removal activities on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function (in conjunction with the Gas Release Program) maintains the minimum time to LFL defined by the waste tank flammability classification (and associated minimum ventilation flow rate requirements). For spontaneous liberation events and other activities (sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal) on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function minimizes the potential for reaching a flammable vapor concentration by providing a continuous purge of the tank vapor space. For activities (sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal) that exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the ventilation system provides sufficient purge flow rate through the tank (in conjunction with the Gas Release Program) to maintain the waste tank bulk vapor space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification. Local flow indication shall be provided for Rapid Generation Tanks and waste tanks undergoing sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities that exceed the Gas Release Criteria stated in Section 3.4.2.11.1. The Waste Tank Purge Ventilation System for Rapid Generation Tanks shall provide at least 72-scfm airflow (measured using installed flow indication). The Waste Tank Purge Ventilation System for Slow Generation Tanks shall provide at least 45-scfm airflow (no flow measurement required). The Waste Tank Purge Ventilation System for Very Slow Generation Tanks (when receiving a steam jetted transfer) shall provide at least 45-scfm airflow (no flow measurement required). The Waste Tank Purge Ventilation System for Tanks 40 and 51 (when classified as an ESP Sludge Slurry Waste Tank) shall provide at least 188-scfm airflow (measured using installed flow indication). For waste tanks undergoing sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the Waste Tank Purge Ventilation System shall provide at least 72-scfm (188-scfm for Tanks 40 and 51) airflow (measured using installed flow indication). (For Type IV Waste Tanks, this control is required to be SS only)

<u>Waste Tank Purge Ventilation System (Type I/II Acidic Chemical Cleaning Waste Tanks)</u>: The Waste Tank Purge Ventilation System for waste tanks classified as a Chemical Cleaning Tank shall maintain the concentration of flammable vapors in the waste tank bulk vapor space to less than or equal to the safety analysis value (25%) accounting for radiolytic and corrosion induced hydrogen generation and trapped gas release from 10,000 gallons of sludge. Local flow indication shall be provided for Chemical Cleaning Tanks. The Waste Tank Purge Ventilation System for Chemical Cleaning Tanks shall provide at least 110-scfm airflow (measured using installed flow indication).

Waste Tank Quiescent Time Program: The Waste Tank Quiescent Time Program shall require the following to protect assumed times to LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks): (For Type IV Waste Tanks and Tank 50 this control is required to be SS only)

1) Determine and track waste tanks required to be in the Waste Tank Quiescent Time Program (Seismic Release Protection and Spontaneous Liberation Protection).

2) Waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) shall be controlled to ensure that the waste tanks will not reach 100% of the LFL (CLFL for Tank 50) (due to trapped gas release from the settled sludge / slurried sludge and subsequent radiolytic hydrogen production) in less than seven days following a seismic event.

3) Waste tanks under the Waste Tank Quiescent Time Program (Spontaneous Liberation Protection) shall be controlled to ensure that the minimum time to LFL (CLFL for Tank 50) defined by the waste tank flammability classification is maintained.

Waste Tank Temperature Monitoring: Periodic temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C during waste tank mixing device operation to protect initial conditions for maintaining flammable vapor concentration in the waste tank (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Ventilation Low Flow Interlock: For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the Waste Tank Purge Ventilation System shall have a low flow interlock to stop the gas release activity. Depending on the activity being performed, the interlock will perform the following when low ventilation flow occurs: (For Type IV Waste Tanks, this control is required to be SS only)

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

3.4.2.11.5.2 Safety Significant Controls

Area Radiation Monitors: The ARMs provide control room notification of a primary containment waste release (applicable to only to operating SMPs).

ARM Location Program: The ARM Location Program shall provide for proper placement of ARMs as well as the appropriate alarm requirements (e.g., control room alarm or local alarm and operator/control room two-way communication) (applicable to only to operating SMPs).

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Waste Tank Explosion event and response to the event to minimize the potential release/personnel exposure.

Hydrogen Monitoring: Periodic hydrogen monitoring for Rapid Generation Tanks and Slow Generation Tanks shall be performed to verify that waste tank hydrogen concentration is less than or equal to the hydrogen concentration safety analysis value determined by the Flammability Control Program (excluding Tank 50). Periodic hydrogen monitoring for Type I/II Acidic Chemical Cleaning Waste Tanks shall be performed to verify that waste tank hydrogen concentration is less than or equal to 25% of the LFL. The periodic hydrogen monitoring for Rapid Generation Tanks, Slow Generation Tanks, and Chemical Cleaning Tanks shall be performed using Measuring and Test Equipment portable monitors.

SMP Column Pressure Boundary: The SMP Column structure design prevents an SMP Column Explosion by preventing waste from entering the SMP column.

SMP Flush/Motor Pressure Boundary: The SMP Flush/Motor Pressure Boundary prevents an SMP Column Explosion by preventing waste from entering the SMP column.

Tank 50 Purge Ventilation System: The Tank 50 Purge Ventilation System (when classified as a Rapid Generation Tank or Slow Generation Tank) shall provide sufficient purge flow rate through the tank to maintain the hydrogen concentration in the waste tank bulk vapor space to less than or equal to 3.8% of the LFL (accounting for radiolytic hydrogen generation). This function protects the initial hydrogen concentration to ensure that the minimum time to CLFL associated with the waste tank flammability classification is protected. During free supernate removal activities on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function (in conjunction with the Gas Release Program) maintains the minimum time to LFL defined by the waste tank flammability classification (and associated minimum ventilation flow rate requirements). For spontaneous liberation events and other activities (sludge agitation, bulk saltcake dissolution, and saltcake interstitial liquid removal) on Rapid Generation Tanks and Slow Generation Tanks, the ventilation system safety function minimizes the potential for reaching a flammable vapor concentration by providing a continuous purge of the tank vapor space. Local flow indication shall be provided for Rapid Generation Tanks. The Tank 50 Purge Ventilation System (when classified as a Rapid Generation Tank) shall provide at least 72-scfm airflow (measured using installed flow indication). The Tank 50 Purge Ventilation System (when classified as a Slow Generation Tank) shall provide at least 45-scfm airflow (no flow measurement required).

Tank 50 Waste Temperature Monitoring: The Tank 50 Waste Temperature Monitoring provides local indication of average bulk waste temperature to verify initial conditions for maintaining flammable vapor concentration in the tank are protected. Periodic temperature monitoring shall be performed to verify that the average bulk waste temperature in Tank 50 is less than or equal to 43°C.

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tanks are passive design features that provide waste confinement (gross confinement) following an explosion in the waste tank and supports ventilation system operation. They provide gross confinement in that the explosion pressures could dislodge the riser plugs and that the riser plugs may not remain in place.

Waste Tank Hydrogen Monitor and High Hydrogen Concentration Interlock: For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, continuous hydrogen monitoring shall be performed using an installed hydrogen monitor with a high hydrogen concentration interlock to stop the gas release activity. Depending on the activity being performed, the interlock will perform the following when high hydrogen concentration occurs:

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

3.4.2.12 Waste Tank Annulus Explosion

3.4.2.12.1 SCENARIO DEVELOPMENT

3.4.2.12.1.1 Background

Type I, II, III, and IIIA primary tanks are enclosed by a secondary containment shell, with the area between the primary tank and secondary containment called an annulus. The secondary containment shell is constructed of carbon steel and surrounded by concrete. The annulus differs in size and capacity for each tank type. In addition to the area surrounding the tank, Type III and IIIA tanks also have a small center annulus formed by the roof support column and inner tank wall. This center annulus allows for ventilation airflow across the tank bottom and then to the outer annulus through radial grooves. Most Type IIIA Waste Tanks have a system of radial grooves in the top of the concrete base slab, which directs any leakage from the secondary liner to a leak detection location. The leak detection location and the connecting system of grooves are collectively called the underliner sump. All Type IIIA Waste Tanks except Tanks 35, 36, and 37 have an underliner sump.

Type IV Waste Tanks do not have an annulus. Two different methods are used for detecting leaks from Type IV Waste Tanks. A gravel-filled channel around the tank is called the sidewall sump. The sidewall sump collects percolated groundwater and leakage through the tank side

wall. Because the sidewall sump is not an enclosed structure, explosions are not postulated in the sidewall sump. A system of grooves in the top of the base slab beneath the tank directs any leakage through the tank bottom to a leak detection location. This system of grooves and the leak detection location are collectively called the leak detection sump.

Flammable vapors could be generated in the annulus as a result of material leaking into the annulus from either the primary waste tank or a waste transfer line that traverses the annulus. Hydrogen released during the radiolytic decomposition of water from waste that may have leaked into the annulus is the primary flammable vapor of concern. For Type I/II Acidic Chemical Cleaning Waste Tanks, corrosion induced hydrogen generation is an additional significant contributor to flammable vapor concentration. Additionally, for Tank 50, potential contributors to flammable vapor concentration include trace organics (less than or equal to 5%) and Isopar® L. Dissolved hydrogen and flammable organics may also be released from the leaked waste (for further details on flammable vapor generation refer to Section 3.4.1.5). Since the annuli have an air atmosphere, a sufficient quantity of oxygen is assumed to be present to allow for complete combustion of any flammable gases. For the purpose of this scenario, no ignition source controls are credited and it is assumed that an ignition source is present.

The leak rate from a waste tank primary containment into the annulus is dependent on both the size and location of the leak site. Other factors, such as ventilation flowrate, waste composition, temperature, salt concentrations, and weight percentage of solids in the spilled solution, may influence the leak rate. Additionally, OA introduction involved with Type I/II Chemical Cleaning Waste Tanks may corrode the waste tank wall and lead to primary containment leakage (beyond that assumed for non-Chemical Cleaning waste tanks). Leakage into any of the annuli is normally detected by annulus leak detection instrumentation (e.g., conductivity probes, dip tubes). If the leakage does not reach the level of detection, it may remain in the annulus for an indefinite amount of time. Waste remaining in the annulus below the level of detection is referred to as residual waste. This residual waste, along with any new leakage, may result in flammable vapors being collected in the annulus. If the concentration of flammable gases reaches the explosive limits, a deflagration or detonation could occur. Otherwise, there is no event. Consequences of a waste tank leak without an explosion are covered in Section 3.4.2.14.

For Type III/IIIA Waste Tanks, the outer annulus communicates with the inner annulus through grooves. Therefore, waste can be expected to go into both the inner and outer annuli whenever there is a leak into the secondary containment. The ratio of liquid volume to vapor volume in the inner annulus is smaller than the outer annulus (the inner annulus is very narrow in the lower areas where liquid would accumulate and has a large air manifold). Therefore, the inner annulus can be bounded by the outer annulus because the inner annulus cannot reach LFL if the outer annulus does not reach LFL (CLFL for Tank 50). As a result, the present analysis only focuses on the deflagration/detonation in the outer annulus.

For Type IIIA Waste Tanks (except Waste Tanks 35, 36, and 37), the underliner sump is designed to detect leakage from the annulus, and is thus a tertiary confinement. No known leaks have occurred from a Type IIIA Waste Tank into the annulus, and consequently no leakage into the underliner sump has ever occurred. Flammable vapors (both hydrogen and methane) from an unknown source have been detected in the underliner sumps. No routine sampling of underliner

sumps was performed prior to discovering elevated flammable vapor concentrations. Since discovery of elevated flammable vapor concentrations, periodic sampling of underliner sumps and leak detection sumps for Type IV Waste Tanks was performed. Even though flammable vapors had been allowed to accumulate for extended periods of time, none of the flammable vapor concentration samples taken exceeded the LFL. Because the LFL was not exceeded despite the fact that no sampling or purging of underliner sumps or leak detection sumps was performed for an extended period of time, it is reasonable to conclude that flammable vapors in the underliner sumps and leak detection sumps will not exceed LEL.

The Waste Tank Annulus Explosion analysis for Waste Tank 48 is contained in Chapter 18.

Further details on the waste tank annuli are provided in Section 2.4.1.

3.4.2.12.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with a Waste Tank Annulus Explosion or underliner/leak detection sump explosion that have non-negligible risk. For the purpose of this analysis, the Waste Tank Annulus Explosion events have been grouped into four different categories:

- Waste Tank wall leak initiated annulus explosions – These events involve a leak from the waste tank wall leading to an annulus explosion
- Transfer line leak initiated annulus explosions – These events involve a leak from the side-wall penetration transfer line leading to an annulus explosion
- Type IV Waste Tank leak detection sump explosions – These events involve a leak into a Type IV Waste Tank leak detection sump leading to an explosion
- Type IIIA Waste Tank underliner sump explosion – These events involve flammable vapors accumulating in a Type IIIA underliner sump leading to an explosion

During chemical cleaning of the 242-16H Evaporator, inadvertent addition of nitric acid could occur to a waste tank, causing potential degradation of tank wall integrity. Isolation valves and administrative controls (242-16H Evaporator Chemical Cleaning Program) are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no degradation of the wall occurs during chemical cleaning operations due to inadvertent acid addition.

Some of the same initiating events that evolve into a Waste Tank Annulus Explosion could also be an initiator for a Waste Tank Wall Failure. The Waste Tank Wall Failure accident is covered in Section 3.4.2.14.

3.4.2.12.1.3 Unmitigated Accident Progression – Waste Tank Annulus Explosion

General Waste Tank Annulus Explosion

(Note: This progression is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.)

- Waste is present in the tank annulus
- Waste Tank Annulus Ventilation System fails (even operating the installed annulus ventilation may not purge flammable vapors from the annulus if the ventilation ductwork is submerged by waste)
- The primary tank or a transfer line traversing the annulus leaks waste into the annulus
- For a waste tank leak, the leak continues for 10 days after reaching residual height (or 10 days following a seismic event) before mitigating actions are taken. For a transfer line leak, the leak is assumed to continue until 15,000 gallons of waste are spilled, and no further mitigating actions are assumed for 10 days
- The additional waste releases flammable vapors into the annulus vapor space
- The flammable vapor release continues for the duration of the event
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the annulus vapor space deflagrate or detonate if the flammable vapor concentration exceeds LFL (CLFL for Tank 50) or LEL at the end of the event duration
- The overpressure that results from the explosion is assumed to eject any installed HEPA filters

The accident progression for Tank 40 is unique because it receives ESP Sludge Slurry transfers via a transfer line that runs through the annulus. Since ESP Sludge Slurry has a higher hydrogen generation rate, the unmitigated accident analysis differs for Tank 40.

Unmitigated consequences were calculated for explosions in Closure Waste Tank Annuli. Prior to grouting in a Closure Waste Tank Annulus, there is no potential for the vapor space to reach 100% of the LFL, given only atmospheric breathing. The grout level will eventually reduce the vapor space volume in the waste tank annulus such that an equilibrium hydrogen concentration of greater than 100% of the LFL may occur (Ref. 284). The time required to reach LFL once that grout level is achieved would be long enough such that a failure to monitor for hydrogen or purge the vapor space is not credible. Reference 281 determined that prior to reaching a waste tank annulus level with a time to LFL of less than 10 days, that an explosion in a Closure Waste Tank Annulus undergoing the grouting process is not credible. At the point the time to LFL reaches less than 10 days, an explosion is considered credible due to the limited time to respond. However, the grout level in the annulus will be equivalent to the highest known historical waste level in the primary tank for both tank types and the associated consequences of this explosion are bounded by the Closure Waste Tank Explosion (Section 3.4.2.11) and do not challenge the

Offsite or exceed the Onsite EGs (Ref. 281). Therefore, mitigated analysis is not required for Closure Waste Tank Annulus Explosions.

Chemical Cleaning Waste Tank Annulus Explosion

(Note: This progression is only applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.)

- Type I or II Waste Tank is undergoing chemical cleaning and contains OA
- Waste containing OA is present in the tank annulus
- Waste Tank Annulus Ventilation System fails
- Waste Tank wall corrodes and the primary containment side wall leaks (transfer line initiated leaks are not considered since transfers that traverse the annulus of Type I/II Chemical Cleaning Waste Tanks are prohibited)
- Waste is leaked into the waste tank secondary containment and instantaneously equalizes to the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level)
- The additional waste releases flammable vapors (due to radiolytic and corrosion induced hydrogen generation) into the annulus vapor space
- The flammable vapor release continues for the duration of the event
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the annulus vapor space deflagrate or detonate if the flammable vapor concentration exceeds LFL or LEL at the end of the event duration (10 days non-seismic and seven days seismic)
- The overpressure that results from the explosion is assumed to eject any installed HEPA filters

For Type I/II Chemical Cleaning Waste Tanks, a transfer line leak initiated Waste Tank Annulus Explosion is not a credible event, since transfers that traverse the annulus of a Type I/II Chemical Cleaning Waste Tanks are prohibited.

One other transfer line leak initiated Waste Tank Annulus Explosion scenario associated with Chemical Cleaning Transfers (or related vent/drain operations) was considered. This involved a transfer line leak initiated accident progression for Tank 51 when the transfer line traversing the annulus is part of the vent and drain path (following a Chemical Cleaning Transfer). This path is not used to receive Chemical Cleaning Transfers, and is only used for the vent/drain operation, thus the amount of potential acidic material going through the line (and potentially leaking to the annulus) would be small (< 50 gallons). Additionally, this material would contain less than or equal to 4 wt. % OA, thus not contributing corrosion induced hydrogen for 70 days. Also for this event to occur, failure of two robust passive SSCs would need to occur in the annulus (core pipe [stainless steel - OA resistant] and transfer line jacket). Based upon this discussion, a Tank 51 Annulus Explosion (transfer line leak initiated scenario during Chemical Cleaning Transfers or related vent/drain operations) was deemed not credible (Ref. 274).

3.4.2.12.1.4 Unmitigated Accident Progression – Type IV Waste Tank Leak Detection Sump Explosion

The following generic accident progression applies to all Type IV Waste Tank leak detection sumps:

- The primary tank leaks waste into the leak detection sump
- Leak detection is not assumed to detect the leak
- No mitigating actions are assumed
- The flammable vapors are released into the leak detection sump vapor space from the waste or from an unknown hydrogen/methane source
- The flammable vapor release continues for the duration of the event, but never reaches the LEL
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the leak detection sump deflagrate at the end of the event duration
- The resulting peak pressure from the deflagration in the leak detection sump is 162.8 psig (Ref. 163)
- The pressure wave resulting from the leak detection sump deflagration reaches the waste tank
- The maximum pressure in the waste tank is approximately 1 psig if the combusted gases were to leak and expand into the vapor space of the waste tank (Ref. 163)
- The tank bottom fails, but the tank top and side walls remain intact (Ref. 175)

3.4.2.12.1.5 Unmitigated Accident Progression – Type IIIA Waste Tank Underliner Sump Explosion

The following generic accident progression applies to all Type IIIA Waste Tank underliner sumps:

- Flammable vapors are released into the underliner sump vapor space from an unknown hydrogen/methane source
- No mitigating actions are assumed
- The flammable vapor release continues for the duration of the event, but never reaches the LEL
- An ignition source is present (no ignition source controls are credited)
- Flammable vapors in the underliner sump deflagrate at the end of the event duration
- The resulting peak pressure from the deflagration in the underliner sump is 162.8 psig (Ref. 163)

- The pressure wave resulting from the underliner sump deflagration reaches the waste tank
- The maximum pressure in the waste tank is approximately 1 psig if the combusted gases were to leak and expand into the vapor space of the waste tank (Ref. 163)
- The tank bottom fails, but the tank top and side walls remain intact (Ref. 175)

3.4.2.12.1.6 Annulus Air Duct Explosion

For Type III/IIIA Waste Tanks, there is a circular air inlet duct in the bottom of the annulus. This duct is welded to the outer wall and the floor of the annulus. It has a width of approximately 10 inches and a variable height ranging from 8 to 36 inches. The circular duct is connected to an inlet duct that rises to the top of the tank (like a chimney). Air is fed to the circular duct via the inlet duct and air exits the circular duct through openings in the side of the duct (12 inches wide and 6 inches high). Without any opening in the top of the circular duct, it is possible for the circular duct to funnel the hydrogen generated by the waste in the duct to the inlet duct once the liquid level in the annulus rises above the 6-inch opening height. However, due to configuration of the annulus ventilation system (i.e., outer annulus inlet dampers/valves open or throttled open with a physical barrier to ensure free air exchange – see Section 3.4.1.5.2), flammable vapors do not exceed LFL and an annulus air duct explosion does not occur.

3.4.2.12.1.7 Mitigated Accident Progression

The unmitigated consequences of the scenarios presented above, excluding the Chemical Cleaning Waste Tank Annulus Explosion, do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.12.4). Excluding Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks, the flammable vapors do not reach the LFL in the annulus of any tank type during the event duration (Tank 50 assumed to contain stoichiometric concentration of Isopar® L). However, Facility Management has chosen to functionally classify the annulus conductivity probes and control room alarms as SS (excluding Tank 50) for residual waste volume (initial condition) protection.

The unmitigated consequences for the Chemical Cleaning Waste Tank Annulus Explosion scenario do not challenge Offsite EGs, but do exceed the Onsite EGs (as documented in Section 3.4.2.12.4). Therefore, mitigated analysis is performed for this scenario. Because the unmitigated consequences exceed the Onsite EGs, two SS levels of control are required. Because the event involves an explosion, one additional SS level of control is required. For this scenario, the detonation pressure may cause waste tank failure.

The unmitigated consequences for Tank 50 annulus explosions do not challenge the Offsite or exceed the Onsite EGs; however, the consequences were qualitatively judged to exceed the applicable Onsite EGs for the FW in the immediate vicinity of the event. Therefore, mitigated analysis is performed for Tank 50 Annulus Explosion. Because only the FW in the immediate vicinity of the event was at risk for the Tank 50 Annulus Explosion, one SS level of control is required. For the Tank 50 Annulus Explosion scenario, the detonation pressure may cause waste tank failure.

Chemical Cleaning Waste Tank Annulus Explosion

As a first level of control, active negative pressure annulus ventilation is required on Type I/II Acidic Chemical Cleaning Waste Tanks. Annulus ventilation is required to prevent flammable vapor accumulation and protect the initial hydrogen concentration within the annulus vapor space.

For Type I/II Acidic Chemical Cleaning Waste Tanks, the flammable vapor accumulation rate includes the effects of radiolytic production and corrosion induced hydrogen generation, and accounts for atmospheric breathing (see Section 3.4.1.5.5).

To satisfy the flammability safety function of the annulus ventilation system, a minimum ventilation flow rate is required. For Type I/II Acidic Chemical Cleaning Waste Tanks, Reference 248 demonstrates a minimum flow rate of 40 scfm is adequate, accounting for the radiolytic and corrosion induced hydrogen generation (at 60 inches in the annulus), to protect the initial hydrogen concentration of 25%. The 40 scfm flow rate does not account for hydrogen released from steam jetted transfers, since steam jetted transfers into or out of Type I/II Chemical Cleaning Waste Tanks (including the annulus) are prohibited. The minimum flow rate of 40 scfm is based on a maximum annulus level of 60 inches. The annulus level is protected by the waste tank HLLCP setpoint initial conditions (≤ 63.8 inches for Type I and ≤ 64.8 inches for Type II). These waste tank primary liquid levels will ensure that, following a tank wall breach, the equilibrium liquid level will be less than or equal to 60 inches in the annulus.

The nominal capacity of the annulus ventilation system on Type I/II Acidic Chemical Cleaning Waste Tanks is much larger than the flow required to maintain the tank below LFL; therefore, flow measurement is not required. Based on a nominal flow capacity of 150 scfm or greater for the annulus ventilation system, it is judged that when the ventilation system is operating, the system is supplying the required flow.

The second level of control is the waste tank annulus leak detection instrumentation (i.e., conductivity probe). The instrumentation will alert operators to the event and allow for mitigation. Even if the leak to the annulus results in a level below the leak detection instrumentation, mitigation is provided by limiting the allowable waste level. The waste tank annulus structure also provides a liquid waste containment function to support conductivity probe functionality.

The waste tank annulus confinement and controls supporting waste tank annulus confinement integrity provides a mitigative third level of control. The waste tank annulus structure also supports ventilation system operation. The controls supporting waste tank annulus confinement integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

Tank 50 Annulus Explosion

For the waste tank wall leak initiated Tank 50 Annulus Explosion scenario, the waste tank structure and controls supporting containment integrity are the first level of control. The controls

supporting waste tank integrity include critical lift controls, structural integrity controls, corrosion controls, and tank top/secondary containment loading controls. The waste tank structure provides primary containment of the waste and ensures leakage from the tank to the annulus is prevented (including post-Design Basis Earthquake [DBE]), thereby preventing the event (see Section 3.4.2.14 for additional information regarding Tank 50 wall leakage).

For the transfer line leak initiated Tank 50 Annulus Explosion scenario, the transfer line core pipe (which traverses the annulus), including the Tank 50 VB drain line, and controls supporting containment integrity are the first level of control. The controls supporting containment integrity include critical lift controls, structural integrity controls, corrosion controls, and transfer controls (water hammer evaluations and pump speed evaluations). The transfer line core pipe provides primary containment of the waste and ensures leakage from the transfer line to the annulus is prevented (including post-DBE), thereby preventing the event.

3.4.2.12.2 FREQUENCY DETERMINATION

The HA classifies Waste Tank Annulus Explosion events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency. Though not credited, the low probability of an ignition source being present with the vapor space above 100% of the LFL (CLFL for Tank 50) significantly reduces the probability of a Waste Tank Annulus Explosion.

3.4.2.12.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.12.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Annulus Explosion STs and are all taken from References 56, 163, 226, 242, and 248, unless otherwise stated:

- The concentration of flammable vapors that accumulate in the underliner/leak detection sump remains below LEL and results in a deflagration only (Ref. 163). To protect this assumed initial condition, the Flammable Vapor Sampling Program ensures that the underliner/leak detection sumps are sampled at least once per year and that actions are taken to remediate any high flammable conditions identified. This assumption is not required to be protected for Closure Waste Tanks. The resulting consequences are bounded by the Waste Tank Top Collapse scenario for these waste tanks (see Section 3.4.2.14).

- For Type I, Type II, Type III, and Type IIIA Waste Tanks (excluding Tank 50 and Type I/II Chemical Cleaning Waste Tanks) the tank leak rates (into the annulus) are as follows:
  - Non-DBE: 0.4 gpm
  - DBE: 4 gpm
- The non-DBE and DBE tank leak rate (into the annulus) for Tank 50 is 0 gpm (see Section 3.4.2.14).
- For Type I/II Chemical Cleaning Waste Tanks, the tank leak rates (into the annulus) are as follows:
  - Non-DBE: No assumed tank leak rate and waste is assumed to leak instantaneously and equalize at the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level).
  - Single seismically-initiated tank leak event (for analysis and consequences in Section 3.4.2.12): No assumed tank leak rate and waste is assumed to leak instantaneously and equalize at the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level).
  - DBE (for analysis and cumulative consequences in Section 3.4.2.18): 4 gpm
- Bounding Sludge Slurry or ESP Sludge Slurry does not leak from the tank into the annulus. Material that leaks to the annulus is dependent on the specific scenario and is discussed in the Material at Risk subsection in Section 3.4.2.12.3.2.
- The contents of an annulus quickly come to equilibrium temperature at the temperature of the annulus (Ref. 56). A maximum temperature of 100°C is assumed after the leak, excluding Type I/II Acidic Chemical Cleaning Waste Tanks. For Type I/II Acidic Chemical Cleaning Waste Tanks, the maximum temperature of the vapor space and waste in the annulus is 75°C.
- The temperature of the liquid waste that leaks from the transfer line into the annulus is 20°C higher than where it originates (Ref. 56). 20°C corresponds to maximum temperature increase due to a steam jet transfer of waste material, as discussed in Section 3.4.1.5.2. (This assumption does not apply to ESP Sludge Slurry transfers through the Tank 40 annulus because steam jet transfers into Tank 40, when Tank 40 is classified as an ESP Sludge Slurry Waste Tank, are prohibited. This assumption does not apply to Type I/II Chemical Cleaning Waste Tanks, since steam jet transfers and transfers that traverse the annulus are prohibited.)
- The volumes of the Type IIIA underliner sump and the Type IV leak detection sump are less than or equal to 60 cubic feet (Ref. 163).

3.4.2.12.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below or are intrinsic to the explosion (detonation or deflagration) model. The value of each of the terms is specific to the location being analyzed.

Material at Risk

The characteristics of the MAR vary for the different annulus explosion scenarios as described below:

- The MAR for a transfer line leak initiated annulus explosion is Bounding Sludge Slurry, excluding Tanks 40 and 50.
- The MAR for a transfer line leak initiated Tank 40 annulus explosion is ESP Sludge Slurry.
- The MAR for a transfer line leak initiated Tank 50 annulus explosion is Tank 50 Supernate.
- The MAR for a wall leak initiated annulus explosion is Bounding Supernate, excluding Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks.
- The MAR for a wall leak initiated Tank 50 annulus explosion is Tank 50 Supernate.
- The MAR for a wall leak initiated Chemical Cleaning Waste Tank Annulus Explosion is Type I/II Waste Tank Chemical Cleaning Slurry (The initial MAR in the annulus is assumed to be Type I/II Waste Tank Chemical Cleaning Slurry [at the residual waste volume], but additional waste leaked into the annulus is diluted by the OA volume that was added to the waste tank.).
- The MAR for a Type IV Waste Tank leak detection sump explosion is Slurried Type IV Tank Waste.

Because the Type IIIA underliner sump is a tertiary confinement and no leakage into the secondary containment has occurred, there is no material at risk for this event. The event is analyzed to evaluate any possible effect on the waste tank. The waste characteristics and inhalation dose potential on a per unit volume basis for the various streams is given in Section 3.4.1.5.1.

The volume of MAR for the annulus explosion events is all of the waste in the annulus based upon the specific scenario. The volume of MAR for the Type IV Waste Tank leak detection sump explosion is the volume of material in the leak detection sump (less than or equal to 60 ft^3, including the leak collection volume).

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

For detonations, the amount of waste that is aerosolized equals the equivalent TNT mass (ARF = 1.0). This assumption is inherent in the TNT equivalent model used for detonations. All particles and droplets, which become airborne, are assumed to be respirable (RF = 1).

For deflagrations, an ARF of 0.1 and RF of 1.0 are applied.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.12.3.3 Flammable Vapor Concentration Models

For the Tank 50 analyses, a flammable vapor concentration of Isopar® L at stoichiometric conditions was used. For the remaining waste tanks, the flammable vapor concentration used in the ST calculations is determined by calculating the hydrogen concentration and correcting for any organics present for each of the locations of concern. The hydrogen concentration and percent LFL at the time of the explosion are determined in References 56 and 248 using the Flammable Vapor Concentration Determination formulas described in Section 3.4.1.1.2.

3.4.2.12.3.4 Explosion (Deflagration/Detonation) Source Term

For the Tank 50 analyses, a detonation is assumed to occur and the TNT equivalent model is used. The mass of liquid (ST) made airborne by the detonation is set equal to the mass of TNT that produces the same energy as is produced by the combustible gas mixture consumed during the detonation. A stoichiometric mixture for Isopar® L is assumed in the analyses.

For the remaining waste tanks, the ST is dependent on whether a deflagration or detonation occurs. If the flammable vapor concentration is between the LFL and the LEL, a deflagration is assumed to occur. If the flammable vapor concentration is at LEL or above, a detonation is assumed to occur. If the flammable vapor concentration is below the LFL, no event will occur. The explosion is modeled in the ST calculation using either the detonation model or deflagration model, depending on whether the LFL (deflagration) or LEL (detonation) has been reached (discussed further in Section 3.4.1.1.2). The results of the explosion are modeled using formulas for energy of combustion and adiabatic combustion pressure (also in Section 3.4.1.1.2).

3.4.2.12.3.5 Source Term Calculation

STs, excluding Tank 50, and Type I/II Acidic Chemical Cleaning Waste Tanks, were calculated in Reference 56 for three scenarios of annulus explosion using the methodologies discussed previously. STs for Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks are discussed

further below. The cases are as follows and cover the General Waste Tank Annulus Explosion scenario:

- Waste tank leak at 4 gpm, with a leak time of 10 days (This is a post-DBE leak)
- Waste tank leak at 0.4 gpm, with a leak time of 10 days after reaching residual height
- Transfer line leak, with the leak volume limited to 15,000 gallons. Sitting time after the leak is 10 days

The results of the analysis are summarized below:

- With a non-DBE leak rate of 0.4 gpm from the tank into the annulus, the flammable vapors do not reach the LFL in the annulus of any tank type. With a DBE leak rate of 4 gpm from the tank into the annulus, the flammable vapor concentration does not reach the LFL in the annulus of any tank type. The tank leak (non-DBE and DBE) will not result in an annulus explosion.
- Following a transfer line leak, the flammable vapors do not reach the LFL in the annulus of any tank type in 10 days. The transfer line will not result in an annulus explosion.

For the purpose of calculating consequences for the Tank 50 analyses, the annulus was assumed to contain sufficient waste for bounding consequences and filled to capacity with a stoichiometric concentration of Isopar® L.

For Type I/II Acidic Chemical Cleaning Waste Tanks, Reference 248 analyzed various scenarios of annulus explosion using the methodologies discussed previously. The cases and results of the analysis are summarized below:

- Waste is in the annulus at the residual waste volume and no tank leak occurs into the annulus. It is assumed that flammable vapor accumulation rate includes the effects of radiolytic production and corrosion induced hydrogen generation (instantaneously) for the residual waste volume.

  For this case, the flammable vapor concentration reaches 100% of the LFL in the annulus in five days. This case is used for determining restoration times for the annulus ventilation system when the annulus level remains at or below the residual waste volume. This case is used in the analysis/progressions in Sections 3.4.2.17, 3.4.2.19, and 3.4.2.20.

- Waste is in the annulus at the residual waste volume and waste is assumed to leak instantaneously (no assumed tank leak rate) and equalize at the equilibrium level in the annulus (60 inches). It is assumed that flammable vapor accumulation rate includes the effects of radiolytic production and corrosion induced hydrogen generation (instantaneously) for the 60-inch height waste volume in the annulus.

  This case is used for reporting the unmitigated consequences (based upon the height in the annulus which produces the maximum consequence) for the bounding annulus explosion scenario (Section 3.4.2.12.4) and determining the annulus ventilation system minimum flow rate requirements.

- Waste is in the annulus at the residual waste volume and waste is assumed to leak instantaneously (no assumed tank leak rate) and equalize at the equilibrium level in the annulus (60 inches). It is assumed that flammable vapor accumulation rate includes the effects of the following:
  - Radiolytic production for the 60-inch height waste volume in the annulus
  - Corrosion induced hydrogen generation (instantaneous) for the residual waste volume in the annulus
  - Corrosion induced hydrogen generation (after 48 hour time delay) for the 60-inch height waste volume in the annulus

  For this case, the flammable vapor concentration reaches 100% of the LFL in the annulus in 2.5 days. This case is used for determining restoration times for the annulus ventilation system when the initial annulus level (at event initiation) was at or below the residual waste volume, but due to the event increases above the residual waste volume.
- Waste is initially in the annulus at the residual waste volume. It is assumed that flammable vapor accumulation rate includes the effects of radiolytic production and corrosion induced hydrogen generation (instantaneously) for the residual waste volume. A waste tank leak occurs at 4 gpm. It is assumed for the leaked waste that flammable vapor accumulation rate includes the effects of the following:
  - Radiolytic production for the waste volume in the annulus (based on leak rate)
  - Corrosion induced hydrogen generation (after 48 hour time delay) for the waste volume in the annulus (based on leak rate)

  For this case, the flammable vapor concentration reaches 100% of the LFL in the annulus in 3.25 days. This case is used for the analysis/progressions in Section 3.2.4.18.

The Type IV leak detection sump explosion consequences are bounded by the Type IV Waste Tank pump column explosion discussed in Section 3.4.2.11 (the Type IV Waste Tank pump column explosion ST is based on a detonation of 90 ft^3 of Slurried Type IV Tank Waste, versus a deflagration of 60 ft^3 for the leak detection sump explosion). The Onsite and Offsite consequences for the Type IV leak detection sump explosion do not challenge the Offsite or exceed the Onsite EGs.

No ST or consequence calculation was required for the Type IIIA Waste Tank underliner sump explosion, since the explosion could result in tank bottom failure only. As discussed in Section 3.4.2.14, events that could cause failure of a primary tank bottom (e.g., underliner sump explosion) pose an environmental hazard, but do not present a significant airborne release concern. The other events analyzed in the Waste Tank Annulus Explosion DBA that results in a deflagration or detonation are annulus explosions related to the Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks. The detonation pressure from these annulus explosions may cause a side wall failure. Therefore, the annulus explosions related to the Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks are Waste Tank Annulus Explosion DBA events that could transition into a Waste Tank Wall Failure accident.

3.4.2.12.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Waste Tank Annulus Explosion event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 2, 226, 248, 255). The consequences reported for Tank 50 and Type I/II Acidic Chemical Cleaning Waste Tanks include consequences from an annulus explosion and consequences from the bounding Waste Tank Wall Failure event (Waste Tank Wall Leak or Waste Tank Top Collapse scenario from Section 3.4.2.14) since it is assumed that the detonation pressure from an annulus explosion may cause waste tank wall failure or tank top collapse.

The unmitigated and mitigated Offsite consequences (≤ 4 rem) for the bounding Waste Tank Annulus Explosion scenario (Chemical Cleaning Waste Tank Annulus Explosion) do not challenge the Offsite EGs. The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the Tank 50 Annulus Explosion do not challenge the Offsite EGs. The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding tank underliner/leak detection sump scenario (Type IV leak detection sump explosion) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding Waste Tank Annulus Explosion scenario (Chemical Cleaning Waste Tank Annulus Explosion) exceed the Onsite EGs. The mitigated Onsite consequences for the bounding Waste Tank Annulus Explosion scenario (Chemical Cleaning Waste Tank Annulus Explosion) are zero because the event is prevented. The consequences to the immediate vicinity worker are also zero because the event is prevented.

The unmitigated Onsite consequences (≤ 50 rem) for the Tank 50 Annulus Explosion do not exceed the Onsite EGs (but were qualitatively judged to exceed the applicable Onsite EGs for the FW in the immediate vicinity of the event). The mitigated Tank 50 Annulus Explosion consequences to the immediate vicinity worker are zero because the event is prevented.

The unmitigated and mitigated Onsite consequences (≤ 8 rem) for the bounding tank underliner/leak detection sump scenario (Type IV leak detection sump explosion) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the location of the sump below grade and the length of time to reach LFL.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.12.5. The consequences of a Waste Tank Annulus Explosion event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.12.5 SUMMARY OF CONTROLS

The leak rates assumed in the analysis (excluding Type I/II Chemical Cleaning Waste Tanks) are based on the waste tank design and the programs in place to protect waste tank wall integrity. The controls required to protect the initial accident assumptions are described below. In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of Waste Tank Annulus Explosion event do not challenge the Offsite or exceed the Onsite EGs and also to

further reduce the associated risk (as discussed earlier in the mitigated accident progression) are required. The following controls are not required for Closure Waste Tanks.

3.4.2.12.5.1 Safety Class Controls

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

Flammable Vapor Sampling Program: Programmatic controls shall be established governing flammable vapor sampling of Type IIIA Waste Tank underliner sumps and Type IV Waste Tank leak detection sumps. The program shall ensure that these locations are sampled for flammable vapors at least once per year and shall determine/identify any actions to be taken should high flammable vapor conditions exist.

High Liquid Level Conductivity Probes: The Type I, Type II, Type III and Type IIIA Waste Tank HLLCPs provide control room alarm following a waste tank high level condition to protect tank wall integrity requirements (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCPs provide control room alarm following a waste tank high level condition (with maximum levels less than or equal to 63.8 inches [Type I] and 64.8 inches [Type II]) to protect a maximum annulus equilibrium liquid level (following a tank wall breach). (For Tank 50, this control is required to be SS only)

Tank Fill Limits Program: The Tank Fill Limits Program provides controls (accounting for various waste level limiting factors such as the structural integrity fill limit) to protect tank wall integrity requirements (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). (For Tank 50, this control is required to be SS only)

Waste Tank: The Type I, Type II, Type III and Type IIIA Waste Tanks are passive design features that provide primary waste containment (within assumed leak rates). (For Tank 50, this control is required to be SS only) (Not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks)

3.4.2.12.5.2 Safety Significant Controls

Transfer Line Core Pipe: Transfer Line integrity (e.g., core pipe) shall ensure primary waste containment for the transfer lines (including the Tank 50 VB drain line) traversing the Tank 50 annulus.

Waste Tank Annulus: The Type I, Type II, Type III and Type IIIA Waste Tank Annulus structure provides liquid waste containment to support conductivity probe functionality. The Type I and Type II Waste Tank Annulus structure provides airborne waste confinement in the waste tank annulus and supports ventilation system operation (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Conductivity Probes: The Type I, Type II, Type III and Type IIIA (excluding Tank 50) Waste Tank Annulus Conductivity Probes provide control room alarm following a waste tank annulus high level condition to protect assumed initial tank annulus conditions.

Waste Tank Annulus Ventilation System: The Type I and Type II Waste Tank Annulus Active Ventilation Systems (negative pressure) shall maintain the concentration of flammable vapors in the waste tank annulus bulk vapor space to less than or equal to 25% LFL accounting for radiolytic and corrosion induced hydrogen generation. The Type I and Type II Waste Tank Annulus Active Ventilation System shall provide at least 40-scfm airflow (no flow measurement required) (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

3.4.2.13 Waste Tank/Pump Tank Overheating

3.4.2.13.1 SCENARIO DEVELOPMENT

3.4.2.13.1.1 Background

During normal operations (except for evaporator operations), all liquid waste, stored and handled at the CSTF, is maintained well below boiling. However, waste at the CSTF has an airborne component associated with it due to evaporation, internal heat generation, heat addition, internal vapor/gas generation, entrainment, and thermal stresses. The only process areas identified in the HA as having the potential for a significant release due to waste heat-up are the waste tanks and pump tanks.

Energy may be deposited in the waste tanks and pump tanks in various ways, including waste tank mixing device operation, planned/unplanned steam introduction, transfer of heated material, and radioactive decay of actinides and fission products in the waste inventories. Cooling coils are typically installed in the waste tanks (except Type IV Waste Tanks) to remove heat directly from the waste. When operating, ventilation flow can also remove heat from the vapor space of the waste tanks and pump tanks. Natural heat removal mechanisms include conduction through the tank walls and floors in contact with the waste, convection across the liquid waste surface, and heat loss from evaporative cooling. If the rate of heat generation exceeds the combined heat losses, the temperature of the waste will increase.

3.4.2.13.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Waste Tank/Pump Tank Overheating that have non-negligible risk. These events can be generally classified into two types, Waste Tank/

Annulus Overheating and Pump Tank Overheating. No overheating events involving dry sludge tanks were identified. An exothermic chemical reaction in the tank vapor space that would generate substantial heat and impart it to the waste is not a credible event, since no potential chemical reactions that could impart heat to the waste have been identified by the facility.

During chemical cleaning of the 242-16H Evaporator, inadvertent addition of nitric acid could occur to a waste tank, causing temperature to increase due to neutralization. Isolation valves and administrative controls (242-16H Evaporator Chemical Cleaning Program) are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no additional heat source is added to a waste tank during chemical cleaning operations due to inadvertent acid addition.

3.4.2.13.1.3 Unmitigated Accident Progression

If the rate of heat generation exceeds the combined heat losses, the temperature of the waste will increase. When the waste temperature is just below the boiling temperature (100°C for water), the liquid simmers and evaporation occurs. The analysis conservatively sets the initial temperature of both sludge and supernate to be the saturation temperature (i.e., onset of boiling, which for pure water at atmospheric pressure is 100°C). The general unmitigated accident progression for tank overheating is as follows:

- Tank (waste tank/annulus or pump tank) is at saturation temperature
- Additional heat is generated in/added to the tank (the scenario specific heat inputs are discussed below)
- When the temperature reaches the boiling temperature, the airborne release occurs from droplet formation due to vapor bubble burst as vapor escapes from the liquid surface and from associated secondary effects
- Liquid rushes in to fill the crater (formed in the liquid surface following the bubble burst) that results in an ascending liquid spout/jet in the center that decays into droplets with larger droplets falling back to surface to create additional droplets from splashing phenomena (Ref. 14)
- Droplets that form (either from simmering or boiling mechanisms) and become suspended are carried away from the liquid surface by buoyant vapor flow
- The buoyant vapor flow carries material out of the tank (no credit is taken for filtration or deposition)
- The airborne material that has escaped from the tank is transported to Onsite and Offsite receptors for eight hours (including heat input time)
- The duration of the overheating exposure is assumed to be eight hours for the purpose of determining STs and resulting receptor doses from plume exposure.

Five Waste Tank and one Pump Tank Overheating scenarios were considered. The scenario-specific accident progression details are discussed below.

Waste tank/annulus overheating is not credible in Closure Waste Tanks due to the following:

- Limited volume of waste and large vapor space volume in the tank
- Restrictions for transferring waste into the tank
- Steam to waste tank primary and annulus jets is isolated
- Waste tank mixing device operation is prohibited
- Grout formulation is designed to not heat the waste to boiling

Static Waste Tank

The static waste tank case represents normal waste-configuration conditions of an undisturbed waste tank with supernate cover over a sludge layer. Heat input to the waste is from radiolytic decay. However, there are systems and controls in place that ensure that this accident can never occur. Historically, due to non-credited heat losses, temperature increases of less than 1°C per week are the highest that have been observed.

The analysis of tank temperature rise does not take into account several means of heat removal from the waste tank, including the Chromate Cooling Water System, Waste Tank Purge Ventilation System, Waste Tank Annulus Ventilation System, and conductive heat losses through the base slab. The first two methods of heat removal (cooling water and purge ventilation) remove significant amounts of heat and are easily capable of handling the waste tank internal heat generation (radiolytic decay heat). For Slow Generation Tanks and Rapid Generation Tanks, the purge ventilation system is always operated. For waste tanks where the need to control temperature is anticipated, the cooling water system is available to control temperature. Loss of either of these two methods of heat removal results in various control room alarms (i.e., low cooling water pressure, blower failure or tank low vacuum alarms for Waste Tank Purge Ventilation Systems). Periodic operator rounds provide additional assurance that the systems are functioning effectively, such as flow indicators on both systems.

Non-credited thermocouples are installed in waste tanks to monitor the temperature of the waste at various locations throughout the tank. Various inputs (e.g., corrosion control limits) are considered in setting maximum temperature limits, with the actual operating limits set below the most restrictive of these inputs. Under normal conditions these thermocouples are monitored daily to ensure that tank temperature limits are not exceeded. If an unexpected temperature increase is noted, actions such as cooling water flow adjustment or annulus ventilation adjustment are carried out to maintain temperature within desired ranges. This ensures that the saturation temperature is never reached, preventing the boiling accident.

Based on the reasons cited above, it is not reasonable to postulate that the accidental boiling of a static waste tank will occur in the CSTF. The low rate of temperature increase has been consistently demonstrated to support reliance on operator actions to monitor and control waste tank temperature. Therefore, no specific safety basis levels of control are needed to prevent this event since the normal conduct of facility operations is more than adequate to prevent its occurrence.

Evaporator Drop Tank

The evaporator drop tank receives hot waste (evaporator bottoms) from the evaporator. Evaporator bottoms refer to the concentrated waste that leaves the evaporator. Evaporator bottoms are of high specific gravity due to high dissolved salt content, which elevates the boiling temperature. With the evaporator bottoms at a higher temperature than the resident waste, the evaporator bottoms are treated in the analysis as a heat source to the resident waste.

Steam-Heated Waste Tank / Annulus

Steam transfer jets are used to transfer supernate from a tank to another area of the CSTF (e.g., to another tank) or an annulus to the primary side of the tank. A failure of the steam transfer jet can lead to a discharge of steam into the waste that agitates and heats the waste. Normal operation of the steam transfer jet is briefly discussed below along with possible failure modes.

Steam is supplied to the transfer jet through a gang valve. From there, the steam is accelerated through a venturi-type eductor assembly. After passing through the nozzle, the high-velocity steam creates a low-pressure region that results in drawing liquid waste up into the jet assembly through the suction pipe. The waste is entrained by the steam and discharged through the transfer jet diffuser and into the discharge line.

Steam can directly enter the waste through the suction pipe if the discharge line is plugged, or for the steam-heated waste tank, if the valve on the discharge line is closed. Steam can also directly enter the waste through leak sites (supply side of the jet fails in some way). Additionally, operational experience indicates that leaks around the packing material of the steam supply side of a telescoping steam transfer jet occasionally occur. The steam jet is assumed to be discharging into the waste for a period of 2 hours (non-seismic and seismic). The airborne release from boiling is assumed to involve Bounding Supernate.

The steam-heated tank/annulus scenario for waste tanks is also analyzed for a seismic event in which common cause failures on the steam-pressure regulating equipment result in a higher delivery pressure.

This steam-heated waste tank/annulus scenario bounds failure modes such as failure in the steam supply line (e.g., packing failure, pipe failure) and plugged, or for the steam-heated waste tank, closed-off (valve in wrong position) discharge line.

Steam-Heated Pump Tank

The only scenario of concern for pump tanks is a steam-heated scenario, similar to the waste tank steam-heated scenario. Fixed steam transfer jets provide a secondary method to empty waste out of a pump tank if the transfer pump fails. The steam transfer jets used in pump tanks, unlike those used in storage tanks, have the main jet assembly (that houses the nozzle) outside the tank. Only the suction line portion extends into the tank. Thus, if a leak occurs in the steam line, the steam discharges outside the tank and does not impinge upon the waste. The analysis considers a plugged or closed-off discharge line as a means for steam discharge into the waste.

The steam jet is assumed to be discharging into the waste for a period of one hour for the non-seismic case (not analyzed for seismic as discussed below). The airborne release from boiling is assumed to involve Bounding Sludge Slurry. However, the nature of the sludge and the assumed liquid cover makes it unlikely that inadvertent steam sparging would mobilize significant quantities of sludge up to the surface where boiling releases occur. Conditions of small liquid cover are addressed by the Aerosolization events in Section 3.4.2.10.

The steam-heated tank scenario for pump tanks is not analyzed for a seismic event, since the seismic event is not a credible initiator for Pump Tank Overheating. Since only the suction nozzle of the transfer jet is within the pump tank proper, there is no scenario where "failure" of a steam jet in a pump tank causes overheating. To cause a pump tank temperature increase to occur, the seismic event would have to occur while the pump tank steam jet was in use, concurrent with both (1) failure of pressure regulating equipment supplying steam to the jet, and (2) blockage of the transfer discharge path (identified initiators include valve closure and salt plugging). The seismic event will neither cause a manual valve in the transfer path to close nor cause a salt plug in the transfer path. Thus, with no credible initiator, there is no reason to consider a seismic pump tank overheat case.

Slurried Waste Tank

Operation of equipment inside waste tanks can cause the liquid temperature to increase to the saturation temperature, which can lead to boiling and subsequent radiological release. However, there are systems and controls in place that ensure that this accident can never occur. In the case of waste tank mixing device operation (the greatest equipment heat addition during normal tank operations), over 3 million BTU/hour could theoretically be transferred to the waste (assuming four waste tank mixing devices operating at their approximate maximum output of 300 horsepower). This could cause a theoretical temperature increase of approximately 1°C per hr when tank level is low (assuming no heat loss from the waste). Historically, however, due to standard plant operating practices and non-credited heat losses, temperature increases of approximately 2-3°C per day are the highest that have been observed. The differences between the theoretical maximum temperature increase and past operating experience are due to a number of factors.

The analysis of tank temperature rise does not take into account several means of heat removal from the waste tank, including the Chromate Cooling Water System, Waste Tank Purge Ventilation System, Waste Tank Annulus Ventilation System, and conductive heat losses through the base slab. The first two methods of heat removal (cooling water and purge ventilation) remove significant amounts of heat and are easily capable of handling the combined total of the waste tanks internal heat generation (radiolytic decay heat) and the heat generated by the waste tank mixing devices. Due to aerosolization concerns, the tanks purge ventilation system is always operated when waste tank mixing devices are operating. For waste tanks where the need to control temperature is anticipated, the cooling water system is available during waste tank mixing device operation. Loss of either of these two methods of heat removal results in various control room alarms (e.g., low cooling water pressure, blower failure, or tank low vacuum alarms for Waste Tank Purge Ventilation Systems). Periodic operator rounds provide

additional assurance that the systems are functioning effectively, such as flow indicators on both systems.

Non-credited thermocouples are installed in waste tanks while performing mixing operations to monitor the temperature of the waste at various locations throughout the tank. Various inputs (e.g., corrosion control limits, in-tank equipment limitations) are considered in setting maximum temperature limits, with the actual operating limits set below the most restrictive of these inputs. Under normal conditions (no activities in a waste tank) these thermocouples are monitored daily to ensure that tank temperature limits are not exceeded. During periods when activities are being carried out in waste tanks (such as waste tank mixing device operation or evaporator bottoms addition), this surveillance is carried out more frequently. If an unexpected temperature increase is noted, actions such as cooling water flow adjustment are carried out to maintain temperature within desired ranges. If satisfactory temperature control could not be maintained, waste tank mixing device operation would be terminated or altered prior to exceeding the established operating temperature limits. This ensures that the saturation temperature is never reached, preventing the boiling accident.

Based on the reasons cited above, it is not reasonable to postulate that the accidental boiling of a waste tank due to operation of waste tank mixing devices will occur in the CSTF. The operation of equipment inside the waste tanks is a routine, deliberate operation, and such operations are carefully monitored and controlled. If the ability to monitor the equipment were lost (e.g., due to control room evacuation), the equipment would be shut down. The low rate of temperature increase due to mixing device operation has been consistently demonstrated to support reliance on operator actions to monitor and control the evolution. Therefore, no specific safety basis levels of control are needed to prevent this event since the normal conduct of facility operations is more than adequate to prevent its occurrence.

Type I/II Chemical Cleaning Waste Tanks

Chemical cleaning using OA will be performed on Type I/II Waste Tanks. Residual sludge heels remaining in tanks will be dissolved in an OA solution, and then the dissolved sludge solutions will be transferred out of the original tanks and stabilized through pH neutralization in the receipt tank. Operation of mixing devices will also be required to support sludge dissolution and acid neutralization. The location of the sludge heels is referred to as the treatment tank. The neutralization of the dissolved sludge solutions will occur in the receipt tank; however, acid neutralization may also be performed in the treatment tank. Chemical cleaning operations involve two new sources of heat input to the waste tank:

- Sludge dissolution due to reaction with OA in the treatment tank
- Neutralization of OA with sodium hydroxide in the receipt or treatment tanks

Sludge dissolution due to reaction of with OA in conjunction with mixing device operation can cause the liquid temperature to increase to the saturation temperature, which can lead to boiling and subsequent radiological release. However, there are systems and controls in place that ensure that this accident can never occur. In the case of sludge dissolution, the volume of sludge heel will be limited to less than 10,000 gallons. Based on this volume, Reference 250 calculates

the maximum temperature increase during sludge dissolution to be less than 16°C. The analysis of temperature increase does not take into account several means of heat removal from the waste tank, including the Chromate Cooling Water System, Waste Tank Purge Ventilation System, Waste Tank Annulus Ventilation System, and conductive heat losses through the slab. Therefore, the actual temperature increase during sludge dissolution is anticipated to be less than 16°C which is manageable. In addition, as discussed previously, the heat generated from mixing devices is also manageable based on current operating practices. Based on reasons cited above, it is not reasonable to postulate that the accidental boiling of a waste tank due to sludge dissolution will occur in the CSTF. Acid additions and mixing device operations are a deliberate evolution that are carefully monitored and controlled. If the ability to monitor is lost, operations would be stopped. Based on this, it is not reasonable to postulate accidental boiling of the treatment tank.

Neutralization of OA with sodium hydroxide in conjunction with mixing device operation can cause the liquid temperature to increase to the saturation temperature, which can lead to boiling and subsequent radiological release. However, there are systems and controls in place that ensure that this accident can never occur. In the case of acid neutralization for the receipt tank, the volume of OA to be added to the treatment tank will be limited to less than 200,000 gallons. Based on this volume, Reference 250 calculates the maximum temperature increase during receipt tank acid neutralization to be less than 17°C. The analysis of temperature increase does not take into account several means of heat removal from the waste tank, including the Chromate Cooling Water System, Waste Tank Purge Ventilation System, Waste Tank Annulus Ventilation System, and conductive heat losses through the slab. Therefore, the actual temperature increase during receipt tank acid neutralization is anticipated to be less than 17°C which is manageable. In addition, as discussed previously, the heat generated from mixing devices is also manageable based on current operating practices. Acid neutralization in the treatment tank is also bounded by the analysis. Based on reasons cited above, it is not reasonable to postulate that the accidental boiling of a waste tank due to acid neutralization will occur in the CSTF. Acid neutralization and mixing device operations are a deliberate evolution that are carefully monitored and controlled. If the ability to monitor is lost, operations would be stopped. Based on this, it is not reasonable to postulate accidental boiling of the receipt or treatment tanks.

3.4.2.13.1.4 Mitigated Accident Progression

The unmitigated consequences of the tank overheating events do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.13.4), with the exception of Steam-Heated Waste Tank/Annulus and Steam-Heated Pump Tank scenarios. Therefore, mitigated analysis is performed for the Steam-Heated Waste Tank/Annulus and Steam-Heated Pump Tank scenarios. Since these scenarios exceed the EGs, two SS levels of control are required.

Steam-Heated Waste Tank

This event is prevented through transfer jet and piping integrity inside Type I, II, III, IIIA and IV Waste Tanks, the controls supporting transfer jet and piping integrity, and through the Transfer Control Program (steam jet flowpath controls) which is the first level of control. The controls supporting piping integrity include critical lift controls, structural integrity controls, corrosion

controls, and transfer controls (water hammer evaluations). The Transfer Control Program requires independent verification of jet discharge path valve position and evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The jet discharge path valve position verification applies to any valve with the potential to block transfer jet flow (including 3-way valves) such that the transfer jet steam is not allowed to transfer waste from the tank (i.e., the steam is directed into the tank). The evaluation shall be performed for jet transfers out of a salt tank and will include the amount of time the transfer may be suspended before flushing is required. The waste tank confinement, controls supporting waste tank confinement integrity, and active ventilation with HEPA filter provide a mitigative second level of control for Type I, II, III, IIIA and IV Waste Tanks. The waste tank structure also supports ventilation system operation. The controls supporting waste tank confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Steam-Heated Waste Tank Annulus

This event is prevented through annulus jet and piping integrity and controls supporting annulus jet and piping integrity which is the first level of control. The controls supporting annulus jet and piping integrity include critical lift controls, structural integrity controls, corrosion controls, and transfer controls (water hammer evaluations). The waste tank annulus confinement, controls supporting waste tank annulus confinement integrity, and the Transfers From Waste Tank Annuli Program provide a mitigative second level of control. Transfers From Waste Tank Annuli Program will ensure that negative pressure HEPA filtered ventilation is in place prior to waste transfers out of the tank annulus via a jetted transfer (steam). The controls supporting annulus confinement integrity include critical lift controls, structural integrity controls, corrosion controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

Steam-Heated Pump Tank

This event is prevented by the Pump Tank Transfer Jet Control Program (isolating the transfer jet when not in use) and through the Transfer Control Program (steam jet flowpath controls) which is the first level of control. The Transfer Control Program requires independent verification of jet discharge path valve position and evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The jet discharge path valve position verification applies to any valve with the potential to block transfer jet flow (including 3-way valves) such that the transfer jet steam is not allowed to transfer waste from the tank (i.e., the steam is directed into the tank). The evaluation shall be performed for jet transfers out of the pump tank that has the potential for salt solids formation and will include the amount of time the transfer may be suspended before flushing is required. The PP structure, controls supporting PP confinement integrity, and PP/pump tank active ventilation with HEPA filter provide a mitigative second level of control. The PP/pump tank structure also supports ventilation system operation. The controls supporting PP confinement integrity include HEPA filter efficiency testing controls, critical lift controls, structural integrity controls, traffic controls, and tank

top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

3.4.2.13.2 FREQUENCY DETERMINATION

The HA classifies Waste Tank/Waste Tank Annulus/Pump Tank Overheating events in the anticipated frequency bin. As discussed above, it is not reasonable to postulate that accidental boiling will occur for waste tanks 1) under static conditions, 2) during waste tank mixing device operations, or 3) Chemical Cleaning operations. Therefore, the Static Waste Tank, Slurried Waste Tank, and Type I/II Chemical Cleaning Waste Tank overheating scenarios are considered to be not credible. No detailed frequency analyses were performed to lower the assumed frequency for the other Waste Tank/Pump Tank Overheating events.

3.4.2.13.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.13.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Waste Tank/Pump Tank Overheating STs and are all taken from Reference 57, unless otherwise stated:

- The minimum flow area in the steam supply line controls the steam mass-flow rate through the steam transfer jet. Gang valves that supply steam to annulus and transfer jets have 1-inch schedule 40 discharge piping, with an inside diameter of 1.049 inches. This segment of pipe is a minimum of 4 feet in length.
- The steam transfer jet used in pump tanks has a 0.5-inch nominal diameter nozzle through which the steam must flow in order to impinge on the waste
- The maximum non-seismic steam pressure is 171 psig
- The maximum seismic steam pressure is 370 psig
- The maximum heat addition rate from evaporator bottoms is 3.0E+06 BTU/hour
- Based on saturated steam at 171 psig (non-seismic) and a calculated mass flow rate (representing choked flow through a 0.5-inch transfer jet nozzle), the steam injection heat load from the pump tank steam transfer jet is calculated as 1.22E+06 BTU/hour.
- Based on saturated steam at 171 psig (non-seismic) and a calculated mass flow rate (representing choked flow through 1-inch, schedule 40 pipe), the steam injection heat load from the waste tank / waste tank annulus steam transfer jet is calculated as 5.36E+06 BTU/hour. For the seismic case (370 psig steam), the calculated steam injection heat load is 1.08E+07 BTU/hour.

- The maximum heat generation rate for a waste tank/annulus from decay heat is 8.0E+05 BTU/hour
- The maximum heat generation rate from waste in a pump tank from decay heat is 3.0 BTU/hour/gallon

3.4.2.13.3.2 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The derivation of the values for each of the terms in the five-factor ST formula is detailed in the following (Ref. 57). The value of each of the terms is specific to the scenario being analyzed.

Material at Risk

The MAR waste stream for the tank overheating accident varies by scenario. For the evaporator drop tank scenario, the waste stream of concern is Evaporator Bottoms. For the steam-heated waste tank/annulus scenarios, the waste stream of concern is Bounding Supernate. For the steam-heated pump tank scenario, the waste stream of concern is Bounding Sludge Slurry. The waste characteristics and inhalation dose potential on a per unit volume basis for these streams are given in Section 3.4.1.5.1.

The volume of MAR for this event is the amount of liquid that boils off.

Damage Ratio

The DR is set equal to one.

Airborne Release Fraction/Respirable Fraction

When the waste temperature reaches the boiling temperature, the airborne release occurs from droplet formation due to vapor bubble burst (disintegration of bubble film) as vapor escapes from the liquid surface and from associated secondary effects (drops from crater collapse and from falling drops back into bulk liquid) (Ref. 14). Specification of the ARF and RF is based on experiments of heated aqueous solutions under conditions of bubbles continuously breaking the surface of the bulk liquid (less than 30% of the volume of liquid as bubbles). A bounding ARF and RF combination of 2E-03 and 1.0 is assessed for boiling conditions (Ref. 14).

Leak Path Factor

The LPFs for waste tanks and pump tanks were calculated in Reference 57, based on the model in Reference 59. Per this model, the LPF due to deposition can be expressed as a function of surface area available for deposition, deposition velocity, and ventilation flow rate. The ventilation flow rate establishes residence time of the vapor space gas in the tank (thus the higher the flowrate, the more conservative the LPF).

The bounding LPF for the waste tanks (primary) is 0.67 (Type I Waste Tanks). The LPF is based on 1,000 cfm ventilation flow.

The LPF is assumed to be one for the waste tank annuli and pump tanks.

The LPF calculations for unmitigated analysis assume that ventilation flow is provided by the installed system with no credit taken for particulate removal by demisters or HEPA filter operation.

3.4.2.13.3.3 Source Term Calculation

The unmitigated ST was calculated in Reference 57 for the various seismic and non-seismic scenarios (evaporator drop tank, steam-heated waste tank/annulus, steam-heated pump tank) using this ST formula. The bounding ST resulted from the Pump Tank Overheating event.

3.4.2.13.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Waste Tank/Pump Tank Overheating event are given in Table 3.4-7 (Ref. 57).

The unmitigated and mitigated Offsite (≤ 0.2 rem) consequences for the bounding scenario (steam-heated pump tank) do not challenge the Offsite EGs.

The unmitigated Onsite (> 100 rem) consequences for the bounding scenario (steam-heated pump tank) exceed the Onsite EGs. The mitigated Onsite consequences of this event are zero since this event is prevented. The unmitigated and bounding mitigated Onsite consequences (≤76 rem) for the Evaporator Drop Tank Overheating scenario do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the controls in place, the presence of the tank structures, and the length of time to reach saturation temperatures.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.13.5. The consequences of a Waste Tank/Pump Tank Overheating event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.13.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Waste Tank / Pump Tank Overheating event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Type I/II Chemical Cleaning Waste Tanks or Closure Waste Tanks.

3.4.2.13.5.1 Safety Class Controls

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

3.4.2.13.5.2 Safety Significant Controls

HDB-8 PVV System: The HDB-8 PVV System ensures that airborne releases within HDB-8 complex are mitigated via HEPA filtration.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions.

Pump Pit: The PP structure (including HEPA filtration) provides airborne waste confinement following waste overheating in the Pump Tank and supports ventilation system operation.

Pump Pit/Pump Tank Active Ventilation System: The PP/Pump Tank Active Ventilation System ensures that airborne releases within the PP are mitigated via HEPA filtration.

Pump Tank: Pump Tank integrity supports ventilation system operation.

Pump Tank Transfer Jet Control Program: Pump Tank Transfer Jets shall be manually isolated from steam while not in use to prevent overheating events.

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions.

Transfer Control Program: To prevent overheating events, the Transfer Control Program shall require independent verification of jet discharge path valve position. The Transfer Control Program shall also require evaluation of the possibility of core pipe pluggage due to salt solids formation if the transfer is shutdown. The evaluation shall be performed for jet transfers out of a salt tank and will include the amount of time that the transfer may be suspended before flushing is required.

Transfers From Waste Tank Annuli Program: Procedures shall be established governing waste transfers out of the waste tank annulus, including verification that a negative pressure ventilation system with HEPA filter shall be installed and operating prior to transferring waste from a waste tank annulus via a jetted transfer (steam).

Ventilation System Performance Monitoring: Ventilation System Performance Monitoring is required when HEPA filtration is credited as a control in an active ventilation system. Ventilation System Performance Monitoring shall ensure that the HEPA filter is operating properly, and capable of performing its credited function. Ventilation System Performance Monitoring checks the ventilation system and the downstream airborne activity periodically to ensure that HEPA filter plugging or breakthrough has not occurred. Monitoring of the downstream airborne activity is only required if the ventilation system condenser or reheater is not in service or is non-functional. Monitoring shall be performed prior to beginning the evolution to establish baseline conditions, and periodically thereafter. The required frequency of monitoring shall be adjusted based on the availability of equipment to remove moisture and condition the exhaust flow before passing through the HEPA filter.

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank structure (including HEPA filtration) provides airborne waste confinement following waste overheating in the waste tank and supports ventilation system operation.

Waste Tank Annulus: The Type I, Type II, Type III, and Type IIIA Waste Tank Annulus structure provides airborne waste confinement following waste overheating in the annulus.

Waste Tank Annulus Jet and Piping: The transfer jet and piping integrity in Type I, Type II, Type III, and Type IIIA Waste Tank annuli shall provide passive containment of the motive steam to prevent overheating of the waste and its subsequent release of radioactive material from the annulus.

Waste Tank Purge Ventilation System: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank Active Ventilation Systems ensure that airborne releases within the waste tank are mitigated via HEPA filtration.

Waste Tank Transfer Jet and Piping: The primary transfer jet and piping integrity in Type I, Type II, Type III, Type IIIA, and Type IV Waste Tanks shall provide passive containment of the motive steam to prevent overheating of the waste and its subsequent release of radioactive material from the waste tank.

3.4.2.14 Waste Tank Wall Failure

3.4.2.14.1 SCENARIO DEVELOPMENT

3.4.2.14.1.1 Background

Loss of waste tank liquid containment could occur if the waste tank primary wall fails (or tank top failure as discussed below). Primary tank wall failure could allow a significant amount of waste to be released depending upon various factors (e.g., leak size, leak location, cause of leak). Type I and Type II primary tanks are enclosed by a partial secondary containment shell. Type III and Type IIIA primary tanks are enclosed by a full secondary containment shell. Type IV Waste Tanks do not have a secondary containment.

The leak rate is dependent on both the size and location of the leak site. Other factors, such as waste rheology, temperature, and weight percentage of solids in the spilled solution, influence the leak rate. Additionally, OA introduction involved with Type I/II Chemical Cleaning Waste Tanks may corrode the waste tank wall and lead to primary containment leakage. Leakage into the annuli is normally detected by annulus leak detection instrumentation (conductivity probes or dip tubes).

Tank top failure (collapse) could allow a significant amount of waste to become airborne from impact due to falling debris. The amount of waste released is dependent on the amount of debris involved in the collapse and the physical characteristics of the MAR (e.g., liquid/dry waste).

The leak rate and wall/tank top structural integrity assumed in the unmitigated analysis are based on the waste tank design and the programs in place to protect waste tank wall/tank top integrity, excluding Type I/II Chemical Cleaning Waste Tanks and Closure Waste Tanks.

For Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks (since these tanks may have undergone Chemical Cleaning), the tank top structural integrity assumed in the unmitigated analysis is based on the waste tank design and the programs in place to protect waste tank top integrity. For these tanks, the unmitigated analysis is not based on an assumed leak rate (waste leaks instantaneously to annulus); therefore, programs to protect waste tank wall integrity are not required for Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks. Additionally, for Type I/II Closure Waste Tanks whose grout level is above the highest known historical waste level, the waste is considered non-dispersible, and programs to protect tank top structural integrity are not required.

For Type I Chemical Cleaning Waste Tanks (and Type I Closure Waste Tanks that underwent Chemical Cleaning), OA may corrode the carbon steel surrounding the column supports and degrade the tank top structural integrity, potentially leading to a loss of tank top structural integrity (e.g., tank top collapse). For Type II Waste Tanks, the steel surrounding the center support column does not perform a load capacity function of the center column to support the tank top, thus thinning of the steel has no impact on tank top structural integrity (Ref. 278, 279). For Type I Waste Tanks (excluding Tank 1), a reasonably conservative maximum general corrosion rate (< 150 mils per year) extrapolated from testing was less than the allowable thinning (> 300 mils total) of the column steel necessary to allow potential degradation of tank top structural support (Ref. 280). Given the short duration of operations involved with chemical cleaning on Type I Waste Tanks, degradation of the column supports leading to a Waste Tank Top Collapse was deemed not credible (Ref. 274). For Tank 1, analysis was not performed to determine the minimum column steel thickness necessary to support tank top structural integrity. Therefore, Tank 1 is prohibited from undergoing Chemical Cleaning operations (Ref. 274).

For Type IV Closure Waste Tanks, the wall/tank top structural integrity assumed in the unmitigated analysis is based on the waste tank design and the programs in place to protect waste tank wall/tank top integrity. Additionally, for Type IV Closure Waste Tanks whose grout level is above the highest known historical waste level, the waste is considered non-dispersible, and programs to protect wall/tank top structural integrity are not required.

For further detail on the waste tank annuli, refer to Section 2.4.1 (Waste Tanks).

3.4.2.14.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with a Waste Tank Wall Failure that have non-negligible risk. For the purpose of this analysis, the Waste Tank Wall Failure event will be divided into four categories: General Waste Tank Wall Leak, Chemical Cleaning Waste Tank Wall Leak, Catastrophic Waste Tank Wall Failure, and Waste Tank Top Collapse.

General Waste Tank Wall Leaks are a loss of primary wall containment resulting in a flow rate of four gpm or less into the annulus. The 4-gpm value was selected in the annulus explosion analysis to represent the highest leak rate that would reasonably be expected to occur, excluding Tank 50, Type I/II Chemical Cleaning Waste Tanks, and Type I/II Closure Waste Tanks. Except for Tank 50, leaks are assumed to occur due to initiators such as corrosion and reactivation of former leak sites (see discussion below for Tank 50 wall leakage). Chemical Cleaning Waste Tank Wall Leaks are a loss of primary wall containment due to severe corrosion resulting in release of the primary tank contents into the annulus with no assumed leak rate. Leaks are analyzed for their potential to cause an annulus explosion (the annulus explosion accident is covered in Section 3.4.2.12). Catastrophic Waste Tank Wall Failure is a loss of primary wall containment resulting in a flow rate of greater than four gpm from the tank into the annulus (excluding Chemical Cleaning Waste Tank Wall Leaks). Waste Tank Top Collapse is the loss of primary wall confinement or tank top structural support due to an exterior load or seismic event causing the waste tank top to drop into the tank, resulting in waste mobilization.

A scenario of concern is a failure of a primary tank side wall allowing a significant amount of waste dropping onto a hard surface. Waste spilling and splashing into a Type I, II, III, or IIIA Waste Tank annulus could cause a significant amount of waste to become airborne in the annulus, posing a radiological hazard if not mitigated. Because Type IV Waste Tanks do not have a secondary containment, the primary tank wall failure could cause a direct release to the ground but would not have a significant airborne release potential. The Type IV Waste Tank Wall Failure poses an environmental hazard due to waste release to the surrounding soil, but does not pose an Offsite or worker hazard and will not be addressed in this DSA. Similarly, events that could cause failure of a primary tank bottom (e.g., a waste tank mixing device dropping and puncturing a tank bottom, sample device interaction with the tank bottom, high pressure lancing operations, underliner sump or leak detection sump explosion) pose an environmental hazard, but do not present a significant airborne release concern. The underliner sump and leak detection sump explosion scenarios are discussed in detail in Section 3.4.2.12.

The initiators listed in the HA (Ref. 1) that could lead to a Catastrophic Waste Tank Wall Failure include tank flooding, tank floating, high differential pressure across the tank wall, low tank wall temperature, and high tank level. Tank floating is no longer considered to be a credible initiator for the Waste Tank Wall Failure (Ref. 219). The causes of a Catastrophic Waste Tank Wall Failure are prevented by maintaining the structural integrity of the waste tank wall. The structural integrity of the waste tank wall involves maintaining tank fill limits (excluding Type IV waste tanks), tank wall nil-ductility transition temperature, and tank corrosion controls. Administrative controls are in place to protect the structural integrity (fill limits, temperature, etc.) of the waste tank wall. Based on these controls it is assumed that no Catastrophic Waste Tank Wall Failure occurs. No controls other than those protecting the assumed initial conditions

regarding tank wall structural integrity are required to prevent Catastrophic Waste Tank Wall Failure.

For Tank 50, leakage from the waste tank wall is assumed to not occur (including post-DBE). The causes of side wall leakage are prevented by maintaining the structural integrity of the waste tank wall. The structural integrity of the waste tank wall involves maintaining tank fill limits, tank wall nil-ductility transition temperature, and tank corrosion controls. Administrative controls are in place to protect the structural integrity (fill limits, temperature, etc.) of the waste tank wall. Additionally, periodic inspections are performed on the waste tank wall. Based on the results of primary tank wall inspections, there has been no indication to date of leaks, cracks, wall thinning, or service induced pitting in Type IIIA tanks. Based on these controls it is assumed that no wall leakage occurs in Tank 50. No controls other than those protecting the assumed initial conditions regarding tank wall structural integrity are required to prevent Tank 50 wall leakage.

Chemical cleaning of the sludge heels that remain in Type I/II Waste Tanks may be performed with OA. OA is corrosive to carbon steel and may result in significant corrosion and degradation of the primary tank wall. Therefore, the analysis involved with Chemical Cleaning Waste Tank Wall Leaks assumes waste leaks instantaneously to the annulus. However, OA has negligible impact on grout/concrete and is not considered a corrosion hazard for this material (Ref. 274). Additionally, while OA may breach the carbon steel waste tank wall it cannot compromise the structural integrity of the concrete vault and is therefore not capable of causing a Waste Tank Top Collapse. Also as previously discussed, OA degradation of the column supports leading to a Waste Tank Top Collapse was deemed not credible (Ref. 274). For Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks, programs to protect waste tank wall integrity are not required.

During chemical cleaning of the 242-16H Evaporator, inadvertent addition of nitric acid could occur to a waste tank, causing potential degradation of tank wall integrity. Isolation valves and administrative controls (242-16H Evaporator Chemical Cleaning Program) are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no degradation of the wall occurs during chemical cleaning operations due to inadvertent acid addition.

Waste tank mixing device operation for waste removal from tanks can cause additional stresses on the primary tank wall. For Type I and II Waste Tanks, References 64, 65, and 297 state that the slurry pump, SMP, and CSMP loads are small compared to other operating loads (i.e., hydrostatic pressures). In addition, the potential erosion/corrosion of SRS waste tanks due to the operation of slurry pumps has been evaluated and shown to be insignificant (Ref. 63). Therefore, operation of slurry pumps, SMPs, and CSMPs is judged to not lead to catastrophic side wall failure.

The original design basis of the waste tanks assumed an upper bound of 400°F for waste temperature. The American Concrete Institute has subsequently issued a standard for the temperature of the concrete in nuclear facility structures above which concrete degradation may occur. Significant reduction in the strength of the concrete in the columns and/or base mat could result in a loss of structural integrity of the tank top and result in tank wall failure. Based on

structural analyses (Ref. 180, 181, 182, 183), the tank wall and bottom temperatures permitted for continued operation are 140°C, excluding Type IV Waste Tanks, which do not contain high heat waste. The waste tank top temperatures permitted are 100°C, with three waste tanks (Tanks 7, 9, and 11) permitted only to 80°C. As discussed previously, administrative controls are in place to protect the structural integrity of the waste tank wall, including temperature monitoring and activities as necessary to preclude approaching the temperatures limits. Since the temperatures of concern will not be reached rapidly in the waste tanks, programmatic controls are adequate.

Many of the initiating events that evolve into Waste Tank Wall Failure can also be initiators for an annulus explosion. The annulus explosion accident is covered in Section 3.4.2.12.

Another accident of concern is the failure of a waste tank top impacting the waste causing an airborne release. The initiators in the HA (Ref. 1) that could lead to a significant airborne release (e.g., failure of the tank top) include overloading the tank top, riser loading from equipment malfunction, crane drops, external events, and seismic events. The causes of a tank top collapse are prevented by maintaining the structural integrity of the waste tank (including the tank top). The structural integrity involves maintaining concrete temperatures, controlling lifts, and controlling tank top loading. Administrative controls are in place to protect assumed initial conditions regarding the structural integrity of the tank top. Type IV Waste Tanks are designated as SS; hence, the event is not precluded with respect to Offsite consequences.

3.4.2.14.1.3 Unmitigated Accident Progression

The unmitigated accident progressions for the General Waste Tank Wall Leak, Chemical Cleaning Waste Tank Wall Leak, and Waste Tank Top Collapse are provided below.

General Waste Tank Wall Leak

(Note: This progression is not applicable to Tank 50, due to an assumed leak rate of 0 gpm as discussed above. This progression is not applicable to Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks that underwent Chemical Cleaning.)

- Type I, II, III, or IIIA Waste Tank primary containment side wall leaks
- Waste is leaked into the waste tank secondary containment (The non-DBE tank leak rate is 0.4 gpm, the DBE tank leak rate is 4 gpm)
- The spilling and splashing of waste causes an airborne release
- Waste Tank Annulus Ventilation System sweeps airborne material from the annulus (annulus ventilation filtration is not assumed)
- The Offsite exposure time for the release is 8 hours
- The Onsite exposure time for the release is 12 hours

Chemical Cleaning Waste Tank Wall Leak

(Note: This progression is only applicable to Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks that underwent Chemical Cleaning.)

- Type I or II Waste Tank is undergoing chemical cleaning and contains OA
- Waste Tank wall corrodes and the primary containment side wall leaks
- Waste is leaked into the waste tank secondary containment and instantaneously equalizes to the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level)
- The spilling and splashing of waste causes an airborne release
- Waste Tank Annulus Ventilation System sweeps airborne material from the annulus (annulus ventilation filtration is not assumed)
- The airborne material is transported to Onsite and Offsite receptors

Waste Tank Top Collapse

- A dropped (or excessive) load or seismic event causes a Type IV Waste Tank top to collapse
- The tank top and/or material covering the tank top (e.g., soil, asphalt) drop into the tank and impact the waste
- The spilling and splashing (liquid waste) or suspension (dry waste) of the impacted waste causes an airborne release
- The airborne material is released via the open waste tank top (no filtration is assumed)
- The Offsite and Onsite exposure time for the release is 8 hours

3.4.2.14.1.4 Mitigated Accident Progression

The unmitigated consequences of the General Waste Tank Wall Leak (within assumed leak rates) and Waste Tank Top Collapse scenarios do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.14.4). Since the unmitigated consequences for these accident scenarios do not challenge the Offsite or exceed the Onsite EGs, no mitigated analysis is required.

The unmitigated consequences for the Chemical Cleaning Waste Tank Wall Leak (Type I/II Chemical Cleaning Waste Tanks) scenario do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.14.4); however, the consequences were qualitatively judged to exceed the applicable Onsite EGs for the FW in the immediate vicinity of the event. Therefore, mitigated analysis is performed for the Chemical Cleaning Waste Tank Wall Leak (Type I/II Chemical Cleaning Waste Tanks) scenario. Because only the FW in the immediate vicinity of the event was at risk, one SS level of control is required.

The unmitigated consequences for Chemical Cleaning Waste Tank Wall Leak (Type I/II Closure Waste Tanks) scenario do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.14.4); therefore, mitigated analysis is not required for Closure Waste Tanks.

Chemical Cleaning Waste Tank Wall Leak

For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tank annulus confinement, controls supporting waste tank annulus confinement integrity, and active negative pressure annulus ventilation with HEPA filter provides a mitigative first level of control. The waste tank annulus structure also supports ventilation system operation. The controls supporting waste tank annulus confinement integrity include HEPA filter efficiency testing controls (95% HEPA efficiency), critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Ventilation System Performance Monitoring is also credited to ensure that the required HEPA filter is operating properly.

For Type I/II Non-Acidic Chemical Cleaning Waste Tanks, the waste tank annulus confinement and controls supporting waste tank annulus confinement integrity, up to and including the inlet and outlet HEPA filters (no active ventilation credited), provides a mitigative first level of control. The controls supporting waste tank annulus confinement integrity include HEPA filter efficiency testing controls (95% HEPA efficiency), critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls.

3.4.2.14.2 FREQUENCY DETERMINATION

The HA classifies Waste Tank Wall Failure events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.14.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

ST information related to the Waste Tank Top Collapse scenario (liquid waste and dry waste) is provided below for Type IV Waste Tanks to determine Offsite consequences. Type IV Waste Tanks are designated as SS; hence, the event is not precluded with respect to Offsite consequences.

3.4.2.14.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Waste Tank Wall Failure STs and are all taken from References 58, 60, 189, and 248, unless otherwise stated:

- For Type I, Type II, Type III, and Type IIIA Waste Tanks (excluding Tank 50, Type I/II Chemical Cleaning Waste Tanks, and Type I/II Closure Waste Tanks) the tank leak rates (into the annulus) are as follows:
  - Non-DBE: 0.4 gpm
  - DBE: 4 gpm
- The non-DBE and DBE tank leak rate (into the annulus) for Tank 50 is 0 gpm (discussed above).
- For Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks the tank leak rates (into the annulus) are as follows:
  - Non-DBE: No assumed tank leak rate and waste is assumed to leak instantaneously and equalize at the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level).
  - Single seismically-initiated tank leak event (for analysis and consequences in Section 3.4.2.14): No assumed tank leak rate and waste is assumed to leak instantaneously and equalize at the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level).
  - DBE (for analysis and cumulative consequences in Section 3.4.2.18): 4 gpm
- Bounding Sludge Slurry or ESP Sludge Slurry does not leak from the tank into the annulus. Material that leaks to the annulus is dependent on the specific scenario and is discussed in the Material at Risk subsection in Section 3.4.2.14.3.2.

3.4.2.14.3.2 Source Term Derivation

Unmitigated ST was derived using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The value of each of the terms is specific to the scenario being analyzed.

Material at Risk

General Waste Tank Wall Leak

The primary containment structure and programs supporting containment integrity ensure that leaks into the annulus are of supernate and would have a leak rate no greater than 4.0 gpm following a DBE and no greater than 0.4 gpm at all other times, excluding Tank 50.

The MAR is Bounding Supernate. The waste characteristics and inhalation dose potential on a per unit volume basis for these waste streams are given in Section 3.4.1.5.1.

The volume of waste involved is 1,920 gallons (4 gpm x 8 hours) for Offsite and Onsite consequence determination.

Chemical Cleaning Waste Tank Wall Leak

For this scenario, the analysis is not based on an assumed leak rate and waste is leaked into the waste tank secondary containment and instantaneously equalizes to the equilibrium level in the annulus (maximum annulus level is 60 inches based on the maximum waste tank primary liquid level).

For Type I/II Chemical Cleaning Waste Tanks, the initial MAR in the tank is assumed to be 10,000 gallons of Type I/II Waste Tank Chemical Cleaning Slurry. For the parametric spill analysis, OA volume is added to the waste tank (which dilutes the MAR but increases the potential spill volume) to obtain the bounding consequence values. However, for analysis and cumulative consequences in Section 3.4.2.18 for Type I/II Chemical Cleaning Waste Tanks, the MAR is Bounding Supernate. The waste characteristics and inhalation dose potential on a per unit volume basis for these waste streams are given in Section 3.4.1.5.1.

For Type I/II Closure Waste Tanks, the MAR is 1.0E+12 rem of aqueous waste. The total aqueous waste dose potential of 1.0E+12 rem is based on a stream with the maximum radiological constituent concentrations in Tanks 9-15 (Ref. 275, 276). For the parametric spill analysis, volume is added to the waste tank (which dilutes the MAR but increases the potential spill volume) to obtain the bounding consequence values.

Waste Tank Top Collapse (Liquid Waste)

Except as noted below, the MAR is that of Slurried Type IV Tank Waste (1.0E+07 rem/gal) as shown in Section 3.4.1.5.1 with the assumed physical characteristics of supernate. This is a conservative value since assuming the supernate release ARF/RF results in higher consequences for this scenario (Ref. 289).

Reference 189 demonstrates that the debris (tank top and overlying soil) from a Type IV tank top collapse can potentially displace up to 138,000 gallons. This is the volume assumed for consequence derivation.

Waste Tank Top Collapse (Dry Waste)

For Closure Waste Tanks, the MAR is 1.0E+12 rem. For Closure Waste Tanks, it is assumed that the total waste inventory (total effective inhalation dose potential) is affected by the tank top collapse. Additionally, the tank top collapse is assumed to affect both the assumed powder layer (evaporated supernate) and the underlying solid aggregate layer (dried sludge) of the dry sludge.

Damage Ratio

The DR is assumed to be one in all scenarios.

Airborne Release Fraction/Respirable Fraction

General Waste Tank Wall Leak

Different ARF and RF values were used for the various release mechanisms (Ref. 60). The values are taken from Reference 14. The ARF/RF values used are:

- Free-Fall Spill: 5.0E-05 / 0.8

The ARR and RF values used in the analysis are based on Reference 14. The ARR/RF values used are:

- Indoor Resuspension: 4.0E-07 / 1.0

Chemical Cleaning Waste Tank Wall Leak

Different ARF and RF values were used for the various releases (Ref. 276). The values are taken from Reference 14. The ARF/RF values used are:

- Type I/II Closure Waste Tanks (aqueous waste): 1.0E-04 / 1.0
- Type I/II Chemical Cleaning Waste Tanks (total waste tank volume ≤ 26,000 gallons): 2.0E-05 / 1.0
- Type I/II Chemical Cleaning Waste Tanks (total waste tank volume > 26,000 gallons): 2.0E-04 / 0.5

Waste Tank Top Collapse (Liquid Waste)

There are two sets of bounding ARFs and RFs from a 3 meter fall, given in Reference 14, that are applicable to waste tank material (Ref. 189). One set applies to aqueous solutions (e.g., Bounding Supernate), ARF = 2E-04, RF = 0.5. The other set applies to slurries (e.g., Bounding Sludge Slurry), ARF = 5E-05, RF = 0.8. The more conservative ARF/RF values (i.e., aqueous solutions) were used in the consequence calculations, regardless of waste type (sludge slurry or supernate).

Waste Tank Top Collapse (Dry Waste)

As discussed earlier, a tank top collapse can potentially affect both the assumed powder layer (evaporated supernate) and the underlying solid aggregate layer (dried sludge) of the dry sludge. Reference 263 specified ARF and RF values that are applicable to the specific event scenario and accident stresses, as discussed below. Based on these discussions, the total respirable ARF for a tank top collapse is the sum of the fractions for the mechanisms.

ARF and RF Values for Powders

A tank top collapse (falling object) can cause resuspension of a powder material on which it falls by two mechanisms. The first mechanism is due to imposing an aerodynamic stress on the surface of the powder as the object nears the powder surface. Reference 14 provides a bounding ARF and RF for this situation of 1.0E-02 and 0.2, respectively. The total respirable ARF due to this release mechanism is, therefore, 2.0E-03. The second mechanism by which a falling object may result in the suspension of powder material is due to vibration/jolting induced by the impact of the object on the solid substrate on which the powder rests. Reference 14 provides a bounding estimate of ARF and RF for the suspension of powders due to vibration of 1.0E-03 and 0.1, respectively. Using these values, the total respirable ARF due to this release mechanism is 1.0E-04.

ARF and RF Values for Aggregate Solids

Brittle materials (e.g., glass, aggregate such as mechanically compacted UO_2, concrete, limestone) can be fragmented when impacted or crushed. The dry sludge is assumed to behave as an aggregate. Therefore, it is susceptible to fragmentation from impact. Reference 14 documents an empirical correlation based on experimental data for the respirable ARF due to impact of a hard object on a hard, unyielding surface. Note that implicit in this correlation is the assumption that the object being dropped onto the surface is at least as hard (i.e., dense) as the surface material being impacted. The correlation is intended to be an indicator of the energy density imparted into the material by the falling object. This correlation is:

$$ARF \times RF = A \times \rho \times g \times h$$

Where:

A = empirical correlation, 2E-11 cm^3 per g-cm^2 /s^2

ρ = specimen density, g/cm^3

g = gravitational acceleration, 980 cm/s^2 at sea level

h = fall height, cm

Reference 14 notes that use of this correlation to estimate the ARF × RF value is considered very conservative, and may be excessively so if large debris from substantial heights is considered. This conservatism is due to various factors including the fact that the majority of the particles generated due to fragmentation of the material by impact will be too large to become airborne or be respirable. However, in this case, relatively small objects are considered as potential objects dropped onto the dry sludge surface so the conservatism in the correlation should not be excessive.

ARR and RF Values for Aerodynamic Entrainment and Resuspension Stress

In addition to the impact of the falling tank top and the vibration of the impact following the collapse, the waste in the tank would be subjected to aerodynamic entrainment and resuspension stress. From Reference 14, an ARR value of 4E-06/hr and RF value of 1 are used. The entrainment ARF (3.2E-05) is determined by multiplying the ARR for entrainment by the duration of the event (8 hours).

Leak Path Factor

The LPF is assumed to be one for all scenarios.

3.4.2.14.3.3 Source Term Calculation

The basic ST methodology was applied to each scenario, with the ST formula applied separately for each of the applicable specific release mechanisms (e.g., free-fall spill, indoor resuspension). The Offsite and Onsite ST results for Bounding Supernate releases into the annulus from General Waste Tank Wall Leaks are documented in Reference 60. The Offsite and Onsite ST results for releases into the annulus from Chemical Cleaning Waste Tank Wall Leaks (including Type I/II Closure Waste Tanks) are documented in Reference 276. The Offsite and Onsite ST results for a Waste Tank Top Collapse are documented in References 189 and 263.

3.4.2.14.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Waste Tank Wall Failure event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 60, 189, 255, 263, 276).

The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding Waste Tank Wall Failure scenario (Chemical Cleaning Waste Tank Wall Leak) do not challenge the Offsite EGs. The unmitigated and mitigated Offsite consequences (≤ 0.1 rem) for the bounding Waste Tank Top Collapse scenario (Type IV Waste Tank – liquid waste) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (≤ 96 rem) for the bounding Waste Tank Wall Failure scenario (Chemical Cleaning Waste Tank Wall Leak – Type I/II Chemical Cleaning Waste Tanks) do not exceed the Onsite EGs (but were qualitatively judged to exceed the applicable Onsite EGs for the FW in the immediate vicinity of the event). The mitigated Chemical Cleaning Waste Tank Wall Leak scenario (Type I/II Chemical Cleaning Waste Tanks) consequences to the immediate vicinity worker are judged not to exceed the applicable Onsite EGs due to the controls in place. The unmitigated and mitigated Onsite consequences (≤ 33 rem) for the Chemical Cleaning Waste Tank Wall Leak scenario (Type I/II Closure Waste Tanks) do not exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the waste tank design and presence of the annulus structure. The unmitigated and mitigated Onsite consequences (≤ 10 rem) for the General Waste Tank Wall Failure scenario (4-gpm leak of Bounding Supernate) also do not exceed the Onsite EGs. The

immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the waste tank design and presence of the annulus structure.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.14.5. The consequences of a Waste Tank Wall Failure event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.14.5 SUMMARY OF CONTROLS

The leak rates assumed in the analysis are based on the waste tank design and the programs in place to protect waste tank wall/tank top integrity, dependent upon the tank type as described in Section 3.4.2.14.1. The controls supporting waste tank wall/tank top structure integrity include critical lift controls, structural integrity controls, corrosion controls, and tank top/secondary containment loading controls. The controls required to protect the initial accident assumptions are described below. In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of Waste Tank Wall Failure event do not exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Type I/II/IV Closure Waste Tanks whose grout height is above the highest known historical waste level.

3.4.2.14.5.1 Safety Class Controls

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

High Liquid Level Conductivity Probes: The Type I, Type II, Type III and Type IIIA Waste Tank HLLCPs provide control room alarm following a waste tank high level condition to protect tank wall integrity requirements (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCPs provide control room alarm following a waste tank high level condition (with maximum levels less than or equal to 63.8 inches [Type I] and 64.8 inches [Type II]) to protect a maximum annulus equilibrium liquid level (following a tank wall breach). (For Tank 50, this control is required to be SS only) (Not applicable to Closure Waste Tanks)

Tank Fill Limits Program: The Tank Fill Limits Program provides controls (accounting for various waste level limiting factors such as the structural integrity fill limit) to protect tank wall

integrity requirements (excluding Type I/II Chemical Cleaning Waste Tanks). For Type I/II Non-Acidic Chemical Cleaning Waste Tanks, the Tank Fill Limits Program (with maximum levels less than or equal to 63.8 inches [Type I] and 64.8 inches [Type II]) provides controls to protect a maximum annulus equilibrium liquid level (following a tank wall breach). (For Tank 50, this control is required to be SS only) (Not applicable to Closure Waste Tanks)

Waste Tank: The Type I, Type II, Type III, and Type IIIA Waste Tanks are passive design features that provide waste confinement. Waste tank wall (within assumed leak rates)/tank top integrity is required, excluding Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks. Waste tank top integrity is required for Type I/II Chemical Cleaning Waste Tanks and Type I/II Closure Waste Tanks. (For Tank 50, this control is required to be SS only)

3.4.2.14.5.2 Safety Significant Controls

Ventilation System Performance Monitoring: Ventilation System Performance Monitoring is required when HEPA filtration is credited as a control in an active ventilation system. Ventilation System Performance Monitoring shall ensure that the HEPA filter is operating properly, and capable of performing its credited function. Ventilation System Performance Monitoring checks the ventilation system and the downstream airborne activity periodically to ensure that HEPA filter plugging or breakthrough has not occurred. Monitoring of the downstream airborne activity is only required if the ventilation system condenser or reheater is not in service or is non-functional. Monitoring shall be performed prior to beginning the evolution to establish baseline conditions, and periodically thereafter. The required frequency of monitoring shall be adjusted based on the availability of equipment to remove moisture and condition the exhaust flow before passing through the HEPA filter.

Waste Tank: The Type IV Waste Tanks (including tank top) are passive design features that provide waste confinement.

Waste Tank Annulus: The Type I and Type II Waste Tank Annulus structure provides airborne waste confinement in the waste tank annulus and supports ventilation system operation (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Ventilation System: The Type I and Type II Waste Tank Annulus Active Ventilation Systems (negative pressure) ensure that airborne releases within the waste tank annulus are mitigated via HEPA filtration (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks). For Type I/II Non-Acidic Chemical Cleaning Waste Tanks, the ventilation system inlet and outlet HEPA filters ensure that airborne releases within the waste tank annulus are mitigated via HEPA filtration when the ventilation system is not operating.

3.4.2.15 Waste Tank Siphon/Pump-Out

3.4.2.15.1 SCENARIO DEVELOPMENT

3.4.2.15.1.1 Background

Loss of waste tank liquid containment would occur if waste were allowed to siphon/pump-out from the waste tank via the waste tank CRW System to the environment or another waste tank leading to a waste tank overflow. The siphon/pump-out could only occur if there was a leak in a CRW cooling coil inside a waste tank below the tank's liquid level coincident with a leak in a CRW System line outside the tank or coincident with a leak in a CRW coil in another waste tank (for a siphon to occur, the CRW System line leak outside the tank or in the other waste tank must be at a lower elevation than the tank's liquid level). CRW leaks are addressed (e.g., cooling coil loop isolated) upon discovery; in very rare cases however (e.g., Waste Tank 30), subsequent operation with small identified leakage is permitted in order to maximize tank cooling.

Reference 258 evaluated waste tanks for siphon and pump-out potential for leaks outside the waste tank through the CRW System. For Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, and 11, the maximum tank liquid level with respect to the CRW System low points is such that a siphon is not credible (the maximum tank liquid level is based on the primary tank top elevation for Waste Tanks 3, 4, 7, 8, 9, 10, and 11; for Waste Tanks 1 and 2 the level is based on the tank fill limit protected by HLLCPs and Tank Fill Limits Program). The tanks in FTF (Waste Tanks 1, 2, 3, 4, 7, 8, 25, 26, 27, 28, 33, 34, 44, 45, 46, and 47) are not susceptible to pump-out due to the system configuration (surge tank aligned to the CRW System). Pump-out from HTF Waste Tanks 9, 10, and 11 is not credible for the same reason. The siphon/pump-out accident is not credible in Type IV Waste Tanks (i.e., Waste Tanks 21, 22, 23, and 24) because they do not have cooling coils. The siphon/pump-out from Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, and 11 into another waste tank resulting in an overflow is not credible, due to the maximum tank liquid level with respect to the CRW System valve house header high point (based on the tank fill limit protected by HLLCPs and Tank Fill Limits Program).

Waste Tank Siphon/Pump-Out is precluded for Closure Waste Tanks by the CRW System being isolated from these waste tanks. Waste Tank Siphon/Pump-Out is precluded for Closure Waste Tank cooling coils that are using the cooling coil flushing/grouting system due to system configuration (see Section 3.4.1.5.2). Waste Tank Siphon/Pump-Out is precluded for waste tank cooling coils that are using the Sealant Deployment System due to system configuration (see Section 3.4.1.5.2).

For further detail on the waste tank systems, refer to Section 2.4.1. For further detail on the Sealant Deployment System, refer to Section 2.8.2.5.

3.4.2.15.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Waste Tank Siphon/Pump-Out that have non-negligible risk.

3.4.2.15.1.3 Unmitigated Accident Progression

- A CRW coil(s) in a Type II, III, or IIIA Waste Tank(s) loses structural integrity (coil failure is assumed coincident with either loss of above-ground piping integrity or coil failure in another waste tank in the seismic scenario, coil failure is assumed to go undetected/unaddressed in the non-seismic scenario)
- CRW System above-ground (to include excavated) piping or a CRW coil(s) in another Type I, II, III, or IIIA Waste Tank(s) loses structural integrity
- CRW System pressure is lost
- The elevation difference between the waste tank liquid level over the broken coils and the above-ground piping or broken CRW coil(s) in other waste tank is sufficient for siphon/pump-out to begin
- Waste is siphoned/pumped-out from the waste tank to the environment via the CRW System or from one waste tank to another via the CRW System leading to a waste tank overflow and release to the environment (outdoor spill)

3.4.2.15.1.4 Mitigated Accident Progression

Because the Onsite (but not Offsite) EGs are exceeded (as documented in Section 3.4.2.15.4), mitigated analysis is required based on the applicable waste tank. Even though the Offsite EGs are not challenged, mitigated analysis was performed to document the reduced risk achieved by implementing controls for those waste tanks posing the more significant Offsite hazard. SC controls were implemented on Waste Tanks 13, 14, 15, 29, 30, 31, 32, 35, and 39 to prevent (or mitigate in the case of Tank 39) the siphon/pump-out event and reduce the consequences to the Offsite receptor. Because Offsite controls are required on only a limited set of waste tanks, some waste tanks will have SC controls while others will have only SS controls. During chemical cleaning of the 242-16H Evaporator, inadvertent addition of nitric acid could occur to a waste tank, causing potential degradation of cooling coils. Isolation valves and administrative controls (242-16H Evaporator Chemical Cleaning Program) are in place to protect inadvertent addition of acid to a waste tank. Based on these controls it is assumed that no degradation of the cooling coils occurs during chemical cleaning operations due to inadvertent acid addition. Table 3.4-10 provides a summary of the controls required for this event.

With respect to the Onsite receptor, controls were selected to prevent the Siphon/Pump-Out event. The Event Response Program (operator response) was selected as a second level of control for many waste tanks. For the seismic case, operators will take action in response to a break following the seismic event. There are multiple non-credited siphon/pump-out indications that will prompt operator response, including waste tank level indication and alarm (upon significant level change), CRW surge tank level indication and alarm, ARMs with alarm in close proximity of the CRW System lines, periodic cooling coil pressure tests, facility wide ARMs with alarm, and shiftly operator rounds. The controls required to prevent the event are grouped by applicable waste tank. Where the CRW header isolation valves are credited, the valves shall be capable of being fully shut. Fully shutting of these valves, regardless of the wear condition of their seat and disk(s) (along with event response) will provide a second level of control and prevent the siphon event from posing a significant risk. The valves would continue to provide

event mitigation and allow additional response time to provide an alternate siphon break, well before the resulting event would develop into a significant siphon accident.

When SSCs are credited in the scenarios below, controls supporting their integrity are also credited. These controls, which are not listed in the individual scenarios below, include the following (depending on the scenario): critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

Waste Tanks 13, 14, and 15

The common CRW supply header and return header for Tanks 13, 14, and 15 each contain two siphon breakers used to eliminate any siphon/pump-out potential. However, CRW supply and return to the cooling coils for Tanks 14 and 15 are not permanently connected and are blanked or physically disconnected when not in use, eliminating any siphon/pump-out potential. The CRW System is connected when operational plans require cooling for Tank 14 or Tank 15. When Tank 14 or Tank 15 is aligned to the common supply and return headers, the installed siphon breakers are credited to eliminate the siphon/pump-out potential from the applicable tank.

The supply and return header siphon breakers for Waste Tank 13, Waste Tank 14 (when connected to the CRW System), and Waste Tank 15 (when connected to the CRW System) are credited as a SC first level of control (seismic and non-seismic) to prevent a CRW siphon/pump-out event.

For Waste Tank 13, Waste Tank 14 (when connected to the CRW System), and Waste Tank 15 (when connected to the CRW System), the second level of control is the Event Response Program (operator response) (seismic and non-seismic), using the CRW supply and return header isolation valves. Operator response will be to close the CRW header isolation valves upon identification of a CRW system pressure boundary break in the waste tank.

Waste Tanks 25, 26, 27, 28, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51

The CRW coil pressure boundary is credited as a SS first level of control (seismic and non-seismic) for Waste Tanks 25, 26, 27, 28, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51 to prevent a CRW Siphon/Pump-Out event. The second level of control is the Event Response Program (operator response) (seismic and non-seismic), using the waste tank CRW header isolation valves. Operator response will be to close the tank CRW header isolation valves upon identification of a CRW System pressure boundary break in the waste tank. (The preceding controls are required on Waste Tanks 25, 26, 27, 28, 44, 45, 46, and 47 for siphon only; pump-out from these tanks is not possible due to the system configuration [surge tank aligned to the CRW System]).

In addition to the above controls, mixing will be prohibited in Tank 39. This prohibited operation is considered to be a SC mitigator, minimizing the potential for sludge solids to be siphoned or pumped out of Tank 39. Although the potential for some sludge solids to be siphoned/pumped out of Tank 39 through the CRW System remains, prohibiting the tank contents from being slurried ensures that the vast majority of sludge solids will remain in the tank. The minor amount of sludge solids that may be removed by the Siphon/Pump-Out event is

considered bounded by the conservatism used in determining the mitigated MAR (i.e., the assumption that all the waste is removed from all the other tanks (i.e., all FTF and HTF waste tanks other than Tanks 30, 32, and 35) provides sufficient margin to account for the small amount of solids that would be removed from this tank). This is considered conservative since historical operations, focused on sludge removal, have been unsuccessful in removing all the sludge from any tank. Therefore, the sludge solids contained within Tank 39 are assumed not to be released in the mitigated scenario.

Waste Tanks 29, 30, 31, 32, 33, 34, and 35

The siphon breakers on Waste Tank 30 will be credited as a SC first level of control (seismic and non-seismic) for Waste Tanks 29, 30, 31, and 32 to prevent a CRW Siphon/Pump-Out event.

For Waste Tank 30, the second level of control is the Event Response Program (operator response) (seismic and non-seismic), using the waste tank CRW coil isolation valves. Operator response will be to close the waste tank CRW coil isolation valves upon identification of a CRW System pressure boundary break in the waste tank.

For Waste Tanks 29, 31, and 32, the CRW coil pressure boundary is credited as a second level of control (non-seismic only) to prevent a CRW Siphon/Pump-Out event. For Waste Tanks 29, 31, and 32, the second level of control is the Event Response Program (operator response) following the Seismic event, using the waste tank CRW header isolation valves. Operator response will be to close the tank CRW header isolation valves upon identification of a CRW System pressure boundary break in the waste tank.

The siphon breakers near Waste Tank 34 will be credited as the SS first level of control (seismic and non-seismic) for Waste Tanks 33 and 34 to prevent a CRW Siphon/Pump-Out event. The CRW coil pressure boundary is credited as a second level of control (non-seismic only) to prevent a CRW Siphon/Pump-Out event. The second level of control is the Event Response Program (operator response) following the Seismic event, using the waste tank CRW header isolation valves. Operator response will be to close the tank CRW header isolation valves upon identification of a CRW System pressure boundary break in the waste tank.

The siphon breakers on Waste Tank 35 will be credited as the SC first level of control (seismic and non-seismic) for Waste Tank 35 to prevent a CRW Siphon/Pump-Out event. The CRW coil pressure boundary is credited as a second level of control (non-seismic only) to prevent a CRW Siphon/Pump-Out event. The second level of control is the Event Response Program (operator response) following the Seismic event, using the waste tank CRW header isolation valves. Operator response will be to close the tank CRW header isolation valves upon the identification of a CRW System pressure boundary break in the waste tank.

In addition to the above controls, sludge slurry transfers out of Tanks 32 and 35 are prohibited. This ensures that the sludge solids in these tanks will not be transferred to other locations which do not have SC controls to prevent the siphon. Therefore, the sludge solids in these tanks are assumed not to be released in the mitigated scenario.

Post-seismic mitigation for all waste tanks is discussed further in Section 3.4.2.18.

3.4.2.15.2 FREQUENCY DETERMINATION

The HA classifies Waste Tank Siphon/Pump-Out events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.15.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.15.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the Waste Tank Siphon/Pump-Out STs and are all taken from Reference 60 unless otherwise stated:

- Maximum flowrate for a seismically-induced siphon spill is 4,000 gpm.

3.4.2.15.3.2 Source Term Derivation

An unmitigated ST for a Waste Tank Siphon/Pump-Out event can be derived using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The terms in the five-factor ST formula are discussed below, including discussion of scenario specific parameters.

Material at Risk

A Waste Tank Siphon/Pump-Out event is conservatively assumed to release 423,000 gallons of Bounding Sludge Slurry above ground in eight hours in the unmitigated scenario. The sludge slurry quantity in the unmitigated scenario is limited to 423,000 gallons of Bounding Sludge Slurry because this value is the equivalent dose potential of all the sludge in the Tank Farms (Ref. 88). A Waste Tank Siphon/Pump-Out event is conservatively assumed to release 172,000 gallons of Bounding Sludge Slurry above ground in eight hours in the mitigated scenario. This sludge slurry quantity is the equivalent dose potential of all the Tank Farms sludge in waste tanks without SC controls (the total amount available for release, from Reference 88, has been reduced to account for the SC controls in place on Waste Tanks 29, 30, 31, 32, 35, and 39). This assumed quantity of sludge slurry is sufficiently bounding such that no additional supernate need be considered. The waste characteristics and inhalation dose potential on a per unit volume basis for the various waste streams is given in Section 3.4.1.5.1.

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction/Respirable Fraction

The ARFs and RFs associated with Waste Tank Siphon/Pump-Out are the same as the above-ground core pipe release model from the Transfer Error accident (Section 3.4.2.9). The ARFs and RFs are described in detail in Reference 60.

Leak Path Factor

The LPF is assumed to be one.

3.4.2.15.3.3 Source Term Calculation

STs were calculated in Reference 60 using the methodology for an above-ground core pipe release model from the Transfer Error accident (Section 3.4.2.9). The Offsite and Onsite ST results are documented in Reference 60.

3.4.2.15.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Waste Tank Siphon/Pump-Out event are given in Table 3.4-7 (Ref. 60).

The unmitigated (≤ 12.1 rem) and mitigated (≤ 5.1 rem) Offsite consequences for the bounding scenario (waste tank siphon due to CRW line failure) do not challenge the Offsite EGs.

The unmitigated Onsite consequences (> 100 rem) for the bounding scenario (waste tank siphon due to CRW line failure without SC controls) exceed the Onsite EGs. The mitigated Onsite consequences for the bounding scenario (waste tank siphon due to CRW line failure) are zero because the event is prevented. The consequences to the immediate vicinity worker are also zero because the event is prevented.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.15.5. The consequences of a Siphon/Pump-Out event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.15.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Waste Tank Siphon/Pump-Out event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression). The following controls are not required for Closure Waste Tanks.

3.4.2.15.5.1 Safety Class Controls

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

Waste Tank 13/14/15 Siphon Breaker: The Waste Tank 13/14/15 Siphon Breaker (located near Tank 13) is credited to prevent a CRW siphon/pump-out event for Waste Tank 13, Waste Tank 14 (when connected to the CRW System), and Waste Tank 15 (when connected to the CRW System).

Waste Tank 30 Siphon Breaker: The Waste Tank 30 Siphon Breaker is credited to prevent a CRW siphon/pump-out event for Waste Tanks 29, 30, 31, and 32.

Waste Tank 35 Siphon Breaker: The Waste Tank 35 Siphon Breaker is credited to prevent a CRW siphon/pump-out event for Waste Tank 35.

3.4.2.15.5.2 Safety Significant Controls

CRW Coil Pressure Boundary: The CRW Coil Pressure Boundary inside Waste Tanks 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51 is a credited design feature to prevent a CRW siphon/pump-out event.

Event Response Program: Procedures shall be established governing required actions following a Waste Tank Siphon/Pump-Out event. These procedures shall require the following operator actions:

1) Close waste tank CRW header isolation valves upon identification of a CRW System boundary break in the waste tank (Waste Tanks 13, 14 [when connected to the CRW System], 15 [when connected to the CRW System], 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51).

2) Close Waste Tank 30 CRW coil isolation valves upon identification of a CRW System boundary break in the waste tank.

High Liquid Level Conductivity Probes: The HLLCPs for Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, and 11 provide control room alarm following a waste tank high level condition to protect assumed initial conditions.

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial conditions to prevent a siphon event for Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, and 11.

Waste Tank 30 CRW Coil Isolation Valves: Waste Tank 30 CRW Coil Isolation Valves are credited design features to prevent a CRW siphon/pump-out event.

Waste Tank 33/34 Siphon Breaker: The Waste Tank 33/34 Siphon Breaker (located near Waste Tank 34) is credited to prevent a CRW siphon/pump-out event for Waste Tanks 33 and 34.

Waste Tank CRW Header Isolation Valves: The Waste Tank CRW Header Isolation Valves for Waste Tanks 13, 14 (when connected to the CRW System), 15 (when connected to the CRW System), 25, 26, 27, 28, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51 are credited design features to mitigate a CRW siphon/pump-out event.

3.4.2.16 299-H Events

3.4.2.16.1 SCENARIO DEVELOPMENT

3.4.2.16.1.1 Background

The Waste Management Maintenance Facility (Building 299-H) serves as a decontamination and repair facility for equipment (e.g., motors, jets, and pumps) from various facilities. Contaminated equipment is drained, flushed, and/or rinsed prior to being sent to Building 299-H, which minimizes the waste contained within or on the equipment. Equipment that needs maintenance or needs to be further decontaminated is brought to the truckwell and moved by overhead crane between the decontamination cell, repair cell, and storage cell. Most of the waste material that enters Building 299-H eventually ends up in the Waste Collection Tank (WCT) after equipment draining, rinsing, and flushing. The WCT is equipped with an agitator to ensure sludge does not accumulate, but is transferred out of the tank. The WCT is periodically transferred to HTF.

Building 299-H operating practices and procedures limit the inventory of radionuclides to within HC 3 inventory limits (Ref. 67). Draining, flushing, and/or rinsing of equipment and materials prior to being sent to Building 299-H minimizes the waste contained within or on the equipment.

3.4.2.16.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Building 299-H Events that have non-negligible risk. The events involve an explosion in the WCT, caused by a buildup of flammable vapors from: 1) hydrogen generation in the waste, 2) WCT agitator lubricating oil, and 3) fuel powered equipment/vehicles.

3.4.2.16.1.3 Unmitigated Accident Progression

For the hydrogen generation event, Reference 294 evaluated a range of operating conditions and their resulting times to LFL. The evaluation (Ref. 294) supports that under normal operating conditions, the time to LFL is likely to be infinite upon loss of ventilation. For abnormal operating conditions (e.g., WCT level at overflow, high temperature, maximum facility inventory), the evaluation (Ref. 294) shows the WCT could develop a flammable atmosphere

after 50 days upon loss of ventilation. However, the time required to reach LFL would be sufficiently long such that failure to remediate an abnormal condition (e.g., de-inventory the WCT, purge the WCT vapor space) is not credible. During normal operations, the WCT is continuously ventilated by redundant vessel ventilation exhaust fans, which maintains the WCT below the LFL. Upon loss of both fans, alarm response stops process evolutions and initiates de-inventorying of the WCT (typically within five days). De-inventorying the WCT significantly increases the time to LFL and allows ample time to re-establish ventilation on the WCT. Additionally, non-credited level indication (dip tubes) allows operators to maintain WCT level within operating limits which maximizes vapor space volume and prevents overflow; thus, increasing the time to LFL. Air supplied to the dip tubes also aids in maintaining the WCT below the LFL (even without operating vessel ventilation). Based on the reasons cited above, it is not reasonable to postulate that an explosion in the WCT due to radiolytic hydrogen generation will occur. Therefore, other than the 299-H Inventory Control Program, no specific safety basis levels of control are needed to prevent this event since the normal conduct of facility operations is more than adequate to prevent its occurrence.

For the WCT agitator lubricating oil event, an explosion due to excessive addition of agitator lubricating oil will not occur in the WCT. The flashpoint of lubricating oils is well above (typically > 350°F [177°C]) the maximum temperature of the WCT (176°F [80°C]) (Ref. 292). The agitator is lubricated typically once a year, with no more than one gallon of lubricating oil.

For the fuel powered equipment/vehicle event, the fuel source is from a postulated fuel tank failure from equipment/vehicles in the facility. Several areas within the facility drain to the WCT. However, fuel powered equipment/vehicles (other than diesel powered) within Building 299-H are prohibited. Unloading vehicles are diesel powered and not stored in the truckwell when not in use. In normal operation, the facility uses the diesel powered unloading vehicles for short durations to load/unload contaminated equipment for decontamination and repair. Diesel fuel has a lower vapor pressure and higher ignition temperature than gasoline, and while waste is stored in the WCT, a flammable mixture cannot occur. However, in isolated instances, the WCT may briefly be subjected to elevated temperatures as described below.

During normal operation, the WCT temperature (30°C ±15°C) is below the flashpoint of No. 2 Diesel Fuel (125°F or 52°C). Therefore, a WCT explosion (detonation or deflagration) with sustained combustion is not credible, even under extreme conditions in the WCT. Prior to transfer (approximately once a month), the WCT contents are neutralized. The routine neutralization process is a controlled/planned activity, performed immediately prior to transfer. This is an exothermic reaction with the WCT temperature remaining below 125°F. In isolated instances, a higher concentration of caustic is used, and the WCT temperature approaches the maximum value of 80°C (Ref. 292) (73°C has been recorded). The temperature remains elevated for only a few hours following neutralization. The neutralization process is a deliberate operation and is not performed without the ventilation system in operation, and would not be performed if a fuel tank failure had resulted in fuel draining into the tank. Additionally, a high temperature alarm associated with the WCT provides notification of abnormal conditions and a standby diesel generator provides backup power to the ventilation system. For the brief post-neutralization period (a few hours) during the isolated instance when using a higher concentration of caustic, it is unlikely that simultaneously an unloading vehicle used for short

durations inside the truckwell will cause a spill of diesel fuel that drains to the WCT and ignites. No Offsite or Onsite consequences are attributed to the 299-H Facility Events (Ref. 255).

3.4.2.16.1.4 Mitigated Accident Progression

The unmitigated consequences of the Building 299-H Events do not challenge the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.16.4). Because the unmitigated accident scenarios have been qualitatively determined to not challenge the Offsite or exceed the Onsite EGs, no mitigated analysis is required.

3.4.2.16.2 FREQUENCY DETERMINATION

The HA classifies Building 299-H Events in the anticipated frequency bin. Due to the qualitative judgment of the accident progression discussed in Section 3.4.2.16.1, Building 299-H Events are judged to be not credible.

3.4.2.16.3 SOURCE TERM ANALYSIS

No unique ST analysis was performed for this accident. The Building 299-H Events identified in Table 3.3-17 pose a minimal and acceptable risk due to the qualitative judgment of the accident progression discussed in Section 3.4.2.16.1.

3.4.2.16.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Building 299-H event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 255). The event is not credible based on the qualitative judgment of the accident progression discussed in Section 3.4.2.16.1. Therefore, the unmitigated and mitigated Offsite (0 rem) and Onsite (0 rem) consequences for the bounding scenario (explosion in the WCT) do not challenge the Offsite or exceed the Onsite EGs. The consequences to the immediate vicinity worker are also zero.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.16.5. The consequences of a Building 299-H event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.16.5 SUMMARY OF CONTROLS

No controls are required to ensure that the unmitigated Building 299-H event consequences do not challenge the Offsite or exceed the Onsite EGs (as discussed in Section 3.4.2.16.4), beyond the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2. The analysis does assume that the 299-H inventory is within HC 3 limits. The 299-H Inventory Control Program is utilized to protect this assumption.

3.4.2.16.5.1 Safety Class Controls

299-H Inventory Control Program: The 299-H Inventory Control Program shall address the controls required to maintain the 299-H inventory within HC 3 limits.

3.4.2.17 Tornado and High Winds Event

3.4.2.17.1 SCENARIO DEVELOPMENT

3.4.2.17.1.1 Background

A Tornado/High Winds event at the CSTF can cause damage to a wide array of equipment and lead to various releases of chemical and radioactive waste. For the purposes of this analysis, the Design Basis Tornado/High Winds consequences are calculated crediting only SSCs qualified to PC-3 (for Offsite consequence) or PC-2 (high winds only) (for Onsite consequence). The PC-2 High Winds criteria and PC-3 Tornado and High Winds criteria are described in Standard 01060 of Reference 83. The Tornado/High Winds event is assumed to impact both HTF and FTF. This Tornado/High Winds event is assumed to damage a number of different process areas, all of which contribute to the ST and consequences.

Although a Tornado/High Winds event may result in a chemical release, no chemical EGs were exceeded for associated HA events and there are no required controls for these progressions. The consequences from chemical release are not quantified or included in the cumulative Tornado/High Winds event consequences. The chemical release consequences are considered bounded by the consequences of the radiological release.

3.4.2.17.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with the Tornado and High Winds event. Since the Tornado/High Winds event potentially involves multiple process areas (i.e., has a cumulative effect), additional events (including some that the HA determined to have negligible consequences) have been identified on Table 3.3-17 and included for consideration (as illustrated in the accident progressions).

3.4.2.17.1.3 Unmitigated Accident Progression

A PC-3 Tornado/High Winds event (as defined in Reference 19) is assumed to impact both the HTF and FTF. Any process SSC that has not been designed or evaluated to the criteria established in Standard 01060 of Reference 83 is assumed to fail as a result of the evaluation basis tornado/high winds. Support systems, such as steam, power, instrument air, and water that are not qualified for tornado/high winds are also assumed to have failed in the worst reasonably conservative configuration.

The unmitigated consequences of the Tornado/High Winds event were not calculated and are assumed to exceed the Offsite and Onsite EGs. Since the EGs are exceeded, mitigated analysis is required.

3.4.2.17.1.4 Mitigated Accident Progression

Before the cumulative effect of a Tornado/High Winds event at the CSTF can be determined, the effect of the Tornado/High Winds event has to be determined on an individual location/process area basis. Other DBAs were reviewed to determine if a Tornado/High Winds event would be an initiator for the accident. Accidents that had a tornado/high winds initiator were evaluated to determine what the worst progression would be for a given location/process area. This evaluation is necessary because some DBAs are mutually exclusive (e.g., Waste Tank Wall Failure, Waste Tank Explosion). In addition, this analysis identified accidents that are unique to a Tornado/High Winds event.

Before the effect a Tornado/High Winds event has on an individual location/process area can be analyzed, overall facility operations must be analyzed to determine what equipment could be operating and what processes could be ongoing at the time of the event. This accident progression assumes the following:

This analysis assumed that upon receipt of a tornado watch/tornado warning/high wind warning, the following actions shall occur:

- Secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs [unless the evaporator lift/pump-out is associated with an exposed GDL as a result of an excavation], and in-progress pot siphons). The transfers that are exempted are based on the location of the GDL below ground/within a cell and the need to avoid GDL pluggage. Securing a transfer includes the following: stopping the prime mover and taking actions to prevent a siphon (e.g., closing siphon isolation valves and opening vent valves).
- Shut down evaporators (secure steam to tube bundles and lances) and secure evaporator feed pumps
- Secure pump tank agitators, waste tank mixing devices, and power to SMPs
- Secure transfer pumps associated with waste tank recirculation

Just prior to the issuance of a tornado watch/tornado warning/high wind warning by the SRS Operations Center (SRSOC) for CSTF, the following processes/operations were assumed to be in progress:

- Two sludge slurry transfers
- One supernate transfer (through a pump tank)
- Three evaporators operating
- One evaporator recycle transfer (in addition to the above supernate transfer)
- One canyon receipt in progress (in addition to the above transfers)
- Four waste tanks (two waste tanks in FTF, two waste tanks in HTF) undergoing mixing operations with SMPs (with up to four SMPs per tank)

Even though this tornado/high winds analysis is based on the above processes/operations, it is not intended that this assumption should limit or restrict facility operations to only those processes/operations listed above. Assuming the above processes/operations are ongoing at the time of the Tornado/High Winds event results in a reasonably conservative accident progression and reasonably bounding consequences. Additional transfers or other normal facility operations (e.g., pumping, jetting, venting) are not restricted by this analysis (as long as the process/operation is not restricted by other sections of the DSA or associated documents, e.g., TSRs).

In the mitigated accident progression discussion that follows, available levels of control are discussed. For those DBA progressions where the required levels of control are identified in the non-tornado/high winds mitigated accident discussion, reference must be made to that non-tornado/high winds mitigated discussion to determine the required number of levels of control. For these progressions, once the required number of levels of control is identified, the control set for the tornado/high winds-related progression, can then be established by combining this information with the available levels of control identified in the following subsections. For those DBA progressions where no controls are required in the non-tornado/high winds progression, the required levels of control (including numbers) are specifically identified in the following subsections.

Given the above assumptions, the effects of a Tornado/High Winds event on individual locations/process areas are evaluated below.

When SSCs are credited in the scenarios below, controls supporting their structural integrity are also credited. These controls, which are not listed in the individual scenarios below, include the following (depending on the scenario): critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

3.4.2.17.1.5 Waste Tanks

The following DBA progressions were evaluated for waste tanks:

Transfer Error (Waste Tank Overflow) and Waste Tank (Primary and Annulus) Aerosolization

The first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices to be secured upon receipt of a tornado watch/tornado warning/high wind warning. These actions will eliminate the initiator for Transfer Error (Waste Tank Overflow) and Aerosolization (waste tank mixing device operation and primary/annulus transfer jets) events, so the accident progressions do not occur. The only transfers allowed to continue (evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs) will not result in a waste tank overflow. Adequate freeboard is maintained in waste tanks that would allow the receipt tank to accept the incoming waste until each transfer is secured, without overflowing. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to

minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to these events.

For Closure Waste Tanks, it is assumed that six waste tanks may be in the waste tank/equipment grouting process. Small liquid additions (e.g., equipment flushing, grout addition), equipment failure associated with the process, or grout line clearing operations may result in a dry sludge tank Aerosolization event (dropped object scenario). Therefore, six waste tanks are assumed to contribute to the overall Offsite and Onsite Tornado/High Winds consequences.

SMP Waste Release (SMP Riser Overflow, SMP Column Spill, SMP Column Spray)

The first level of control is the Severe Weather Response Program, which requires waste tank mixing devices and power to the SMPs to be secured upon receipt of a tornado watch/tornado warning/high wind warning. These actions will eliminate the initiator for the SMP Waste Release scenarios, so the accident progressions do not occur. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a SMP Waste Release event.

Waste Tank Explosion

The Tornado/High Winds event is not an initiator for a Waste Tank Explosion in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Explosion, and the controls discussed below do not apply to Closure Waste Tanks.

The Tornado/High Winds event is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). Excluding Type I/II Acidic Chemical Cleaning Waste Tanks, the Flammability Control Program provides a first level of control and ensures that the time to reach 100% of the LFL (CLFL for Tank 50) following a Tornado/High Winds event is at least seven days in the waste tank (assuming no ventilation). The seven days allows time to either restore ventilation or provide alternate ventilation, thereby preventing the waste tanks from reaching 100% of the LFL (CLFL for Tank 50). Also part of the first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), waste tank mixing devices, and transfer pumps associated with waste tank recirculation to be secured upon receipt of a tornado watch/tornado warning/high wind warning. These actions will stop sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste (or waste containing Isopar® L) is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. It is assumed that the average bulk waste temperature for Tank 50 is within limits prior to the Tornado/High Winds event; however, these actions prevent additional heat input to the waste.

For Type I/II Acidic Chemical Cleaning Waste Tanks, the time to reach 100% of the LFL may be three days. The first level of control for these waste tanks is the Event Response Program (operator response) following the Tornado/High Winds event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL. Additional operator actions may include neutralizing the waste of a Chemical Cleaning Tank. Once the waste of a Type I/II Acidic Chemical Cleaning Waste Tank has been neutralized (i.e., pH is greater than or equal to 7) and the tank made a Type I/II Non-Acidic Chemical Cleaning Waste Tank, the waste tank may be reclassified, thus ensuring a minimum of seven days to reach 100% of the LFL. Also part of the first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices to be secured upon receipt of a tornado watch/tornado warning/high wind warning.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank structure provides a second level of control. This structure provides airborne waste confinement following an explosion in the waste tank. The waste tank structure is considered to be PC-2 high wind qualified by virtue of its underground location. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Waste Tank Explosion.

Slurry Pump/SMP Column Explosion

There is no credible initiator for a Slurry Pump Column Explosion during a Tornado/High Winds event. This analysis assumes that a Tornado/High Winds event will not result in an ignition source for a Slurry Pump Column Explosion. The slurry pump column is enclosed and the potential ignition sources (e.g., electrical wiring) are outside the column. In addition, due to the design of the pump column and shaft, it is not expected that movement of the shaft inside the

pump column will result in an ignition source. Therefore, there are no Offsite or Onsite consequences associated with a Slurry Pump Column Explosion.

There is no credible initiator for a SMP Column Explosion during a Tornado/High Winds event. This analysis assumes that a Tornado/High Winds event will not result in failure of the underground portion of the SMP pressure boundary (i.e., SMP flush/motor pressure boundary and SMP pump column pressure boundary) in a manner that will result in waste accumulating in the pump column. Therefore, there are no Offsite or Onsite consequences associated with a SMP Column Explosion.

Waste Tank Wall Failure, Transfer Error (Annulus Spill), and Waste Tank Annulus Explosion (except Type I/II Acidic Chemical Cleaning Waste Tanks)

The Tornado/High Winds event is not an initiator for a Transfer Error (Annulus Spill), Waste Tank Annulus Explosion, or Waste Tank Wall Failure (Waste Tank Wall Leak [within assumed leak rates]/Waste Tank Top Collapse). The structural integrity of the below grade waste tanks is not assumed to be impacted by the tornado/high winds or related missiles. Since the waste tank structural integrity is not impacted, there will be no leakage into the annulus to result in an annulus explosion. All tank structures are considered to withstand a PC-3 tornado/high winds by virtue of their underground location. Type I, II, III, and IIIA tanks are protected from missiles by at least 22 inches of concrete roof. Type IV Waste Tanks are protected by a 7-inch thick concrete dome covered with dirt and blacktop above the dome to protect against missiles. Additionally, the waste transfer lines that traverse the annuli are protected from the effects of a Tornado/High Winds event by virtue of their location within the annuli so no spill to the annulus from these lines will occur. Therefore, no Offsite or Onsite consequences are attributed to these events.

There is no credible initiator for a Type IV Waste Tank leak detection sump explosion or Type IIIA underliner sump explosion during a Tornado/High Winds event given the underground location of these sumps, the lack of a credible ignition source, and as discussed above, the structural integrity of the primary waste tanks (i.e., no resulting tank leakage). Therefore, no Offsite or Onsite consequences are attributed to these events.

Waste Tank Wall Failure, Transfer Error (Annulus Spill), and Waste Tank Annulus Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

The Tornado/High Winds event is not an initiator for a Transfer Error (Annulus Spill), since transfers that traverse the annulus of a Type I/II Chemical Cleaning Waste Tank are prohibited. The Tornado/High Winds event is not an initiator for a Waste Tank Wall Failure (Waste Tank Wall Leak/Waste Tank Top Collapse). The structural integrity of the below grade waste tanks is not assumed to be impacted by the tornado/high winds or related missiles. Since the waste tank structural integrity is not impacted, there will be no leakage into the annulus. All tank structures are considered to withstand a PC-3 tornado/high winds by virtue of their underground location. Type I and II waste tanks are protected from missiles by at least 22 inches of concrete roof.

For the purposes of this analysis, the Tornado/High Winds event is not an initiator for leakage into the annulus. However, it is assumed at the initiation of event the annulus contains the residual volume of Chemical Cleaning waste with OA. At this residual volume and including the effects of radiolytic production and corrosion induced hydrogen generation (accounting for atmospheric breathing) the time to 100% of the LFL is five days (see Section 3.4.2.12). The Tornado/High Winds event is assumed to fail the installed equipment credited for annulus explosion prevention during normal operation (e.g., waste tank annulus active ventilation).

The first level of control is the Event Response Program (operator response) following the Tornado/High Winds event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered "one" waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent the annulus of Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank annulus structure provides a second level of control. This structure provides airborne waste confinement following an explosion in the waste tank annulus. The waste tank annulus structure is considered to be PC-2 high wind qualified by virtue of its underground location. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, no Offsite or Onsite consequences are attributed to these events.

Waste Tank Overheating

For the tornado/high winds evaluation, one evaporator drop tank is assumed to be at saturated conditions at the time of the event. The Tornado/High Winds event is assumed to preclude any actions to address the continued heat generation in the evaporator drop tank. The evaporator drop tank is therefore assumed to contribute to the overall Offsite and Onsite Tornado/High Winds consequence as a result of overheating due to decay heat generation. Since the steam supply and transfer jet are within the waste tank, and transfer line pluggage/valve position change cannot occur due to a Tornado/High Winds event; the steam-heated waste tank scenario

cannot occur as a result of a Tornado/High Winds event, and the event progression is not credible.

Waste Tank Annulus Overheating

For the tornado/high winds evaluation, the steam supply and transfer jet are within the waste tank annulus, and transfer line pluggage change cannot occur due to a Tornado/High Winds event; the steam-heated waste tank annulus scenario cannot occur as a result of a Tornado/High Winds event, and the event progression is not credible.

Waste Tank Siphon via the Chromate Cooling Water System

The Tornado/High Winds event is not an initiator for a waste siphon/pump-out from a waste tank via the CRW System. A Tornado/High Winds event is not expected to fail the CRW System and waste tank cooling coils simultaneously, allowing waste to be released. For waste tanks that already have failed coils (e.g., Waste Tank 30), it is not credible that the control in place to address the failed coil (i.e., siphon breakers) will fail in such a way as to permit a siphon. No Offsite or Onsite consequences are attributed to a waste siphon/pump-out from a waste tank via the CRW System.

Waste Tank Vapor Space Release

In addition to the above waste tank DBA progressions, one additional release is assumed to occur that is unique to a Tornado/High Winds event. The event is assumed to result in the release of the waste tank vapor space contents (to the atmosphere) for every HTF waste tank. The vapor content that is released is conservatively assumed to be 90% of the total tank capacity volume. The equivalent liquid volume of water drawn out of the waste tanks as vapor is assumed to be all supernate. Release of the waste tanks vapor space contents contributes to the overall Offsite and Onsite Tornado/High Winds consequences.

3.4.2.17.1.6 Evaporators

The following DBA progressions were evaluated for the evaporators:

Evaporator Pot Explosion and Evaporator Overpressure

The Tornado/High Winds event is a credible initiator for an Evaporator Pot Explosion event or an Evaporator Overpressure event. Three levels of control are required for the Evaporator Pot Explosion event while two levels of control are required for the Evaporator Overpressure event. The first level of control is the Severe Weather Response Program, which requires evaporators to be shutdown (secure steam to tube bundles and lances) and evaporator feed pumps to be secured upon receipt of a tornado watch/tornado warning/high wind warning. In addition, the evaporator shutdown is assumed to be a controlled event so that, after shutdown, there are at least 10 days for operator action (e.g., provide pot purge to avoid reaching LFL). As a result of shutting down

the evaporator, there is not a tornado/high winds initiator for these accident progressions. The mitigative capabilities of the evaporator cell structure provide a second level of control. The evaporator cell is tornado/high winds qualified and will provide mitigation through passive confinement. For Evaporator Pot Explosion, the third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to these events.

Evaporator Overflow/Leaks/Spills and Evaporator Cell Explosion

The Tornado/High Winds event is a credible initiator for an Evaporator Overflow/Leaks/Spills event or an Evaporator Cell Explosion event. Three levels of control are required for the Evaporator Cell Explosion event while two levels of control are required for the Evaporator Overflow/Leaks/Spills event.

The evaporator cell is tornado/high winds qualified and will protect equipment inside the cell. Since the equipment is protected, there will be no spill of the evaporator pot or jumper contents into the cell to result in an LFL condition and subsequent explosion. The evaporator cell structure serves as the first level of control. The second level of control is the Severe Weather Response Program, which requires evaporators to be shutdown (secure steam to tube bundles and lances) and evaporator feed pumps to be secured upon receipt of a tornado watch/tornado warning/high wind warning. These actions will minimize any potential post-tornado/high winds release. For Evaporator Cell Explosion, the third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, there are no Tornado/High Winds event initiators for these accident progressions and no Offsite or Onsite consequences are attributed to this event.

Evaporator Overheads Receiver Tank Release

In addition to the above evaporator DBA progressions, it is assumed that a Tornado/High Winds event will release the contents of the evaporator overheads receiver tanks; however, the consequences are judged to be negligible so no controls are required. No Offsite or Onsite consequences are attributed to this event.

3.4.2.17.1.7 Transfer Lines

The following DBA progressions were evaluated for the transfer lines:

Transfer Error (Above-Ground Core Pipe, including Excavated Pipes, Release)

The first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs [unless the evaporator lift/pump-out is associated with an exposed GDL as a result of an excavation], and in-progress pot siphons) to be secured upon receipt of a tornado watch/tornado warning/high

wind warning. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, there are no Tornado/High Winds event initiators for this accident progression and no Offsite or Onsite consequences are attributed to this event.

Transfer Line Explosion and Transfer Line Jacket/Encasement Explosion

The facility is not assumed to simultaneously have an undetected core pipe leak, a jacket/encasement vapor space at LFL, and a Tornado/High Winds event; therefore, no Offsite or Onsite consequences are attributed to a Transfer Line Jacket/Encasement Explosion.

For the Transfer Line Explosion progression, it is assumed that one above-ground core pipe is at or above LFL at the time of the Tornado/High Winds event. The Tornado/High Winds event is assumed to result in an ignition source (e.g., lightning). The core pipe is assumed to explode, venting pressurized gases to the atmosphere and contributing to the overall Offsite and Onsite Tornado/High Winds consequence. The pipe that explodes is assumed to be the above-ground transfer line with the largest volume and is assumed to contain waste material with an inhalation dose potential less than or equal to 3.5E+07 rem/gal. Offsite and Onsite consequences are, therefore, attributed to a tornado/high winds initiated Transfer Line Explosion.

Transfer Line Residual Release

In addition to the above transfer line DBA progressions, it is assumed that one other release occurs that is unique to a Tornado/High Winds event. For this event, it is assumed that liquid transfers will be secured (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs [unless the evaporator lift/pump-out is associated with an exposed GDL as a result of an excavation], and in-progress pot siphons) upon receipt of a tornado watch/tornado warning/high wind warning; however, the transfer lines will not be drained or flushed before the Tornado/High Winds event occurs. Since there was not enough time to flush the transfer lines, it is assumed that sludge slurry will remain in the transfer lines (100% of pipe volume of above-ground section). The above-ground portion of the transfer lines are not PC-3 tornado/high winds qualified, so it is assumed that they will be damaged and release their contents to the environment. This analysis assumes that the released material is the sludge slurry from the above-ground portion of two bounding transfer lines. It is assumed that the material in the underground portion of the transfer lines is unaffected. The released material contributes to the overall Offsite and Onsite Tornado/High Winds consequences.

3.4.2.17.1.8 Transfer Facilities

The following DBA progressions were evaluated for transfer facilities:

Transfer Facility Fire

It is assumed that a Tornado/High Winds event does not cause ignition of any combustibles that may be present in transfer facilities. The Tornado/High Winds event is therefore judged to not result in a transfer facility fire. No Offsite or Onsite consequences are attributed to this event.

Transfer Facility Explosion, Transfer Error (Core Pipe Failure into a Secondary Containment – Spill or Spray), and Aerosolization

A Tornado/High Winds event is a credible initiator for each of these events (excluding the Tank 50 to Z-Area Transfer Facility Explosion [LPDT Explosion]). The first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and pump tank agitators to be secured upon receipt of a tornado watch/tornado warning/high wind warning. These actions will eliminate the initiator for Transfer Errors, Transfer Facility Explosions, and Aerosolization Events. For Transfer Error and Aerosolization, the second level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to these events.

For Transfer Facility Explosions, the mitigative capabilities of the transfer facility secondary containment structures provide a second level of control. The secondary containment structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified) since loss of confinement prior to the event would prevent the event (i.e., the flammable vapors would not accumulate). If the structure survives and the event does occur, the secondary containment will provide mitigation through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to these events.

A Tornado/High Winds event is not a credible initiator for Tank 50 to Z-Area Transfer Facility Explosion (LPDT Explosion). The LPDT only has material in it if the Tank 50 to Z-Area transfer line has a core pipe leak or if there is a reason to drain the Tank 50 to Z-Area transfer line. The total volume of the Tank 50 to Z-Area transfer line is 5,975 gallons (Ref. 1). If the Tank 50 to Z-Area transfer line leaks/drains to the LPDT, the remaining vapor space volume would be approximately 1,525 gallons (Ref. 1). Comparing those values to Reference 313, the LPDT will not reach LFL within 300 days following a Tornado/High Winds induced failure of the ventilation system so no explosion is assumed to occur.

Transfer Error (Pump Tank Overflow)

The first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) to be secured upon receipt of a tornado watch/tornado warning/high wind warning. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequence is attributed to this event.

Pump Pit and Pump Tank Explosion

The first level of control is the Severe Weather Response Program, which requires liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and pump tank agitators to be secured upon receipt of a tornado watch/tornado warning/high wind warning. The hydrogen release in a pump tank following a tornado watch/tornado warning/high wind warning initiated transfer shutdown is assumed to be at a low enough level so that the pump tanks will not reach LFL before ventilation is either restarted or alternate ventilation provided (assuming ventilation is lost during the tornado/high winds). Upon shutdown of a transfer, dissolved hydrogen release in the pump tank is no longer a concern. The non-HDB-8 Complex pump tanks are equipped with credited passive vents that serve as the first level of control to extend their time to reach LFL (HDB-8 Complex pump tanks do not have passive vents like the other pump tanks). The mitigative capabilities of the PP structure provide a second level of control. The PP structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified) since loss of confinement prior to the event would prevent the event (i.e., the flammable vapors would not accumulate). If the structure survives and the event does occur, the PP structure will provide mitigation through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequence is attributed to this event.

Pump Tank Overheating

The Tornado/High Winds event for the steam-heated pump tank scenario is not a credible event. Since only the transfer jet suction nozzle is located within the pump tank and the steam supply piping and remainder of the jet assembly is outside the pump tank (no impingement on the waste will happen should a leak occur) and transfer line pluggage/valve position change cannot occur due to a Tornado/High Wind event, this progression is not credible. No Offsite or Onsite consequences are attributed to this event.

3.4.2.17.1.9 <u>299-H</u>

The accident of concern in 299-H is a WCT Explosion (analyzed in Section 3.4.2.16). A Tornado/High Winds event is not a credible initiator for a WCT Explosion. For the diesel

powered unloading vehicle event, unloading vehicles are only in the 299-H truckwell for a short duration, making it unlikely that a Tornado/High Winds event would occur simultaneously and cause a spill of diesel fuel that drains to the WCT and ignites (diesel fuel will not flash at temperatures below 125°F [52°C]). The hydrogen generation and WCT agitator lubricating oil events are also assumed to not occur (see Section 3.4.2.16). No Offsite or Onsite consequences are attributed to the 299-H Facility.

3.4.2.17.1.10 HEPA Filter and Waste Box Release

The Tornado/High Winds event is assumed to damage unclipped waste boxes (e.g., B-25s) and HEPA filters throughout the facility. The unclipped waste boxes and HEPA filters will contribute to the overall Offsite and Onsite Tornado/High Winds consequences. This simultaneous failure of numerous waste boxes and HEPA filters is unique to the NPH events (see Section 3.4.2.17.3).

3.4.2.17.1.11 Transportation Accident

Since the Tornado/High Winds event already includes consequences associated with release of material from waste boxes, no additional Offsite or Onsite consequences are attributed to a transportation accident.

3.4.2.17.2 FREQUENCY DETERMINATION

The HA classifies PC-3 Tornado/High Winds events in the unlikely frequency bin. The HA classifies PC-2 Tornado/High Winds events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.17.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below. Since the Tornado/High Winds event involves multiple process areas (as discussed previously), the cumulative ST involves many mechanisms discussed in other DBAs. While the other DBAs were used in determining the overall consequences, only the unique Tornado/High Winds event analysis is discussed here.

3.4.2.17.3.1 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The value of each of the terms in the five-factor ST formula is specific to the location/release mechanism being analyzed. The unique scenarios associated with the Tornado/High Winds event are waste tank vapor release, transfer line residual release, HEPA filter release, and waste box release.

Material at Risk

The MAR waste stream for the Tornado/High Winds event varies for the individual process areas and release mechanisms. The waste characteristics and inhalation dose potential on a per unit volume basis for streams of concern are given in Section 3.4.1.5.1.

The MAR for the unique scenarios associated with the Tornado/High Winds event is as follows (Ref. 87, 292):

- For waste tank vapor release, The MAR is the equivalent liquid volume of supernate, V_{WATER}, drawn out as vapor with the air:

  $$V_{WATER} = (V_D)(S_{VAPOR})$$

  Where:

  V_D = the volume of vapor displaced from the tank during the passage of the tornado/high winds

  S_{VAPOR} = the specific amount of water vapor present in the tank vapor space

- For transfer line residual releases, the MAR is the residual sludge slurry material that will be left in the transfer lines after the shut down (assumed to be 100% of the cross-sectional area of the pipes). The two assumed above-ground transfer line segments measure 110 feet and 56 feet in length. Although the consequences are based on these two transfer line segment volumes, additional transfers that might be in-progress in above-ground transfer lines would have an insignificant increase in reported consequences.
- To represent the amount of material that could reasonably be available for HEPA filter release, 20 HEPA filters (10% of the approximately 200 total HEPA filters) are assumed to be at maximum loading. Two of these 20 filters are assumed to be from dry sludge tanks and, therefore, the filter loading is representative of sludge solids. Two other tanks are assumed to be sludge slurry waste and, therefore, the filter loading is Bounding Sludge Slurry. The loading of the remaining 16 filters is assumed to be representative of supernate. The maximum loading for each HEPA filter is assumed to be 1 Curie of Cs-137. It is reasonably conservative to represent the total loading on all HEPA filters by fully loading 20 HEPA filters since the HEPA filters are radiologically surveyed periodically and most HEPA filters would be only fractionally loaded at any given time.
- To represent the amount of material that could reasonably be available for waste box releases, the MAR from solid waste stored in the area is assumed to be 60 Ci of Cs-137 in supernate waste (Maximum High-Activity Supernate) and 520 Ci of Cs-137 in sludge waste (Maximum High-Activity Sludge) (Ref. 292).

Damage Ratio

The DR is assumed to be one for all scenarios.

Airborne Release Fraction

The ARFs used in the analysis are based on Reference 14, as detailed in Reference 87. The ARFs used are as follows:

- For waste tank vapor release, an ARF of 1.0 is used
- For transfer line residual releases, an ARF of 5.0E-04 is used (The bounding ARF value for a free-fall spill of slurry for a 3 meter fall distance with less than 40% solids is 5.0E-05 in Reference 14. Since the analyzed tornado/high winds conditions do not precisely match the conditions of Reference 14, an additional order of magnitude increase was imposed. Thus an ARF of 5.0E-04 was used.)
- For HEPA filter releases, an ARF of 1.0E-02 was used
- For waste box releases, an ARF of 1.0E-03 was used

The ARRs used in the analysis are based on Reference 14, as detailed in Reference 87. The ARRs used are as follows:

- For transfer line residual releases and waste box releases an ARR of 4.0E-07 was used
- For HEPA filter releases, an ARR of 4.0E-05 was used

Respirable Fraction

The RF is assumed to be 0.8 for transfer line residual releases and one for all other unique scenarios.

Leak Path Factor

The LPF is assumed to be one for all scenarios.

3.4.2.17.3.2 Source Term Calculation

The STs for the unique scenarios associated with the Tornado/High Winds event (Waste Tank Vapor Release, Transfer Line Residual Release, and HEPA Filter and Waste Box Release) were calculated in Reference 87 using the preceding ST factors. To determine the overall tornado/high winds consequences, the unique scenarios STs must be added to the Waste Tank Aerosolization, Transfer Line Explosion, and Waste Tank Overheating STs.

3.4.2.17.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of a Tornado/High Winds event are given in Table 3.4-7 (the reported unmitigated consequences are assumed to exceed the Offsite and Onsite EGs, since unmitigated consequences were not calculated).

The mitigated Offsite (≤ 0.7 rem) and Onsite (≤ 21.3 rem) consequences do not challenge the Offsite or exceed the Onsite EGs. The immediate vicinity worker risk is also judged to not exceed the applicable Onsite EGs due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.17.5.

The individual mitigated consequence contributor breakdown is as follows:

	Consequences (rem)	
Source	**Onsite**	**Offsite**
Drop Tank Overheating	≤ 7.6	≤ 0.1
Waste Tank Vapor Space Release	≤ 0.1	≤ 0.1
Transfer Line Explosion	≤ 9.5	≤ 0.1
Transfer Line Residual Release	≤ 0.3	≤ 0.1
HEPA Filter Release (a)	≤ 0.1	≤ 0.1
Waste Box Release	≤ 0.1	≤ 0.1
Waste Tank Aerosolization (b)	≤ 3.6	≤ 0.1

(a) The Offsite and Onsite consequences reflect a release from 20 HEPA filters at maximum loading with two filters from dry sludge tanks, two filters from sludge slurry tanks, and 16 filters from supernate tanks with the Onsite receptor being exposed to all HEPA filters considered (Ref. 87). Reference 264 evaluated a release from 20 HEPA filters at maximum loading with nine filters from dry sludge tanks, two filters from sludge slurry tanks, and nine filters from supernate tanks with the Onsite receptor being exposed to 25% of HEPA filters considered. This evaluation concluded that the consequences are reasonably conservative for up to nine dry sludge tanks.

(b) The Offsite and Onsite consequences reflect six Dropped Object scenarios (bounded by Type I Waste Tanks) evaluated in Reference 263.

3.4.2.17.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Tornado/High Winds event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression) or establish the initial conditions at the time of the Tornado/High Winds event (e.g., HLLCPs, Waste Tank Mixing Device Operation). The following controls are not required for Closure Waste Tanks.

3.4.2.17.5.1 Safety Class Controls

242-16H/242-25H Evaporator Cells: The evaporator cell structure provides protection of the evaporator and associated equipment from the effects of a PC-3 Tornado/High Winds event. The

evaporator cell structure also provides airborne waste confinement following a primary containment waste release or an explosion in the evaporator cell.

Event Response Program: Procedures shall be established governing required actions following a Tornado and High Winds event. These procedures shall require the following operator actions for Type I/II Acidic Chemical Cleaning Waste Tanks:

1) Restore primary purge ventilation or install/operate portable ventilation systems on waste tanks, prioritized on a time to LFL basis.

2) Restore annulus ventilation or install/operate portable ventilation systems on waste tank annuli, prioritized on a time to LFL basis.

The portable ventilation systems, discussed above, are not required to be functionally classified as SC equipment. Additional information regarding waste tank and waste tank annulus portable ventilation system requirements can be found in Section 5.5.2.13.

Flammability Control Program: The Flammability Control Program provides the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

1) Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification. For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tanks shall be classified as Chemical Cleaning Tanks and the time to LFL (three days) is not calculated.

2) Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50, Very Slow Generation Tanks, and Type I/II Acidic Chemical Cleaning Waste Tanks). The hydrogen concentration LFL limit shall account for potential organics.

3) Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the tank vapor space to reach the LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks).

4) Determine, track, and ensure that only 14 waste tanks can reach LFL in less than seven days including:

   - Effects of post-seismic trapped gas release, assuming no ventilation

   - Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks to have the potential to become flammable in less than seven days. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCP maximum levels shall be less than or equal to 63.8 inches (Type I) and 64.8 inches (Type II). The HLLCPs are not credited with functioning during or following the Tornado/High Winds event, but protect assumed initial conditions at the time of the Tornado/High Winds event. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Severe Weather Response Program: Upon receipt of a tornado watch/tornado warning/high wind warning by the SRSOC for CSTF actions shall be initiated to perform the following:

1) Secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs [unless the evaporator lift/pump-out is associated with an exposed GDL as a result of an excavation], and in-progress pot siphons). Securing a transfer includes the following: stopping the prime mover and taking actions to prevent a siphon (e.g., closing siphon isolation valves and opening vent valves).

2) Shut down evaporators (secure steam to tube bundles and lances) and secure evaporator feed pumps.

3) Secure pump tank agitators, waste tank mixing devices, and power to SMPs.

4) Secure transfer pumps associated with waste tank recirculation.

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following during operations associated with Chemical Cleaning Transfers (or related vent/drain operations) to protect initial conditions for corrosion induced hydrogen generation rate assumptions:

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, Tank 51 Drain VB, FPP-1, FPP-2, and HPP-3. Chemical Cleaning Transfers (or related vent/drain operations) are also permitted in transfer paths that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell.

- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks, waste tanks, or transfer facilities outside of the intended transfer path.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1, HPT-3, and the waste tanks associated with the vent/drain path.
- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Prior to transfer initiation of a Chemical Cleaning Transfer (or related vent/drain operations), verification shall be performed to ensure that sufficient inhibitors are present in the applicable receipt waste tank to ensure neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers (or related vent/drain operations), at least one waste tank mixing device shall be operating in the applicable receipt waste tank to ensure adequate mixing and neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers, acidic waste shall enter the receipt tank via a flowpath that is below the waste tank liquid level.

Waste Tank Temperature Monitoring: Temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks to protect initial conditions for corrosion induced hydrogen generation rate assumptions.

3.4.2.17.5.2 Safety Significant Controls

Diversion Box: The DB structure provides airborne waste confinement following an explosion in the DB. The DB structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Tornado/High Winds initiated event and response to the event to minimize the potential release/personnel exposure.

H-Area Catch Tank Encasement: The H-Area Catch Tank Encasement provides airborne waste confinement following an explosion in the catch tank. The H-Area Catch Tank Encasement is considered to be PC-2 high wind qualified by virtue of its underground location.

High Point Flush Pit: The HPFP structure provides airborne waste confinement following an explosion in the HPFP. The HPFP structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

LDB Drain Cell: The LDB Drain Cell structure provides airborne waste confinement following an explosion in the LDB Drain Cell. The LDB Drain Cell structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

Pump Pit: The PP structure provides airborne waste confinement following an explosion in the PP or pump tank. The PP structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

Pump Tank Passive Vents: The Pump Tank Passive Vents provide a flowpath between the pump tank vapor space and PP vapor space to extend the time to reach LFL in the pump tank. (not applicable to HPT-7, HPT-8, HPT-9, and HPT-10)

Transfer Line Encasement: The Transfer Line Encasements draining to the H-Area Catch Tank provide airborne waste confinement following a primary containment waste release. The Transfer Line Encasement structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

Valve Box: The VB structure provides airborne waste confinement following an explosion in the VB. The VB structure is not required to withstand high winds (i.e., the structure is not required to be PC-2 high wind qualified).

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank structure provides airborne waste confinement following an explosion in the waste tank.

Waste Tank Annulus: The Type I and Type II Waste Tank Annulus structure provides airborne waste confinement following an explosion in the waste tank annulus and provides liquid waste containment to support conductivity probe functionality (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Conductivity Probes: The Type I and Type II Waste Tank Annulus Conductivity Probes provide control room alarm following a waste tank annulus high level condition to protect assumed initial tank annulus conditions. The Type I and Type II Waste Tank Annulus Conductivity Probes are not credited with functioning during or following the Tornado/High Winds event, but protect assumed initial conditions at the time of the Tornado/High Winds event (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Mixing Device Operation: Controls on SMP operation shall be established. These controls shall ensure that if an external water source is connected to the SMP, that the SMP is operated at or below the maximum allowable pump speed of 500 rpm. This speed (less than or

equal to 500 rpm) shall be verified by manually reducing the speed at the VFD until the speed is at or below 500 rpm. This shall be independently verified prior to connecting an external water source to the pump. To ensure that the VFD speed is not modified during the time when the SMP is operating and the external water source is connected, an operator shall be stationed at the VFD. The primary role of this operator shall be verifying that the VFD speed is not altered. A lockable physical barrier may be installed which prevents VFD speed changes, in lieu of stationing an operator.

3.4.2.18 Seismic Event

3.4.2.18.1 SCENARIO DEVELOPMENT

3.4.2.18.1.1 Background

A Seismic event at the CSTF can cause damage to a wide array of equipment and lead to various releases of chemical and radioactive waste. For the purposes of this analysis, the DBE consequences are calculated crediting only SSCs qualified to PC-3 (for Offsite consequence) or PC-2 (for Onsite consequence). The PC-2 and PC-3 seismic criteria are described in Standard 01060 of Reference 83.

Although a Seismic event may result in a chemical release, no chemical EGs were exceeded for associated HA events and there are no required controls for these progressions. The consequences from chemical release are not quantified or included in the cumulative Seismic event consequences. The chemical release consequences are considered bounded by the consequences of the radiological release.

3.4.2.18.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with the Seismic event. Since the Seismic event potentially involves multiple process areas (i.e., has a cumulative effect), additional events (including some that the HA determined to have negligible consequences) have been identified on Table 3.3-17 and included for consideration (as illustrated in the accident progressions).

3.4.2.18.1.3 Unmitigated Accident Progression

A PC-3 Seismic event (as defined in Reference 19) is assumed to strike the CSTF. Any process SSC that has not been designed or evaluated to the criteria established in Standard 01060 of Reference 83 is assumed to fail as a result of the Seismic event. Support systems, such as steam, power, instrument air, and water that are not qualified for a Seismic event, are also assumed to have failed in the worst reasonably conservative configuration.

The unmitigated consequences of the Seismic event were not calculated and are assumed to exceed the Offsite and Onsite EGs. Since the EGs are exceeded, mitigated analysis is required.

3.4.2.18.1.4 Mitigated Accident Progression

Before the cumulative effects of a Seismic event at the CSTF can be determined, the effect of a Seismic event has to be determined on an individual location/process area basis. Other DBAs were reviewed to determine if a Seismic event would be an initiator for the accident. Accidents that had a seismic initiator were further reviewed to determine what the worst progression would be for a given location/process area. This evaluation is necessary because some DBAs are mutually exclusive (e.g., Waste Tank Wall Failure, Waste Tank Explosion). In addition, this analysis identified accidents that are unique to a Seismic event.

Before the effect of a Seismic event on an individual location/process area can be analyzed, overall facility operations must be analyzed to determine what equipment could be operating and what processes could be ongoing at the time of the event.

This accident progression assumes the following processes/operations are in progress at the time of the Seismic event:

- Two sludge slurry transfers
  - One Waste Tank 40 to DWPF sludge slurry transfer
  - One sludge slurry transfer through a pump tank
- One supernate transfer (through a pump tank)
- Three evaporators operating
- One evaporator recycle transfer (in addition to the above supernate transfer)
- One canyon receipt in progress (in addition to the above transfers)
- Four waste tanks (two waste tanks in FTF, two waste tanks in HTF) undergoing mixing operations with SMPs (with up to four SMPs per tank)

Even though this seismic analysis assumes the above processes/operations are ongoing at the time of the Seismic event, it is not intended that this assumption should limit or restrict facility operations to only those processes/operations listed above. Assuming the above processes/operations are ongoing at the time of the Seismic event results in a reasonably conservative accident progression and reasonably bounding consequences. Additional transfers or other normal facility operations (e.g., pumping, jetting, venting) are not restricted by this analysis (as long as the process/operation is not restricted by other sections of the DSA or associated documents, e.g., TSRs).

This analysis assumed that following a Seismic event, the following actions shall occur within the stated timeframes. Additional actions are stated in the Event Response Program following a Seismic event; however, these actions are conditionally-based or do not have credited response times.

- Secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) within 2 hours.

- Shut down evaporators (secure steam to tube bundles and lances within 1 hour and secure air to the tube bundles and lances within 2 hours).
- Secure evaporator feed pumps within 1 hour.
- Secure pump tank agitators, waste tank mixing devices, transfer pumps associated with waste tank recirculation, and power to SMPs within 2 hours.

With respect to transfers, the analysis assumes that the maximum amount of waste that will be spilled is 15,000 gallons (the 15,000-gallon value is the maximum missing waste volume prior to transfer being secured, and is not tied to a specific flowrate). Control room availability is not explicitly required, because it is expected that either (a) the applicable control building will survive the Seismic event, allowing it to be utilized for any post-seismic actions, or (b) the seismic event that damages the control building, such that actions cannot be taken, is assumed to be severe enough to cause actions (e.g., secure power to SMPs, secure liquid transfers, and shut down evaporator operations by tripping power, steam, and air). Even if the control building damage does not cause the post-seismic required action (e.g., secure liquid transfers), the required actions can be accomplished through multiple means (credited and non-credited) outside of the control building. When an action to secure waste transfers is specified in the accident progressions below, the equipment needed to perform the action is also credited.

When SSCs are credited in the scenarios below, controls supporting their integrity are also credited. These controls, which are not listed in the individual scenarios below, include the following (depending on the scenario): critical lift controls, structural integrity controls, corrosion controls, traffic controls, connector installation controls, transfer controls, and tank top/secondary containment loading controls.

In the mitigated accident progression discussion that follows, available levels of control are discussed. For those DBA progressions where the required levels of control are identified in the non-seismic mitigated accident discussion, reference must be made to that non-seismic mitigated discussion to determine the required number of levels of control. For these progressions, once the required number of levels of control is identified, the control set for the seismic-related progression can then be established by combining this information with the available levels of control identified in the following subsections. For those DBA progressions where no controls are required in the non-seismic progression, the required levels of control (including numbers) are specifically identified in the following subsections.

Given the above assumptions, the effects of a Seismic event on individual locations/process areas are evaluated below.

3.4.2.18.1.5 <u>Waste Tanks</u>

The following DBA progressions were evaluated for waste tanks:

Transfer Error (Waste Tank Overflow)

The first level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure liquid transfers (excluding evaporator GDL

flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and evaporator feed pumps following the event. The only transfers allowed to continue (evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs) will not result in a waste tank overflow. Adequate freeboard is maintained in waste tanks that would allow the receipt tank to accept the incoming waste until each transfer is secured, without overflowing. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Transfer Error (Waste Tank Overflow).

Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure)

A Seismic event is not an initiator for a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure) in Closure Waste Tanks or Type I/II Chemical Cleaning Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure), and the controls discussed below do not apply to Closure Waste Tanks or Type I/II Chemical Cleaning Waste Tanks.

For the remaining waste tanks, a Seismic event is a credible initiator for a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure). The transfer lines within the waste tank annuli serve as the first level of control and are credited as SC (PC-3 seismically qualified), so a Seismic event will not result in a line break and spill. The second level of control is the Waste Tank annulus structure, which provides containment and airborne confinement. No Offsite or Onsite consequences are attributed to a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure).

SMP Waste Release (SMP Riser Overflow, SMP Column Spill, SMP Column Spray)

An SMP Waste Release (SMP Riser Overflow, SMP Column Spill, SMP Column Spray) could occur in the four waste tanks undergoing mixing operations with SMPs (the SMP Waste Release scenarios are detailed in Section 3.4.2.9). Of the 16 operating SMPs (4 SMPs per tank, 2 tanks per Tank Farm), it is assumed that 8 will involve High-Rem waste and 8 will involve Low-Rem waste. The three SMP Waste Release scenarios are mutually exclusive (on a per pump basis) so only the consequences associated with the bounding SMP Waste Release accident (SMP Riser Overflow) will contribute to Offsite mitigated consequences. The SMP Riser Overflow consequences are ≤ 2.42 rem per High-Rem waste tank and ≤ 0.322 rem per Low-Rem waste tank. Therefore, the total SMP Waste Release Offsite consequence (unmitigated and mitigated) contribution to the seismic scenario is ≤ 5.5 rem.

Since all three SMP Waste Release scenarios have significant Onsite consequences, controls have been implemented to protect the Onsite worker from each scenario. For the SMP Waste Release scenarios, two levels of control are required. The seismically qualified riser leak detection instrumentation (i.e., conductivity probe) interlocked to stop the SMP will serve as the first level of control to prevent riser overflow, unless the SMP riser is capable of free draining. If the SMP riser has been shown to be capable of free draining, the first level of control is the SMP riser drain (a passive design feature). In either case, the waste tank SMP riser structure is

required as part of the first level of control. The riser structure provides airborne waste confinement following a primary containment waste release into the riser, and, where required, also provides a liquid waste containment function to support conductivity probe functionality. The second level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure power to SMPs, using a seismically qualified method.

For SMP Column Spill and SMP Column Spray, the seismically qualified SMP flush/motor pressure boundary was chosen as the first level of control. The second level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure power to SMPs, using a seismically qualified method. No mitigated Onsite consequences are attributed to a SMP Waste Release event (SMP Riser Overflow, SMP Column Spill, SMP Column Spray).

Waste Tank (Primary and Annulus) Aerosolization

A Seismic event is not an initiator for an Aerosolization event involving steam/air line sparging in a waste tank or waste tank annulus in Closure Waste Tanks or Type I/II Chemical Cleaning Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent this event, and the controls discussed below do not apply to Closure Waste Tanks or Type I/II Chemical Cleaning Waste Tanks. For the remaining waste tanks, a Seismic event could be an initiator for an Aerosolization event involving steam/air line sparging in a waste tank or waste tank annulus; however, the steam/air lines and jets are qualified to withstand a Seismic event. The waste tank and waste tank annulus confinements provide a second level of control.

A Seismic event is not an initiator for an Aerosolization event involving rooster tailing of a waste tank mixing device. The Seismic event is not expected to cause a waste tank mixing device to move in such a way that would initiate the rooster tailing accident progression. A Seismic event will not initiate a diaphragm pump leak. The diaphragm pump is considered to be more robust than the air supply; therefore, it is not reasonably conservative to assume a post-seismic Aerosolization event from this source. No Offsite or Onsite consequences are attributed to the waste tank Aerosolization Events described above.

The Seismic event is a credible initiator for the aerosolization in a dry sludge tank (Section 3.4.2.10) due to a dropped object scenario on Closure Waste Tanks, but is not a credible initiator for an aerosolization in a dry sludge tank due to the liquid addition scenario for Closure Waste Tanks. The Seismic event causes a dropped object to strike the dry sludge in six Closure Waste Tanks. The liquid addition scenario is intended to address large liquid additions, which are prohibited on Closure Waste Tanks. An inadvertent large liquid addition concurrent with a Seismic event is not credible. Small liquid additions to Closure Waste Tanks (e.g., equipment flushes, grout additions) are bounded by the “dropped object scenario.” Addition of liquid to Closure Waste Tanks via the in-tank cooling coils is not credible from the CRW System since these tanks are isolated from the system. However, addition of liquid to Closure Waste Tanks via the in-tank cooling coils is credible due to cooling coil flushing/grouting which is considered a small liquid addition. It is assumed that six “dropped object scenarios” occur in Closure Waste Tanks and will contribute to the Offsite and Onsite consequences. The total Offsite consequence

contribution to the Seismic scenario is ≤ 0.1 rem. The total Onsite consequence contribution to the Seismic scenario is ≤ 3.6 rem.

Waste Tank Explosion (except Type I/II Acidic Chemical Cleaning Waste Tanks)

A Seismic event is not an initiator for a Waste Tank Explosion in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Explosion, and the controls discussed below do not apply to Closure Waste Tanks.

In a waste tank, a Seismic event could release the hydrogen trapped inside the waste tank saltcake and sludge (a discussion of trapped hydrogen is provided in Section 3.4.1.5.3). The Seismic event is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). The controls credited in addressing the release of trapped gas during a Seismic event are discussed in detail in Section 3.4.2.11.

Excluding the trapped gas hydrogen contribution, the Flammability Control Program ensures that the time to reach 100% of the LFL (CLFL for Tank 50) is at least seven days in every waste tank, but even with the credited controls, the trapped gas contribution may cause some waste tanks to reach 100% of the LFL (CLFL for Tank 50) in less than seven days. As a result, for the waste tanks where seven days is not available to either restore ventilation or provide alternate ventilation, the waste tank vapor space could reach LFL (CLFL for Tank 50). An ignition source is assumed to be present so a PC-3 Seismic event is assumed to result in at least one Waste Tank Explosion. Offsite and Onsite consequences are therefore attributed to one or more seismic initiated Waste Tank Explosions.

Waste Tank Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

The Seismic event is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). For Type I/II Acidic Chemical Cleaning Waste Tanks, the time to reach 100% of the LFL may be three days. The first level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL. Additional operator actions may include neutralizing the waste of a Chemical Cleaning Tank. Once the waste of a Type I/II Acidic Chemical Cleaning Waste Tank has been neutralized (i.e., pH is greater than or equal to 7) and the tank made a Type I/II Non-Acidic Chemical Cleaning Waste Tank, the waste tank may be reclassified, thus ensuring a minimum of seven days to reach 100% of the LFL. Additional operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered "one" waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank structure provides a second level of control. This structure provides airborne waste confinement following an explosion in the waste tank. The waste tank structure is qualified to withstand a PC-3 earthquake and is located underground. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure.

Slurry Pump/SMP Column Explosion

This analysis assumes that a Seismic event will not result in an ignition source for a Slurry Pump Column Explosion. The slurry pump column is enclosed and the potential ignition sources (e.g., electrical wiring) are outside the column. In addition, due to the design of the pump column and shaft, it is not expected that movement of the shaft inside the pump column will result in an ignition source. Therefore, there are no Offsite or Onsite consequences associated with a Slurry Pump Column Explosion.

The SMP Column Explosion could occur in the four waste tanks undergoing mixing operations with SMPs. The SMP Column Explosion scenarios would be as detailed in Section 3.4.2.11; however, the column explosion and SMP Waste Release are mutually exclusive (on a per pump basis) and the bounding Offsite consequences of the SMP Waste Release are greater.

Since an ignition source is assumed to be present for the SMP Column Explosion, controls have been implemented to protect the Onsite worker from this event. The first level of control is the seismically qualified SMP flush/motor pressure boundary and SMP pump column pressure boundary, which will serve to stop waste from leaking into the column and prevent the event. The second level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure power to SMPs, using a seismically qualified method. The third level of control is the mitigative airborne waste confinement capability of the waste tank structure and the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the

potential release/personnel exposure. Therefore, there are no Onsite consequences associated with a SMP Column Explosion.

Waste Tank Annulus Explosion (except Type I/II Acidic Chemical Cleaning Waste Tanks)

A Seismic event is not an initiator for a Waste Tank Annulus Explosion in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Annulus Explosion, and the controls discussed below do not apply to Closure Waste Tanks.

For the remaining waste tanks, a Seismic event is a credible initiator for a Waste Tank Annulus Explosion. The first level of control is the waste tank structure. All Type I, II, III/IIIA Waste Tanks are qualified to withstand a PC-3 earthquake and are located underground. The waste tank is assumed to maintain its structural integrity during a Seismic event and not collapse; however, the Seismic event could result in a waste tank leak (within assumed leak rates), excluding Tank 50. For Tank 50 post-DBE, leakage from the waste tank wall does not occur. For the remaining waste tanks, the leak is expected to be small enough (≤ 4 gpm) so that the annulus will not reach LFL in less than 10 days. The mitigative capabilities of the waste tank annulus provide a second level of control. The waste tank annulus is part of the waste tank structure and is qualified to withstand a PC-3 earthquake and is located underground. The waste tank annulus is assumed to maintain its structural integrity during a Seismic event and not collapse and will provide mitigation through containment of liquid waste and passive airborne waste confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, there are no Offsite or Onsite consequences attributed to a waste tank wall leak leading to an annulus explosion.

In addition to a primary tank leak into the annulus, one other seismically initiated annulus explosion accident that was considered was a leak from a transfer line into the annulus. Although the unmitigated consequences of a transfer line leak into the annulus leading to an explosion do not challenge the Offsite or exceed the Onsite EGs, this accident is prevented to reduce the overall consequences associated with the Seismic event. The transfer line is credited as SC (PC-3 seismically qualified) and a first level of control, so it will not leak into the annulus if a Seismic event occurs while a transfer is in progress. The airborne confinement capability of the waste tank annulus structure provides a second level of control. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, there are no Offsite or Onsite consequences attributed to a leak from a transfer line into the annulus leading to an annulus explosion.

As discussed above, waste tank wall leaks (within assumed leak rates) could occur due to a Seismic event, excluding Tank 50. However, the Type III/IIIA Waste Tanks (including annulus structure) are qualified to withstand the Seismic event; therefore, leaks into a Type III/IIIA annulus from a wall leak will be confined within the annulus. Thus, there is no leak path into a Type IIIA Waste Tank underliner sump and a subsequent explosion in these sumps is not credible following a Seismic event. A leak from a Type IV Waste Tank could accumulate in a Type IV leak detection sump, however given the length of time to reach LFL, the underground

location of these sumps, and the lack of any significant ignition source, it is judged that a Type IV Waste Tank leak detection sump explosion is not credible following a Seismic event. Therefore, there are no Offsite or Onsite consequences attributed to a waste tank underliner or leak detection sump explosion.

Waste Tank Annulus Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

A Seismic event is a credible initiator for a Waste Tank Annulus Explosion. All Type I and Type II Waste Tanks are qualified to withstand a PC-3 earthquake and are located underground. The waste tank is assumed to maintain its structural integrity during a Seismic event and not collapse; however, the Seismic event could result in a waste tank leak (within assumed leak rate of ≤ 4 gpm). It is assumed at the initiation of event the annulus contains the residual volume of Chemical Cleaning waste with OA. At this residual volume and assumed leak rate, and including the effects of radiolytic production and corrosion induced hydrogen generation (accounting for atmospheric breathing), the time to 100% of the LFL is three days (see Section 3.4.2.12). The Seismic event is assumed to fail the installed equipment credited for annulus explosion prevention during normal operation (e.g., waste tank annulus active ventilation).

The first level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent the annulus of Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank annulus structure provides a second level of control. This structure provides airborne waste confinement following an explosion in the waste tank annulus. The waste tank annulus is part of the waste tank structure and is qualified to withstand a PC-3 earthquake and is located underground. The waste tank annulus is assumed to maintain its structural integrity during a Seismic event and not collapse and will provide mitigation through passive airborne waste confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to

minimize the potential release/personnel exposure. Therefore, no Offsite or Onsite consequences are attributed to this event.

In addition to a primary tank leak into the annulus, one other seismically initiated annulus explosion accident that was considered was a leak from a transfer line into the annulus. However, transfers that traverse the annulus of a Type I/II Chemical Cleaning Waste Tank are prohibited, thus this event is not credible. Therefore, no Offsite or Onsite consequences are attributed to this event.

Waste Tank Wall Failure

A Seismic event is not an initiator for a catastrophic Waste Tank Wall Failure. Waste tanks (tank top only for Type IV Waste Tanks) are qualified to withstand a Seismic event and are located underground. The waste tank is assumed to maintain its structural integrity during a Seismic event and not collapse; however, the Seismic event could result in a waste tank leak, excluding Tank 50. The Offsite consequences associated with a single tank wall leak for a single tank are ≤ 0.1 rem. The Onsite consequences associated with a tank wall leak is ≤ 1.0 rem for a single tank (see Section 3.4.2.14 for assumptions related to Seismic event cumulative consequences). It is reasonably conservative to assume that the overall Offsite tank wall failure consequences following a Seismic event can be represented by adding the DBA consequence for fifteen individual waste tank failures. Assuming fifteen waste tanks would bound the consequence associated with every Type I and Type II Waste Tank leaking. Fifteen waste tanks are, therefore, assumed to contribute to the overall Offsite consequence as a result of a leak into the annulus. Only eight waste tanks (the most Type I and Type II Waste Tanks in one area) are assumed to contribute to the overall Onsite consequence, because the 100-meter receptor cannot be simultaneously affected by waste tanks in both F-Area and H-Area.

In addition to tank wall leakage, the Seismic event could cause Waste Tank Top Collapse for Type IV Waste Tanks since the waste tanks and programs to protect waste tank integrity are designated as SS for these tanks. The Offsite consequences associated with a Waste Tank Top Collapse are ≤ 0.1 rem. These consequences are for a liquid waste tank top collapse and bound the consequences for a dry waste tank top collapse (Closure Waste Tanks). It is conservative to assume that the overall Offsite Waste Tank Top Collapse consequences following a Seismic event can be represented by adding the DBA consequences for four Type IV Waste Tanks since tank top structural integrity (SC, PC-3) is maintained on other tanks as described in Section 3.4.2.14. Since Type IV Waste Tanks maintain tank top structural integrity (SS, PC-2), no Onsite consequences are attributed to a Waste Tank Top Collapse scenario.

Waste Tank Overheating

For the seismic evaluation, one evaporator drop tank is assumed to be at saturated conditions at the time of the event. The Seismic event is assumed to preclude any actions to address the continued heat generation in the evaporator drop tank. The evaporator drop tank is therefore assumed to contribute to the overall Offsite and Onsite seismic consequence as a result of overheating due to decay heat generation. Since the steam jet supply and transfer jet piping is

seismically qualified, and transfer line pluggage/valve position change cannot occur due to a seismic event; the steam-heated waste tank scenario cannot occur as a result of a Seismic event, and the event progression is not credible.

Waste Tank Annulus Overheating

For the seismic evaluation, the steam jet supply and transfer jet piping is seismically qualified, and transfer line pluggage cannot occur due to a seismic event; the steam-heated waste tank annulus scenario cannot occur as a result of a Seismic event, and the event progression is not credible.

Waste Tank Siphon Via the Chromate Cooling Water System

A Seismic event is not an initiator for a waste siphon/pump-out from a waste tank via the CRW System in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Siphon/Pump-Out, and the controls discussed below do not apply to Closure Waste Tanks.

A Seismic event could be an initiator for a waste siphon/pump-out from a waste tank via the CRW System. As discussed in Section 3.4.2.15, mixing is prohibited in Waste Tank 39, sludge slurry transfers out of Waste Tanks 32 and 35 are prohibited, and seismically qualified SC controls (siphon breakers) were implemented on Waste Tanks 13, 14 (when connected to the CRW System), 15 (when connected to the CRW System), 29, 30, 31, 32, and 35 to prevent/mitigate the siphon/pump-out event and reduce the consequences to the Offsite receptor. Because PC-3 qualified controls are not available on all waste tanks to prevent or mitigate the siphon/pump-out, there are Offsite consequences associated with a waste siphon from a waste tank via the CRW System.

As discussed in Section 3.4.2.15, PC-2 seismically qualified SS controls are credited in preventing the siphon/pump-out (SS siphon breakers on Waste Tanks 33 and 34; SS cooling coils on Waste Tanks 25, 26, 27, 28, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51). The second level of control is the Event Response Program (operator response) following the Seismic event, using the associated isolation valves. Operator actions include: closure of waste tank CRW header isolation valves upon identification of a CRW System boundary break in the tank (Waste Tanks 13, 14 [when connected to the CRW System], 15 [when connected to the CRW System], 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51) and closure of Waste Tank 30 CRW coil isolation valves upon identification of a CRW System boundary break in the tank. Therefore, there are no Onsite consequences associated with a waste siphon/pump-out from a waste tank via the CRW System.

3.4.2.18.1.6 <u>Evaporators</u>

Several of the evaporator accident progressions had seismic initiators; however, some were considered to be mutually exclusive. To determine a reasonably conservative accident scenario, evaporator accident progressions that resulted in the worst case Offsite and Onsite consequences

were assumed to occur. Other evaporator accidents could occur instead of the accidents assumed here and appropriate controls are identified, but the consequences of those accidents are bounded by the chosen accidents.

The following DBA progressions were evaluated for the evaporators:

Evaporator Overpressure

In this analysis, a Seismic event is a credible initiator for an overpressure accident in the 242-16H and 242-25H Evaporators. The 242-16H Evaporator tube bundle is assumed to contain a crack prior to the Seismic event. The Seismic event could cause other pressure limiting equipment to fail, thereby exacerbating the effect of the initial tube bundle crack. The 242-25H Evaporator tube bundle is assumed to remain intact during the Seismic event and not contribute to the Seismic event consequences. The Seismic event is not assumed to cause the tube bundle and evaporator lance orifices to fail in such a way as to increase the consequences of the event for either of the evaporators. The 242-16H Evaporator Tube Bundle Steam PCV (first level of control) and Tube Bundle Steam PRV (second level of control) are required to assist in limiting the steam pressure and flow at the 242-16H Evaporator tube bundle and lance. The 242-25H Evaporator Lance Steam PCV (first level of control) and Lance Steam PRV (second level of control) are required to limit steam pressure and flow at the 242-25H Evaporator lance line. The Emergency Response Program is also part of the second level of control. This program governs personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. This accident is assumed to have negligible contribution to the overall Offsite seismic consequences but contribute to the overall Onsite seismic consequences.

Evaporator Overflow, Leaks, and Spills

In this analysis, a Seismic event is a credible initiator for an Evaporator Overflow/Leaks/Spills event in the 242-16H or 242-25H Evaporator; however, a 242-25H overflow/leak/spill event and a 242-16H overflow/leak/spill event (with the exception of a transfer jumper leak) are considered to be mutually exclusive with an overpressure event (see above for 242-16H and 242-25H Evaporator Overpressure event). If the evaporator pot is filled and overflowing liquid, it will not spray waste into the cell. Since the 242-16H Evaporator Cell transfer jumpers are only PC-2 qualified, a leak resulting in Offsite consequences could occur simultaneously with a 242-16H Evaporator Overpressure event. The transfer line jumper provides a first level of control. The second level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure liquid transfers through the jumpers. The 242-16H Evaporator Cell transfer jumper leak accident progression is assumed to contribute to the overall Offsite seismic consequences, but not to the overall Onsite seismic consequences.

Evaporator Pot Explosion and Evaporator Cell Explosion

A Seismic event is not a credible initiator for an Evaporator Cell Explosion. The evaporator cells do not reach LFL within 10 days following a seismically induced overflow/leak/spill event so no explosion is assumed to occur.

An unmitigated Evaporator Pot Explosion at a stoichiometric hydrogen-air mixture (assuming only partial fill, which maximizes consequences) could have greater consequences (e.g., 40 rem Onsite for 242-25H) than the Evaporator Overpressure or the 242-16H Evaporator Cell transfer jumper leak accident, but it would take approximately 300 days to reach a stoichiometric hydrogen-air mixture at the partial fill level (Ref. 152). As the evaporator pot level increases, the time it takes to reach a stoichiometric hydrogen-air mixture decreases, but the resulting consequences also decrease as the vapor space (and corresponding hydrogen energy) decrease. After the evaporator is shutdown, assuming the level reaches the maximum fill level, it would take over 85 days to reach a stoichiometric hydrogen-air mixture. For the evaporator to reach stoichiometric in 8 hours would require a liquid volume of approximately 18,500 gallons based on the maximum hydrogen generation rate in Reference 152. The corresponding vapor volume (approximately 100 gallons) is significantly less than the vapor volume assumed to explode in the bounding 40-rem scenario (approximately 12,000 gallons). Therefore, the consequence of this detonation is considered bounded by the 242-25H Evaporator Overpressure and the 242-16H Evaporator Cell transfer jumper leak accident consequences and no controls are required. There are no Offsite or Onsite consequences attributed to Evaporator Pot Explosion or Evaporator Cell Explosion Events.

Evaporator Overheads Receiver Tank Release

In addition to the above evaporator DBA progressions, it is assumed that a Seismic event will release the contents of the evaporator overheads receiver tanks; however, the consequences are judged to be negligible so no controls are required. No Offsite or Onsite consequences are attributed to this event.

3.4.2.18.1.7 Transfer Lines

The following DBA progressions are not applicable to events involving transfer jumpers in the evaporator cell, which are included in the Evaporator Overflow/Leaks/Spills DBA progression discussed previously in Section 3.4.2.18.1.6. For Contingency Transfer System transfers, the flexible hose-in-hose is not required during and following a Seismic event and is not seismically qualified though it is not expected to leak in a Seismic event. The risk of allowing waste to leak from a waste tank and remain in the annulus is judged more significant than the risk of failure of the Contingency Transfer System flexible hose-in-hose transfer line during a Seismic event. A Seismic event is not postulated during a Contingency Transfer System transfer, since this would require a waste tank wall to leak first, followed by a Seismic event during the Contingency Transfer System transfer. Therefore, analysis of the consequences due to a Contingency Transfer System leak during a Seismic event is not required.

The following DBA progressions were evaluated for the transfer lines:

Transfer Error (Above-Ground Core Pipe, Including Excavated Pipes, Release)

The transfer line from Tank 50 to Z-Area is not required to be SC, PC-3 seismically qualified, and thus a Seismic event may result in a line break and spill. However, the Transfer Error (Above-Ground Core Pipe, Including Excavated Pipes, Release) event associated with Tank 50 to Z-Area is considered to be mutually exclusive with the Tank 50 to Z-Area Transfer Line Jacket Explosion. There are no Offsite or Onsite consequences attributed to a seismic initiated Transfer Error (Above-Ground Core Pipe, Including Excavated Pipes, Release) event associated with Tank 50 to Z-Area.

For the remaining transfer lines, the transfer lines are SC (PC-3 seismically qualified) and serve as a first level of control, so a Seismic event will not result in a line break and spill. Additionally as a first level of control, the 242-16H Evaporator Feed Pump Backflow Prevention Devices (SC, PC-3 seismically qualified) provide containment of liquid waste to mitigate an above-ground radioactive material release or spill via the Flush Water System.

The second level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons). The Evaporator Flush Water System spill is assumed to contribute to the overall Offsite and Onsite seismic consequences.

Transfer Line Explosion and Transfer Line Jacket/Encasement Explosion

A Seismic event is assumed to not initiate a Transfer Line Explosion. Even if a core pipe is at LFL, the ground movement and associated pipe movement resulting from a Seismic event are not expected to result in an ignition source inside the core pipe. Instrumentation (e.g., conductivity probes) and other electrical sources in the facility (e.g., motors, wiring) are outside the core pipe and will not cause a spark inside the core pipe. The metal spacer plates in the transfer system are in the jacket, such that sparking due to movement of these plates will occur in the jacket, not in the core pipe. There are no Offsite or Onsite consequences attributed to a seismic initiated Transfer Line Explosion.

A Seismic event is a credible initiator for a Transfer Line Jacket Explosion associated with the transfer line from Tank 50 to Z-Area. The Tank 50 to Z-Area Transfer Line Jacket Explosion accident is assumed to have negligible contribution to the overall Offsite seismic consequences but contribute to the overall Onsite seismic consequences. For the remaining transfer lines, a Transfer Line Jacket/Encasement Explosion is assumed not to occur. Transfer line integrity (e.g., core pipe, valves, jumpers, and connectors) ensures primary waste containment. There are no Offsite or Onsite consequences attributed to a seismic initiated Transfer Line Jacket/Encasement Explosion.

3.4.2.18.1.8 Transfer Facilities

The following DBA progressions are not applicable to events involving transfer jumpers in the evaporator cell, which are included in Section 3.4.2.18.1.6. The following DBA progressions were evaluated for transfer facilities:

Pump Pit and Pump Tank Explosion

A Seismic event is a credible initiator for a Pump Tank Explosion. The in-progress supernate transfer assumed at the time of the Seismic event is assumed to result in a Pump Tank Explosion. A transfer of supernate (using a steam jet as the motive force) will release dissolved hydrogen. The Seismic event is assumed to fail the outgoing pump in the pump tank so that the level rises. It is also assumed to fail the ventilation. The resultant small pump tank vapor space results in a very short time to LFL and subsequent Pump Tank Explosion. The non-HDB-8 Complex pump tanks are equipped with passive vents that serve as the first level of control to extend their time to reach LFL (HDB-8 Complex pump tanks do not have passive vents like the other pump tanks). The installed active ventilation system and diesel generator for HDB-8 Complex PPs are credited as the first level of control to prevent a Pump Tank Explosion during a PC-2 Seismic event. The PP/pump tank supports ventilation system operation. The mitigative capabilities of the PP structure provide a second level of control for all pump tanks. The PP structures are qualified to withstand a PC-3 earthquake. The PP structure is assumed to maintain its structural integrity during a seismic event and not collapse and will provide mitigation through passive confinement. The third level of control for all pump tanks is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure.

Trapped hydrogen release from waste in the pump tanks is not a concern (Ref. 307); however, even with the control set stated above, one pump tank is conservatively assumed to explode (due to release of dissolved hydrogen). The MAR for this accident is conservatively assumed to be Bounding Sludge Slurry and is assumed to contribute to the overall Offsite and Onsite seismic consequences (from an explosion with a follow-on Transfer Error spill).

A Seismic event is a credible initiator for a PP Explosion. The waste primary containment (i.e., pump tank, transfer line) serves as the first level of control and does not rupture as a result of a PC-3 Seismic event. The mitigative capabilities of the PP secondary containment structure provide a second level of control. The PP structures are qualified to withstand a PC-3 earthquake. The PP structure is assumed to maintain its structural integrity during a Seismic event and not collapse. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a PP explosion.

Transfer Facility Explosion

A Seismic event is a credible initiator for a Transfer Facility Explosion. The SC PC-3 seismically qualified core piping and jumpers (including core pipe associated with the transfer lines from MCU to Tank 50 and from the Tank 50 VB to Tank 50 [via the C-1 Riser]) serve as the first level of control. The core pipe associated with the transfer lines from MCU to Tank 50 and from the Tank 50 VB to Tank 50 (via the C-1 Riser) prevents potential leakage of MCU material to the LDB Drain Cell. The mitigative capabilities of the secondary containment (VB, DB, H-Area Catch Tank Encasement, LDB Drain Cell) provide a second level of control. The secondary containment structures are qualified to withstand a PC-3 earthquake except the H-Area Catch Tank Encasement and LDB Drain Cell. The H-Area Catch Tank Encasement and LDB Drain Cell are SS only and are qualified to withstand a PC-2 earthquake. The secondary containment is assumed to maintain its structural integrity during a Seismic event and not collapse and will provide mitigation through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure.

Core pipe associated with the transfer line from Tank 50 to Z-Area is not required to be SC, PC-3 seismically qualified, and thus a Seismic event may result in a line break which causes a Tank 50 to Z-Area Transfer Facility Explosion. However, the Tank 50 to Z-Area Transfer Facility Explosion is considered to be mutually exclusive with the Tank 50 to Z-Area Transfer Line Jacket Explosion. There are no Offsite or Onsite consequences attributed to a seismic initiated Tank 50 to Z-Area Transfer Facility Explosion.

Transfer Error (Core Pipe Release into a Secondary Containment – Spill or Spray)

The transfer line from Tank 50 to Z-Area is not required to be SC, PC-3 seismically qualified, and thus a Seismic event may result in a core pipe release into a secondary containment. However, the Transfer Error (core pipe release into a secondary containment – spill or spray) event associated with Tank 50 to Z-Area is considered to be mutually exclusive with the Tank 50 to Z-Area Transfer Line Jacket Explosion. There are no Offsite or Onsite consequences attributed to a seismic initiated Transfer Error (core pipe release into a secondary containment – spill or spray) event associated with Tank 50 to Z-Area.

For the remaining transfer lines, a Seismic event is a credible initiator for a Transfer Error (core pipe release into a secondary containment – spill or spray). The transfer line core pipe within the transfer facility secondary containment structures (e.g., DB, VB) is credited as SC (PC-3 seismically qualified) and a first level of control. For large secondary containments (greater than or equal to 15,000 gallons), the secondary containment structure was credited as the second level of control. The secondary containment structure provides containment of the liquid waste and provides airborne waste confinement following a core pipe failure. The PPs, large DBs (i.e., FDB-4, HDB-2, HDB-7, HDB-8), and the H-Area Catch Tank all have an available liquid waste containment volume greater than 15,000 gallons (for the H-Area Catch Tank, the encasements that lead to the catch tank were considered in determining the available liquid waste containment volume). The second level of control for small secondary containments (e.g., VBs,

small DBs) is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, there are no Offsite or Onsite consequences attributed to a Transfer Error (core pipe release into a secondary containment - spill or spray).

Transfer Error (Pump Tank Overflow)

The only transfer facility design basis Transfer Error accident with a seismic initiator is an overflow of a pump tank. The in-progress sludge slurry transfer (through a pump tank) assumed at the time of the Seismic event is assumed to result in a pump tank overflow of 15,000 gallons into the PP. For this accident, the PP/pump tank ventilation is assumed not to fail (90% HEPA efficiency) and results in dispersion of the waste into the environment. It is also assumed that the receipt pump tank for an in-progress canyon transfer can receive the entire transfer volume without overflowing the pump tank. The first level of control is the Event Response Program (operator response) following the Seismic event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons). The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Seismic initiated event and response to the event to minimize the potential release/personnel exposure. The Pump Tank Overflow (i.e., High-Rem transfer through an HTF pump tank) is assumed to contribute to the overall Offsite and Onsite seismic consequences.

Transfer Facility Fire

It is assumed that a Seismic event does not cause ignition of any combustibles that may be present in transfer facilities. The Seismic event is therefore judged to not result in a transfer facility fire. This accident does not contribute to the overall Offsite and Onsite seismic consequences.

Transfer Facility Aerosolization

A Seismic event could cause a steam jet to fail, resulting in an Aerosolization event. As discussed in Section 3.4.2.10, controls (the PP and DB sump steam jets are PC-3 seismically qualified) are credited with preventing Aerosolization events involving the PP and DB sumps during and following a Seismic event. The PP and DB confinement provide a mitigative second level of control. The jets in pump tanks are not analyzed for a Seismic event, since the Seismic event is not a credible initiator. Since only the suction nozzle of the transfer jet is within the pump tank proper, there is no scenario where “failure” of a steam jet in a pump tank causes the event. To cause aerosolization to occur, the Seismic event would have to occur while the pump tank steam jet was in use, concurrent with both (1) failure of pressure regulating equipment supplying steam/air to the jet, and (2) blockage of the transfer discharge path (identified initiators include valve closure and salt plugging). The Seismic event will neither cause a manual valve in the transfer path to close nor cause a salt plug to form in the transfer path. Thus, with no credible initiator, there is no reason to consider a seismic pump tank case. A Seismic event is not an

initiator for any other transfer facility Aerosolization event (e.g., PTA). The initial pump tank conditions at the onset of the Seismic event (waste level) will not be affected by the Seismic event in such a way as to lead to an Aerosolization event. This accident does not contribute to the overall Offsite and Onsite seismic consequences.

Pump Tank Overheating

The Seismic event for the steam-heated pump tank scenario is not a credible event. Since only the transfer jet suction nozzle is located within the pump tank and the steam supply piping and remainder of the jet assembly is outside the pump tank (no impingement on the waste will happen should a leak occur) and transfer line pluggage/valve position change cannot occur due to a Seismic event, this progression is not credible.

3.4.2.18.1.9 299-H

The accident of concern in 299-H is a WCT Explosion (analyzed in Section 3.4.2.16). A Seismic event is assumed not to be an initiator for a 299-H WCT Explosion. For the diesel powered unloading vehicle event, unloading vehicles are only in the 299-H truckwell for a short duration, making it unlikely that a Seismic event would occur simultaneously and cause a diesel fuel spill that drains to the WCT and ignites (diesel fuel will not flash at temperatures below 125°F [52°C]). The hydrogen generation and WCT agitator lubricating oil events are also assumed to not occur (see Section 3.4.2.16). No Offsite or Onsite consequences are attributed to the 299-H Facility.

3.4.2.18.1.10 HEPA Filter and Waste Box Release

The Seismic event is assumed to damage unclipped waste boxes (e.g., B-25s) and HEPA filters throughout the facility. The unclipped waste boxes and HEPA filters will contribute to the overall Offsite and Onsite seismic consequence. This simultaneous failure of numerous waste boxes and HEPA filters is unique to the NPH events (see Section 3.4.2.18.3).

3.4.2.18.1.11 Transportation Accident

Since the Seismic event already includes consequences associated with release of material from waste boxes, no additional Offsite or Onsite consequences are attributed to a transportation accident.

3.4.2.18.2 FREQUENCY DETERMINATION

The HA classifies a PC-3 Seismic event in the unlikely frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.18.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below. Since the Seismic event involves multiple process areas (as discussed previously), the cumulative ST involves many mechanisms discussed in other DBAs. While the other DBAs were used in determining the overall consequences, only the unique Seismic event analysis is discussed here.

3.4.2.18.3.1 Source Term Derivation

The unmitigated radiological ST can be expressed in terms of airborne release of activity, using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The value of each of the terms in the five-factor ST formula is specific to the location/release mechanism being analyzed. The unique scenarios associated with the Seismic event are HEPA filter release and waste box release.

Material at Risk

The MAR waste stream for the Seismic Events varies for the individual process areas and release mechanisms. The waste characteristics and inhalation dose potential on a per unit volume basis for streams of concern are given in Section 3.4.1.5.1.

The MAR for the unique scenarios associated with the Seismic event is as follows (Ref. 66, 292):

- To represent the amount of material that could reasonably be available for HEPA filter release, 20 HEPA filters (10% of the approximately 200 total HEPA filters) are assumed to be at maximum loading. Two of these 20 filters are assumed to be from dry sludge tanks and, therefore, the filter loading is representative of sludge solids. Two other tanks are assumed to be sludge slurry waste and, therefore, the filter loading is Bounding Sludge Slurry. The loading of the remaining 16 filters is assumed to be representative of Bounding Supernate. The maximum loading for each HEPA filter is assumed to be 1 Curie of Cs-137. It is reasonably conservative to represent the total loading on all HEPA filters by fully loading 20 HEPA filters since the HEPA filters are radiologically surveyed periodically and most HEPA filters would be only fractionally loaded at any given time.
- To represent the amount of material that could reasonably be available for waste box releases, the MAR from solid waste stored in the area is assumed to be 60 Ci of Cs-137 in supernate waste (Maximum High-Activity Supernate) and 520 Ci of Cs-137 in sludge waste (Maximum High-Activity Sludge) (Ref. 292).
- For the above-ground leak of Evaporator Bottoms via the 242-16H Evaporator Flush Water System, the waste volume assumed is 500 gallons. This value is based on an assumed leak rate of one gpm through the backflow prevention devices over an 8-hour period.

Damage Ratio

The DR is assumed to be one for all scenarios.

Airborne Release Fraction

The ARFs used in the analysis are based on Reference 14, as detailed in Reference 66. The ARFs used are as follows:

- For HEPA filter releases, an ARF of 1.0E-03 was used
- For waste box releases, an ARF of 1.0E-03 was used

Respirable Fraction

The RF is assumed to be one for all scenarios.

Leak Path Factor

The LPF is assumed to be one for all scenarios.

3.4.2.18.3.2 Source Term Calculation

The ST for the unique scenarios associated with a Seismic event (HEPA Filter and Waste Box Release) was calculated in Reference 66 using the preceding ST factors. To determine the overall seismic consequences, the unique scenarios STs must be added to the other DBA STs.

3.4.2.18.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of a Seismic event are given in Table 3.4-7 (the reported unmitigated consequences are assumed to exceed the Offsite and Onsite EGs, since unmitigated consequences were not calculated).

The mitigated Offsite (≤ 15.5 rem) consequences do not challenge the Offsite EGs. The mitigated Onsite (> 100 rem) consequences exceed the Onsite EGs. The immediate vicinity worker risk is also judged to exceed the applicable Onsite EGs.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.18.5.

The individual mitigated consequence contributor breakdown is given below. The consequences given below are very conservative with respect to the Onsite receptor (i.e., it is not expected that the same Onsite individual would receive all consequences reported below) (Ref. 190):

	Consequences (rem)	
Source	**Onsite**	**Offsite**
Drop Tank Overheating	≤ 7.6	≤ 0.02
Waste Tank Explosion (a)	> 100	≤ 3
Pump Tank Explosions	> 100	≤ 0.66
Waste Tank Siphon/Pump-out	0.0	≤ 5.1
Waste Tank Wall Failure (b)	≤ 8	≤ 0.1
Waste Tank Top Collapse (d)	0.0	≤ 0.4
Waste Tank Aerosolization (Closure Waste Tanks)	≤ 3.6	≤ 0.1
Evaporator Overpressure/Leak and Spill (c)	≤ 9.8	≤ 0.1
241-96H ARP Events (e)	≤ 6.1	≤ 0.1
MCU Events (e)	≤ 4.61	≤ 0.1
Transfer Error (Pump Tank Overflow)	≤ 27.7	≤ 0.07
Transfer Error (242-16H Evaporator Flush Water System Spill)	≤ 4.0	≤ 0.01
Transfer Line Jacket Explosion (Tank 50 to Z-Area)	≤ 2.6	≤ 0.1
SMP Waste Release (SMP Riser Overflow)	0.0	≤ 5.5
HEPA Filter Release (f)	≤ 0.12	≤ 0.01
Waste Box Release	≤ 6.75	≤ 0.06

(a) The Offsite consequences reflect a reasonably conservative value for multiple Waste Tank Explosions during a Seismic event. This value was based on analysis (Ref. 268) which provided consequences for multiple waste tank explosions based on typical waste tank conditions. The analysis determined consequences with and without entrainment effects and varied parameters such as supernate level (to increase hydrogen concentration to LFL/LEL), thus providing conservative consequence values for all cases analyzed. For each case analyzed in Reference 268, the total Offsite consequence was ≤ 3 rem.

(b) The Offsite consequences reflect fifteen tank wall failures. The Onsite consequences reflect eight tank wall failures, since no single individual can be 100 meters from both Tank Farms.

(c) The Onsite consequences reflect 100-meter exposure from the 242-25H overpressure event (≤ 9.8 rem during operation). The Evaporator Overpressure Onsite consequences are not cumulative, since no single individual can be 100 meters downwind from the 242-16H and 242-25H Evaporators. The Offsite consequences reflect the consequences from an overpressure event for the 242-16H Evaporator, including a simultaneous 242-16H transfer jumper leak.

(d) The Offsite consequences reflect four tank top collapses (Type IV Waste Tanks). These consequences are for a liquid waste tank top collapse and bound the consequences for a dry waste tank top collapse (Closure Waste Tanks).

(e) The Onsite consequences reflect 241-96H ARP events as discussed in Section 3.3.3.3. The Onsite consequences reflect MCU events as described in Reference 242. The Offsite consequences for these events would be negligible.

(f) The Offsite and Onsite consequences reflect a release from 20 HEPA filters at maximum loading with two filters from dry sludge tanks, two filters from sludge slurry tanks, and 16 filters from supernate tanks with the Onsite receptor being exposed to all HEPA filters considered (Ref. 66). Reference 264 evaluated a release from 20 HEPA filters at maximum loading with nine filters from dry sludge tanks, two filters from sludge slurry tanks, and nine filters from supernate tanks with the Onsite receptor being exposed to 25% of HEPA filters considered. This evaluation concluded that the consequences are reasonably conservative for up to nine dry sludge tanks.

As shown in the consequence breakdown, major contributors to the post-seismic consequence include the Waste Tank and Pump Tank Explosion Events. Some installed equipment that might be used to prevent and/or mitigate the Waste Tank and Pump Tank Explosion Events was not credited because of known vulnerabilities during a Seismic event (Ref. 179). The vulnerability review process that was established for DSA preparation looked at overall accident risk and decisions were made and documented for the disposition of each identified risk. The risk acceptance of the Seismic event consequences is based upon this review and measures that have been put in place to prevent/mitigate these two major contributors. These measures include (but are not limited to):

<u>For Pump Tank Explosions</u>

- Required installation of backup portable ventilation equipment during specified steam jetted transfers.
- The Event Response Program (following the Seismic event) to ensure: 1) liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and pump tank agitators are secured following a Seismic event; 2) HDB-8 PVV System exhaust fan inlet damper position alignment to prevent bypass flow conditions associated with an open inlet damper on the idle exhaust fan in response to a loss of air or power, and 3) restoration of pump tank ventilation or operate backup ventilation on tanks receiving steam jetted transfers from a source with an inventory greater than 1,200 gallons (excluding HDB-8 Complex pump tanks and pump tanks receiving canyon transfers).

<u>For Waste Tank Explosions</u>

- The Event Response Program to ensure: 1) liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), waste tank mixing devices, power to SMPs, and transfer pumps associated with waste tank

recirculation are secured following the Seismic event; 2) installation and operation of portable ventilation systems are prioritized on a time to LFL (CLFL for Tank 50) basis, following a Seismic event; and 3) manual hydrogen monitoring of the waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) following a Seismic event.

- The Flammability Control Program to ensure controls are in place to ensure that only a specified number of tanks can reach the LFL (CLFL for Tank 50) in less than seven days and less than 24 hours following a Seismic event.

3.4.2.18.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to reduce the consequences of a Seismic event (as discussed earlier in the mitigated accident progression) or establish the initial conditions at the time of the Seismic event (e.g., HLLCPs, Waste Tank Mixing Device Operation).

3.4.2.18.5.1 Safety Class Controls

242-16H Evaporator Feed Pump Backflow Prevention Devices: The 242-16H Evaporator Feed Pump Backflow Prevention Devices provide containment of liquid waste to mitigate an above-ground radioactive material release or spill via the Flush Water System.

242-16H Evaporator Chemical Cleaning Program: Controls shall be established to ensure that the acidic material used in chemical cleaning operations for the 242-16H Evaporator is not added to a waste tank (only required during chemical cleaning operations). These controls shall include: 1) isolation of the evaporator when the vessel contains material with a pH less than 7.0, and 2) sampling/verifying the evaporator cell sump contents have a pH greater than or equal to 7.0 prior to transfer to a waste tank.

242-16H Evaporator Isolation Valves: The 242-16H Evaporator Isolation Valves provide passive containment of the acidic waste material in the evaporator (only required during chemical cleaning operations) to prevent the introduction of acidic material into a waste tank.

Diversion Box: DB structural integrity is required to support transfer line integrity (II/I). The DB structure also provides airborne waste confinement following a primary containment waste release, an explosion, or waste aerosolization into the DB. HDB-8 Complex also supports ventilation system operation (this control is SS only).

Diversion Box Sump Steam Jet (Including Steam Supply Piping): DB Sump Steam Jet integrity shall provide air/steam containment to prevent waste aerosolization.

Event Response Program: Procedures shall be established governing required actions following a Seismic event. These procedures shall require the following operator actions:

1) Secure liquid transfers (excluding evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs).

2) Shut down evaporators (secure steam/air to tube bundles and lances) and secure evaporator feed pumps.

3) Secure pump tank agitators, waste tank mixing devices, and power to SMPs.

4) Secure transfer pumps associated with waste tank recirculation.

5) Restore primary purge ventilation or install/operate portable ventilation systems on waste tanks, prioritized on a time to LFL (CLFL for Tank 50) basis.

6) Perform manual hydrogen monitoring of the waste tanks (excluding Tank 50) under the Waste Tank Quiescent Time Program (Seismic Release Protection) upon loss of waste tank ventilation.

7) Close waste tank CRW header isolation valves upon identification of a CRW System boundary break in the waste tank (Waste Tanks 13, 14 [when connected to the CRW System], 15 [when connected to the CRW System], 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51).

8) Close Waste Tank 30 CRW coil isolation valves upon identification of a CRW System boundary break in the waste tank.

9) Ensure HDB-8 PVV System exhaust fan inlet damper position alignment to prevent bypass flow conditions associated with an open inlet damper on the idle exhaust fan in response to a loss of air or power.

10) Restore ventilation or operate backup ventilation on pump tanks receiving steam jetted transfers from a source with an inventory greater than 1,200 gallons (excluding HDB-8 Complex pump tanks and pump tanks receiving canyon transfers).

11) Restore annulus ventilation or install/operate portable ventilation systems on waste tank annuli on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.

The portable ventilation systems, discussed in Items 5 and 11 above, are not required to be functionally classified as SC equipment. Additional information regarding waste tank and waste tank annulus portable ventilation system requirements can be found in Section 5.5.2.13. For Items 7, 8, 9, and 10, these controls are required to be SS only.

Flammability Control Program: The Flammability Control Program provides the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

1) Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification. For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tanks shall be classified as Chemical Cleaning Tanks and the time to LFL (three days) is not calculated.

2) Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50, Very Slow Generation Tanks, and Type I/II Acidic Chemical Cleaning Waste Tanks). The hydrogen concentration LFL limit shall account for potential organics.

3) Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the tank vapor space to reach the LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks).

4) Determine, track, and ensure that only seven waste tanks can reach LFL in less than 24 hours assuming no ventilation and including the effects of post-seismic trapped gas release.

5) Determine, track, and ensure that only 14 waste tanks can reach LFL in less than seven days including:

   - Effects of post-seismic trapped gas release, assuming no ventilation

   - Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

   Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks to have the potential to become flammable in less than seven days. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

Gas Release Program: The Gas Release Program shall require the following to protect hydrogen concentration assumptions in the waste tank bulk vapor space during sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities: (For Type IV Waste Tanks and Tank 50 this control is required to be SS only)

1) Prior to initiating sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities, determine if the activity will cause the waste tank to exceed the Gas Release Criteria stated in Section 3.4.2.11.1.

2) Prior to initiating sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities, controls shall be established to ensure the waste tank bulk vapor space hydrogen concentration is less than or equal to the initial value assumed in the hydrogen release engineering evaluation.

3) For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the activity shall be controlled to maintain the waste tank bulk vapor space hydrogen concentration less than or equal to the safety analysis value and maintain the minimum time to LFL defined by the waste tank flammability classification.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCP maximum levels shall be less than or equal to 63.8 inches (Type I) and 64.8 inches (Type II). The HLLCPs are not credited with functioning during or following the Seismic event, but protect assumed initial conditions at the time of the Seismic event. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

High Point Flush Pit: HPFP structural integrity is required to support transfer line integrity (II/I). The HPFP structure also provides airborne waste confinement following a primary containment waste release, an explosion in the HPFP, or waste aerosolization in the HPFP.

Pump Pit: PP structural integrity is required to support transfer line integrity (II/I). The PP structure also provides airborne waste confinement following a primary containment waste release, an explosion in the PP or pump tank, or waste aerosolization into the PP. The HDB-8 Complex PPs also support ventilation system operation (this control is SS only).

Pump Pit Sump Steam Jet (Including Steam Supply Piping): PP Sump Steam Jet integrity shall provide air/steam containment to prevent waste aerosolization.

Pump Tank: Pump Tank integrity shall ensure primary waste containment. The HDB-8 Complex pump tanks also support ventilation system operation (this control is SS only).

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Transfer Line Core Pipe: Transfer Line integrity (e.g., core pipe, valves, jumpers, connectors, and associated gaskets) shall ensure primary waste containment (transfer jumpers in the evaporator cells are required to be SS only). Flexible hose-in-hose transfer line used for Contingency Transfer System transfers is not required during and following a Seismic event and is required to be SS only.

Valve Box: VB structural integrity is required to support transfer line integrity (II/I). The VB structure also provides airborne waste confinement following a primary containment waste release into the VB (includes drain VB) or an explosion in the VB.

Waste Tank: The Type I, Type II, Type III, and Type IIIA Waste Tank structure provides airborne waste confinement following waste aerosolization or an explosion in the waste tank, including the SMP Column Explosion (for this event, only an SS control is required). The leak rates assumed in the Waste Tank Wall Failure and Waste Tank Annulus Explosion analyses are based on the waste tank design.

Waste Tank 13/14/15 Siphon Breaker: The Waste Tank 13/14/15 Siphon Breaker (located near Tank 13) is credited to prevent a CRW siphon/pump-out event for Waste Tank 13, Waste Tank 14 (when connected to the CRW System), and Waste Tank 15 (when connected to the CRW System).

Waste Tank 30 Siphon Breaker: The Waste Tank 30 Siphon Breaker is credited to prevent a CRW siphon/pump-out event for Waste Tanks 29, 30, 31, and 32.

Waste Tank 35 Siphon Breaker: The Waste Tank 35 Siphon Breaker is credited to prevent a CRW siphon/pump-out event for Waste Tank 35.

Waste Tank Annulus Jet and Piping: Type I, Type II, Type III, and Type IIIA Waste Tank Annulus Jets and Piping integrity shall provide air/steam containment to prevent waste aerosolization and overheating of the waste.

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following during operations associated with Chemical Cleaning Transfers (or related vent/drain operations) to protect initial conditions for corrosion induced hydrogen generation rate assumptions:

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, Tank 51 Drain VB, FPP-1, FPP-2, and HPP-3. Chemical Cleaning Transfers (or related vent/drain operations) are also permitted in transfer paths that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell.

- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks, waste tanks, or transfer facilities outside of the intended transfer path.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1, HPT-3, and the waste tanks associated with the vent/drain path.
- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Prior to transfer initiation of a Chemical Cleaning Transfer (or related vent/drain operations), verification shall be performed to ensure that sufficient inhibitors are present in the applicable receipt waste tank to ensure neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers (or related vent/drain operations), at least one waste tank mixing device shall be operating in the applicable receipt waste tank to ensure adequate mixing and neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers, acidic waste shall enter the receipt tank via a flowpath that is below the waste tank liquid level.

<u>Waste Tank Quiescent Time Program</u>: The Waste Tank Quiescent Time Program shall require the following to protect assumed times to LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks): (For Type IV Waste Tanks and Tank 50 this control is required to be SS only)

1) Determine and track waste tanks required to be in the Waste Tank Quiescent Time Program (Seismic Release Protection).

2) Waste tanks under the Waste Tank Quiescent Time Program (Seismic Release Protection) shall be controlled to ensure that the waste tanks will not reach 100% of the LFL (CLFL for Tank 50) (due to trapped gas release from the settled sludge / slurried sludge and subsequent radiolytic hydrogen production) in less than seven days following a seismic event.

Waste Tank Temperature Monitoring: Temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks to protect initial conditions for corrosion induced hydrogen generation rate assumptions.

Waste Tank Transfer Jet and Piping: Waste Tank Transfer Jet and Piping integrity shall provide air/steam containment to prevent waste aerosolization and overheating of the waste.

Waste Tank Ventilation Low Flow Interlock: For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, the Waste Tank Purge Ventilation System shall have a low flow interlock to stop the gas release activity. Depending on the activity being performed, the interlock will perform the following when low ventilation flow occurs: (For Type IV Waste Tanks, this control is required to be SS only)

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

3.4.2.18.5.2 Safety Significant Controls

242-16H Evaporator Tube Bundle Steam Pressure Control Valve and Tube Bundle Steam Pressure Relief Valve: The Evaporator Tube Bundle Steam PCV and Tube Bundle Steam PRV are required to limit steam pressure and flow to the evaporator tube bundle and lance line. A manually operated valve on the PCV bypass line for the 242-16H Evaporator must be administratively controlled closed during evaporator operation.

242-16H/242-25H Evaporator Lance Air Supply Line Orifices: The Evaporator Lance Air Supply Line Orifices limit air pressure and flow to the evaporator pot to within assumed overpressurization analysis values.

242-16H/242-25H Evaporator Lance Steam Supply Line Orifices: The Evaporator Lance Steam Supply Line Orifices limit steam pressure and flow to the evaporator pot to within assumed overpressurization analysis values.

242-16H/242-25H Evaporator Tube Bundles: The Evaporator Tube Bundles are passive design features that provide air/steam containment and protect assumed initial conditions (242-16H crack size).

242-25H Evaporator Lance Steam Pressure Control Valve and Lance Steam Pressure Relief Valve: The Evaporator Lance Steam PCV and Lance Steam PRV are required to limit steam

pressure and flow to the evaporator lance line. A manually operated valve on the PCV bypass line for the 242-25H Evaporator must be administratively controlled closed during evaporator operation.

CRW Coil Pressure Boundary: The CRW Coil Pressure Boundary inside Waste Tanks 25, 26, 27, 28, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51 is a credited design feature to prevent a CRW siphon/pump-out event.

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Seismic initiated event and response to the event to minimize the potential release/personnel exposure.

Equipment Needed to Secure Power to SMPs: The equipment needed to secure power to SMPs shall be available to respond to indications of a primary containment release and limit waste releases.

Equipment Needed to Stop Waste Transfers: The equipment needed to stop waste transfers shall be available to respond to indications of a primary containment release and limit waste releases, with the exception of batch transfers of less than 15,000 gallons (into waste tanks only), Contingency Transfer System transfers, and siphoning/lifting/pump-outs of the contents of an evaporator pot.

H-Area Catch Tank: The H-Area Catch Tank provides airborne waste confinement following a primary containment waste release. The H-Area Catch Tank also provides containment of liquid radioactive waste.

H-Area Catch Tank Encasement: The H-Area Catch Tank Encasement provides airborne waste confinement following an explosion in the catch tank.

HDB-8 Diesel Generator: The HDB-8 Diesel Generator supplies power to the HDB-8 PVV System upon loss of normal power.

HDB-8 PVV System: The HDB-8 PVV System provides a flowpath and purge flow to purge the HDB-8 Complex pump tanks.

LDB Drain Cell: The LDB Drain Cell structure provides airborne waste confinement following a primary containment waste release into the LDB Drain Cell or an explosion in the LDB Drain Cell.

Pump Tank Backup Ventilation Systems Program: Backup portable ventilation (with power supply) shall be installed and functional for pump tanks which are receiving steam jetted transfers from a source with an inventory greater than 1,200 gallons (excluding HDB-8 Complex pump tanks and pump tanks receiving canyon transfers). The portable ventilation systems are not required to be seismically qualified.

Pump Tank Passive Vents: The Pump Tank Passive Vents provide a flowpath between the pump tank vapor space and PP vapor space to extend the time to reach LFL in the pump tank. (not applicable to HPT-7, HPT-8, HPT-9, and HPT-10).

SMP Column Pressure Boundary: The SMP Column structure design prevents a pump column explosion by preventing waste from entering the column.

SMP Flush/Motor Pressure Boundary: The SMP Flush/Motor Pressure Boundary prevents the SMP Waste Release and pump column explosion events by preventing waste from entering the SMP column.

Transfer Line Encasement: The Transfer Line Encasements draining to the H-Area Catch Tank provide airborne waste confinement following a primary containment waste release.

Waste Tank: The Type IV Waste Tank structure provides airborne waste confinement following waste aerosolization or an explosion in the waste tank.

Waste Tank 30 CRW Coil Isolation Valves: Waste Tank 30 CRW Coil Isolation Valves are credited design features to prevent a CRW siphon/pump-out event.

Waste Tank 33/34 Siphon Breaker: The Waste Tank 33/34 Siphon Breaker (located near Waste Tank 34) is credited to prevent a CRW siphon/pump-out event for Waste Tanks 33 and 34.

Waste Tank Annulus: The Type I, Type II, Type III, and Type IIIA Waste Tank Annulus structure provides liquid waste containment and provides airborne waste confinement following waste aerosolization in the annulus or an explosion in the waste tank annulus. The Type I and Type II Waste Tank Annulus provides liquid waste containment to support conductivity probe functionality (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Conductivity Probes: The Type I and Type II Waste Tank Annulus Conductivity Probes provide control room alarm following a waste tank annulus high level condition to protect assumed initial tank annulus conditions. The Type I and Type II Waste Tank Annulus Conductivity Probes are not credited with functioning during or following the Seismic event, but protect assumed initial conditions at the time of the Seismic event (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank CRW Header Isolation Valves: The Waste Tank CRW Header Isolation Valves for Waste Tanks 13, 14 (when connected to the CRW System), 15 (when connected to the CRW System), 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51 are credited design features to mitigate a CRW siphon/pump-out event.

Waste Tank Hydrogen Monitor and High Hydrogen Concentration Interlock: For waste tanks undergoing sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal which exceed the Gas Release Criteria stated in Section 3.4.2.11.1, continuous hydrogen monitoring shall be performed using an installed hydrogen monitor with a high hydrogen concentration interlock to stop the gas release activity.

Depending on the activity being performed, the interlock will perform the following when high hydrogen concentration occurs:

- stop waste tank mixing devices (tanks undergoing sludge agitation or bulk saltcake dissolution using waste tank mixing devices)
- stop transfer pumps associated with waste tank recirculation (tanks undergoing bulk saltcake dissolution using transfer pumps associated with waste tank recirculation)
- close the dissolution liquid addition valves (tanks undergoing bulk saltcake dissolution)
- stop transfer pumps associated with saltcake interstitial liquid removal (tanks undergoing saltcake interstitial liquid removal)

Waste Tank Mixing Device Operation: Controls on SMP operation shall be established. These controls shall ensure that if an external water source is connected to the SMP, that the SMP is operated at or below the maximum allowable pump speed of 500 rpm. This speed (less than or equal to 500 rpm) shall be verified by manually reducing the speed at the VFD until the speed is at or below 500 rpm. This shall be independently verified prior to connecting an external water source to the pump. To ensure that the VFD speed is not modified during the time when the SMP is operating and the external water source is connected, an operator shall be stationed at the VFD. The primary role of this operator shall be verifying that the VFD speed is not altered. A lockable physical barrier may be installed which prevents VFD speed changes, in lieu of stationing an operator. This control is not credited during or following the Seismic event, but protects assumed initial conditions at the time of the Seismic event.

Waste Tank SMP Riser: The Waste Tank SMP Riser structure provides airborne waste confinement following a primary containment waste release into the riser. The riser structure also provides liquid waste containment to support conductivity probe functionality. Some risers freely drain directly to the waste tank, precluding the need for riser leak detection capability.

Waste Tank SMP Riser Conductivity Probes and Interlocks: During SMP operation, the Waste Tank SMP Riser Conductivity Probes shall be interlocked to shutdown the SMP following a primary containment waste release into the riser. (This control is not applicable to risers that have been shown to be free draining).

3.4.2.19 Wildland Fire

3.4.2.19.1 SCENARIO DEVELOPMENT

3.4.2.19.1.1 Background

Wildland fires have been shown to have the potential to affect SRS nuclear facilities (Ref. 86). A Wildland Fire can cause damage to a wide array of equipment and lead to releases of chemical and radioactive waste. The purpose of this analysis is to identify locations of hazardous materials or safety-related SSCs that are considered susceptible to wildland fire effects.

The primary defense of the CSTF against Wildland Fire propagation is the general design and configuration of the Tank Farms. The waste tanks are underground steel and concrete structures. The pump tanks and evaporator pots are steel containments inside concrete cells. The other transfer facilities (e.g., DBs, catch tanks) are in underground concrete structures. For further detail on the CSTF design, refer to Chapter 2.

Although a Wildland Fire event may result in a chemical release, no chemical EGs were exceeded for associated HA events and there are no required controls for these progressions. The consequences from chemical release are not quantified or included in the cumulative Wildland Fire event consequences. The chemical release consequences are considered bounded by the consequences of the radiological release.

3.4.2.19.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with a Wildland Fire. Since the Wildland Fire event potentially involves multiple process areas (i.e., has a cumulative effect), additional events (including some that the HA determined to have negligible consequences) have been identified on Table 3.3-17 and included for consideration (as illustrated in the accident progressions).

3.4.2.19.1.3 Unmitigated Accident Progression

A Wildland Fire is assumed to strike both HTF and FTF. The effect of the Wildland Fire at the CSTF has been assessed by general location/process area. Using the other DBAs as guidance, each area was evaluated to determine what the worst progression would be for a given location/process area. This evaluation is necessary because the DBAs for some process areas are mutually exclusive (e.g., Waste Tank Wall Failure, Waste Tank Explosion). Support systems such as steam, power, instrument air, and water are assumed to have failed in the worst reasonably conservative configuration.

The unmitigated consequences of the Wildland Fire event were not calculated and are assumed to exceed the Offsite and Onsite EGs. Since the EGs are exceeded, mitigated analysis is required.

3.4.2.19.1.4 Mitigated Accident Progression

Before the cumulative effects of a Wildland Fire event at the CSTF can be determined, the effect of a Wildland Fire event has to be determined on an individual location/process area basis. Other DBAs were reviewed to determine if a Wildland Fire event would be an initiator for the accident. Accidents that had a Wildland Fire initiator were further reviewed to determine what the worst progression would be for a given location/process area. In addition, this analysis identified accidents that are unique to a Wildland Fire event.

This analysis assumed that following the Wildland Fire initiated event, the following actions shall occur:

- Secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons). The transfers that are exempted are

based on the location of the GDL below ground/within a cell and the need to avoid GDL pluggage.

- Shut down evaporators (secure steam to tube bundles and lances) and secure evaporator feed pumps.
- Secure pump tank agitators and waste tank mixing devices.
- Secure transfer pumps associated with waste tank recirculation.
- Restore primary purge ventilation or install/operate portable ventilation systems on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.
- Restore annulus ventilation or install/operate portable ventilation systems on waste tank annuli on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.
- If conditions do not permit restoration of primary purge ventilation or annulus ventilation (or installation/operation of portable ventilation) on Type I/II Acidic Chemical Cleaning Waste Tanks, neutralize the waste tank contents to the maximum extent practical (e.g., add inhibitor).

3.4.2.19.1.5 Waste Tanks

The following DBA progressions were evaluated for waste tanks:

Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure)

A Wildland Fire is not an initiator for a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure) since the structural integrity of the transfer line core piping traversing the annulus is assumed to not be impacted by the Wildland Fire. No Offsite or Onsite consequences are attributed to a Transfer Error (Waste Tank Annulus Spill Due to Core Pipe Failure).

Transfer Error (Waste Tank Overflow) and SMP Waste Release (SMP Riser Overflow, SMP Column Spill, SMP Column Spray)

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices prior to the Wildland Fire reaching the waste tank transfer systems. These actions will eliminate the initiator for Transfer Error (Waste Tank Overflow) and SMP Waste Release (SMP Riser Overflow, SMP Column Spill, SMP Column Spray) events. The only transfers allowed to continue (evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs) will not result in a waste tank overflow. Adequate freeboard is maintained in waste tanks that would allow the receipt tank to accept the incoming waste until each transfer is secured, without overflowing. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated

event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to Transfer Error/SMP Waste Release events.

Waste Tank (Primary and Annulus) Aerosolization

A Wildland Fire is not an initiator for Waste Tank Aerosolization (Steam Jet Failure/Rooster Tailing) in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Aerosolization (Steam Jet Failure/Rooster Tailing), and the controls discussed below do not apply to Closure Waste Tanks. A Wildland Fire is not an initiator for Waste Tank Aerosolization (Steam Jet Failure) in Type I/II Chemical Cleaning Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Aerosolization (Steam Jet Failure), and the controls discussed below (related to Steam Jet Failure) do not apply to Type I/II Chemical Cleaning Waste Tanks.

For the remaining waste tanks, the first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices prior to the Wildland Fire reaching the waste tank transfer systems. These actions will eliminate the initiator for Waste Tank Aerosolization (Steam Jet Failure/Rooster Tailing) events. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Waste Tank Aerosolization for these events.

A Wildland Fire causing a release due to aerosolization in a dry sludge tank (dropped object scenario) is considered incredible. No Onsite or Offsite consequences are attributed to a dry sludge tank release.

Waste Tank Explosion

A Wildland Fire is not an initiator for a Waste Tank Explosion in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Explosion, and the controls discussed below do not apply to Closure Waste Tanks.

The Wildland Fire is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). Excluding Type I/II Acidic Chemical Cleaning Waste Tanks, the Flammability Control Program serves as the first level of control and ensures that the time to reach 100% of the LFL (CLFL for Tank 50) following a loss of ventilation is at least seven days in the waste tank. The seven days allows time to either restore ventilation or provide alternate ventilation, thereby preventing the waste tanks from reaching 100% of the LFL (CLFL for Tank 50). Also part of the first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), waste tank mixing devices, and transfer pumps associated with waste tank recirculation. These actions will stop sludge agitation,

bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste (or waste containing Isopar® L) is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. It is assumed that the average bulk waste temperature for Tank 50 is within limits prior to the Wildland Fire event; however, these actions prevent additional heat input to the waste.

For Type I/II Acidic Chemical Cleaning Waste Tanks, the time to reach 100% of the LFL may be three days. The first level of control for these waste tanks is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL. If conditions do not permit restoration of primary purge ventilation (or installation/operation of portable ventilation), the waste tank contents shall be neutralized to the maximum extent practical (e.g., add inhibitor). Once the waste of a Type I/II Acidic Chemical Cleaning Waste Tank has been neutralized (i.e., pH is greater than or equal to 7) and the tank made a Type I/II Non-Acidic Chemical Cleaning Waste Tank, the waste tank may be reclassified, thus ensuring a minimum of seven days to reach 100% of the LFL. Additional operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The mitigative capabilities of the waste tank structure provide a second level of control. The controls supporting waste tank structure integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The waste tanks are qualified to withstand a Wildland Fire (constructed of non-combustible material) and are located underground. The waste tank structure is assumed to maintain its structural integrity during a Wildland Fire event and not collapse and will provide mitigation through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event

and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Waste Tank Explosion.

Slurry Pump/SMP Column Explosion

There is no credible initiator for a Slurry Pump Column Explosion during a Wildland Fire event. This analysis assumes that a Wildland Fire event will not result in an ignition source for a Slurry Pump Column Explosion. The slurry pump column is enclosed and the potential ignition sources (e.g., electrical wiring) are outside the column. In addition, the waste tanks and slurry pump columns are qualified to withstand a Wildland Fire (constructed of non-combustible material) and the waste tanks are located underground. The waste tank structure and slurry pump columns are assumed to maintain their structural integrity during a Wildland Fire event. Therefore, there are no Offsite or Onsite consequences associated with a Slurry Pump Column Explosion.

There is no credible initiator for a SMP Column Explosion during a Wildland Fire event. This analysis assumes that a Wildland Fire event will not result in failure of the underground portion of the SMP pressure boundary (i.e., SMP flush/motor pressure boundary and SMP pump column pressure boundary) in a manner that will result in waste accumulating in the pump column. The waste tanks and SMP columns are qualified to withstand a Wildland Fire (constructed of non-combustible material) and the waste tanks are located underground. The waste tank structure and SMP columns are assumed to maintain their structural integrity during a Wildland Fire event. Therefore, there are no Offsite or Onsite consequences associated with a SMP Column Explosion.

Waste Tank Annulus Explosion (except Type I/II Acidic Chemical Cleaning Waste Tanks)

A Wildland Fire is not an initiator for a Waste Tank Annulus Explosion since the structural integrity of the waste tanks is not assumed to be impacted by the Wildland Fire. No Offsite or Onsite consequences are attributed to this event.

Leaks from a waste tank will not occur as a result of a Wildland Fire event; therefore, a Type IIIA Waste Tank underliner sump explosion cannot occur either. Likewise there is no credible initiator for a Type IV Waste Tank leak detection sump explosion during a Wildland Fire event. Therefore, no Offsite or Onsite consequences are attributed to these events.

Waste Tank Annulus Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

For the purposes of this analysis, the Wildland Fire is not an initiator for leakage into the annulus. However, it is assumed at the initiation of event the annulus contains the residual volume of Chemical Cleaning waste with OA. At this residual volume and including the effects of radiolytic production and corrosion induced hydrogen generation (accounting for atmospheric breathing) the time to 100% of the LFL is five days (see Section 3.4.2.12). The Wildland Fire is assumed to fail the installed equipment credited for annulus explosion prevention during normal operation (e.g., waste tank annulus active ventilation).

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to restore ventilation or install/operate portable ventilation systems prioritized on the time to LFL. If conditions do not permit restoration of annulus ventilation (or installation/operation of portable ventilation), the waste tank contents shall be neutralized to the maximum extent practical (e.g., add inhibitor). Additional operator actions may include neutralizing the waste in the annulus.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered "one" waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent the annulus of Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank annulus structure and controls supporting waste tank annulus confinement integrity provide a second level of control. This structure provides airborne waste confinement following an explosion in the waste tank annulus. The waste tank annuli are qualified to withstand a Wildland Fire (constructed of non-combustible material) and are located underground. The waste tank annulus structure is assumed to maintain its structural integrity during a Wildland Fire event and not collapse and will provide mitigation through passive confinement. The controls supporting waste tank annulus confinement integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls.

The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, no Offsite or Onsite consequences are attributed to this event.

Waste Tank Overheating

For the Wildland Fire evaluation, one evaporator drop tank is assumed to be at saturated conditions at the time of the Wildland Fire. The Wildland Fire is assumed to preclude any actions to address the continued heat generation in the evaporator drop tank. The evaporator drop tank is therefore assumed to contribute to the overall Offsite and Onsite Wildland Fire consequence as a result of overheating. Since the steam supply and transfer jet are within the waste tank, and transfer line pluggage/valve position change cannot occur due to a Wildland Fire

event; the steam-heated waste tank scenario cannot occur as a result of a Wildland Fire event, and the event progression is not credible.

Waste Tank Annulus Overheating

For the Wildland Fire evaluation, the steam supply and transfer jet are within the waste tank annulus, and transfer line pluggage change cannot occur due to a Wildland Fire event; the steam-heated waste tank annulus scenario cannot occur as a result of a Wildland Fire event, and the event progression is not credible.

Waste Tank Wall Failure

A Wildland Fire is not an initiator for a Waste Tank Wall Failure since the structural integrity of the waste tanks is not assumed to be impacted by the Wildland Fire. No Offsite or Onsite consequences are attributed to a Waste Tank Wall Failure.

Waste Tank Siphon

A Wildland Fire is not an initiator for a Waste Tank Siphon. The Wildland Fire will not cause the simultaneous CRW System failures required for the event to occur. No Offsite or Onsite consequences are attributed to a Waste Tank Siphon.

3.4.2.19.1.6 Evaporators

The following DBA progressions were evaluated for the evaporators:

Evaporator Overpressure; Evaporator Overflow, Leaks, and Spills

The first level of control for these scenarios is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), shutdown the evaporators (secure steam to tube bundles and lances), and secure evaporator feed pumps prior to the Wildland Fire reaching the Evaporator Systems. These actions will eliminate the initiator for the Evaporator Overpressure; Evaporator Overflow, Leaks, and Spills events. The mitigative capabilities of the evaporator cell structure provide a second level of control. The controls supporting evaporator cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The evaporator cells are qualified to withstand a Wildland Fire (constructed of non-combustible material). The evaporator cell structure is assumed to maintain its structural integrity during a Wildland Fire event and not collapse and will provide mitigation through passive confinement. No Offsite or Onsite consequences are attributed to the preceding evaporator events.

Evaporator Pot Explosion and Evaporator Cell Explosion

The first level of control for these scenarios is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), shutdown the evaporators (secure steam to tube bundles and lances), and secure evaporator feed pumps prior to the Wildland Fire reaching the Evaporator Systems. These actions will eliminate the initiator for the Evaporator Pot Explosion and Evaporator Cell Explosion events. The mitigative capabilities of the evaporator cell structure provide a second level of control. The controls supporting evaporator cell structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The evaporator cells are qualified to withstand a Wildland Fire (constructed of non-combustible material). The evaporator cell structure is assumed to maintain its structural integrity during a Wildland Fire event and not collapse and will provide mitigation through passive confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to the preceding evaporator events.

3.4.2.19.1.7 Transfer Lines

The following DBA progressions were evaluated for the transfer lines:

Transfer Error (Above-Ground Core Pipe, Including Excavated Pipes, Release)

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) prior to the Wildland Fire reaching the transfer system. This action will eliminate the initiator for the Transfer Error (Above-Ground Core Pipe, Including Excavated Pipes, Release) events. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Transfer Error.

Transfer Line Explosion and Transfer Line Jacket/Encasement Explosion

The HA does not postulate that a Wildland Fire will cause a Transfer Line or Transfer Line Jacket/Encasement Explosion. No Offsite or Onsite consequences are attributed to these transfer line events.

3.4.2.19.1.8 Transfer Facilities

The following DBA progressions were evaluated for transfer facilities:

Transfer Facility Fire

It is assumed that a Wildland Fire event does not cause ignition of any combustibles that may be present in transfer facilities. The DB, HPFP, PP, VB, and evaporator cell structures are qualified to withstand a Wildland Fire (constructed of non-combustible material). The DB, HPFP, PP, VB, and evaporator cell structures are assumed to maintain their structural integrity during a Wildland Fire event and not collapse. The Wildland Fire event is therefore judged to not result in a transfer facility fire. The HA does not postulate that a Wildland Fire will cause an LDB Drain Cell Transfer Facility Fire. No Offsite or Onsite consequences are attributed to this event.

Transfer Facility Explosion

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) prior to the Wildland Fire reaching the transfer system. This action will eliminate the initiator for the Transfer Facility Explosion event. The mitigative capabilities of the Transfer Facility structures (DBs, HPFP, PPs, and VBs) provide a second level of control. The controls supporting Transfer Facility structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The DB, HPFP, PP, and VB structures are qualified to withstand a Wildland Fire (constructed of non-combustible material). The DB, HPFP, PP, and VB structures are assumed to maintain their structural integrity during a Wildland Fire event and not collapse and will provide mitigation through secondary confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. The HA does not postulate that a Wildland Fire will cause an LDB Drain Cell or H-Area Catch Tank Explosion. No Offsite or Onsite consequences are attributed to a Transfer Facility Explosion.

A Wildland Fire event is not a credible initiator for Tank 50 to Z-Area Transfer Facility Explosion (LPDT Explosion). The LPDT only has material in it if the Tank 50 to Z-Area transfer line has a core pipe leak or if there is a reason to drain the Tank 50 to Z-Area transfer line. The total volume of the Tank 50 to Z-Area transfer line is 5,975 gallons (Ref. 1). If the Tank 50 to Z-Area transfer line leaks/drains to the LPDT, the remaining vapor space volume would be approximately 1,525 gallons (Ref. 1). Comparing those values to Reference 313, the LPDT will not reach LFL within 300 days following a Wildland Fire event induced failure of the ventilation system so no explosion is assumed to occur.

Transfer Error (Core Pipe Failure into a Secondary Containment – Spill or Spray; Pump Tank Overflow)

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) prior to the Wildland Fire reaching the transfer system. This action will eliminate the initiator for the

Transfer Error (Core Pipe Failure into a Secondary Containment – Spill or Spray; Pump Tank Overflow) events. The mitigative capabilities of the Transfer Facility structures (DBs, HPFP, PPs, and VBs) provide a second level of control. The controls supporting Transfer Facility structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The DB, HPFP, PP, and VB structures are qualified to withstand a Wildland Fire (constructed of non-combustible material). The DB, HPFP, PP, and VB structures are assumed to maintain their structural integrity during a Wildland Fire event and not collapse and will provide mitigation through secondary confinement. No Offsite or Onsite consequences are attributed to a Transfer Error.

Pump Pit and Pump Tank Explosion

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and pump tank agitators prior to the Wildland Fire reaching the transfer system. The hydrogen release in a pump tank following a Wildland Fire initiated transfer shutdown is assumed to be at a low enough level so that the pump tanks will not reach LFL before ventilation is either restarted or alternate ventilation provided (assuming ventilation is lost during the Wildland Fire). Upon shutdown of a transfer, dissolved hydrogen release in the pump tank is no longer a concern. For the non-HDB-8 pump tanks, the passive vents also serve as part of the first level of control to extend the time to reach LFL. The mitigative capabilities of the PP structures provide a second level of control. The controls supporting PP structure integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The PP structures are qualified to withstand a Wildland Fire (constructed of non-combustible material). The PP structures are assumed to maintain their structural integrity during a Wildland Fire event and not collapse and will provide mitigation through secondary confinement. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a PP and Pump Tank Explosion.

Transfer Facility Aerosolization

The first level of control is the Event Response Program (operator response) following the Wildland Fire initiated event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and pump tank agitators prior to the Wildland Fire reaching the transfer system. These actions will eliminate the initiator for the Transfer Facility Aerosolization event. The second level of control is the Emergency Response Program, which will govern personnel evacuation following the Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure. No Offsite or Onsite consequences are attributed to a Transfer Facility Aerosolization.

Pump Tank Overheating

The Wildland Fire event for the steam-heated pump tank scenario is not a credible event. Since only the transfer jet suction nozzle is located within the pump tank and the steam supply piping and remainder of the jet assembly is outside the pump tank (no impingement on the waste will happen should a leak occur) and transfer line pluggage/valve position change cannot occur due to a Wildland Fire event, this progression is not credible.

3.4.2.19.1.9 299-H and Miscellaneous Releases

The HA assumes that the Wildland Fire could cause other miscellaneous releases. These events were judged by the initial CSTF HA (Ref. 1) to have negligible Offsite consequences by themselves, but they are included here due to the cumulative nature of the Wildland Fire event. These include fire propagating to the 299-H Facility, to a transport truck, and to a containment hut. A margin will be added to the Wildland Fire consequences to account for these and other miscellaneous releases that may be caused by the fire.

It is assumed that the Wildland Fire could reach waste boxes before action could be taken to move or protect them. Therefore, Wildland Fire consequences will be attributed to waste boxes. The cumulative waste box consequence is assumed to be bounded by the waste box consequence associated with a Seismic event (Section 3.4.2.18).

It is assumed that the Wildland Fire could cause a release from HEPA filters, either from a HEPA filter fire or by clogging the HEPA filter with soot, causing a filter blowout. These events were judged by the initial CSTF HA (Ref. 1) to have negligible Offsite consequences by themselves, but they are included here due to the cumulative nature of the Wildland Fire event. The cumulative HEPA filter consequence is assumed to be bounded by the HEPA Filter Release consequence associated with a Seismic event (Section 3.4.2.18).

3.4.2.19.2 FREQUENCY DETERMINATION

The HA classifies Wildland Fire events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.19.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and dose calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Since the Wildland Fire event involves multiple process areas (as discussed previously), the cumulative ST involves many mechanisms discussed in other DBAs. The STs of prime concern (Waste Tank Overheating and waste box release) are discussed in Sections 3.4.2.13 and 3.4.2.18, and will not be discussed here.

3.4.2.19.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the Wildland Fire event are given in Table 3.4-7 (the reported unmitigated consequences are assumed to exceed the Offsite and Onsite EGs, since unmitigated consequences were not calculated).

The mitigated Offsite (≤ 0.1 rem) and Onsite (≤ 15.5 rem) consequences do not challenge the Offsite or exceed the Onsite EGs. The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs based on the time available to respond to the event and due to the controls in place.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.19.5.

The individual consequence contributor breakdown is as follows:

	Consequences (rem)	
Source	Onsite	Offsite
Drop Tank Overheating	≤ 7.6	≤ 0.02
HEPA Filter Release	≤ 0.12	≤ 0.01
Waste Boxes	≤ 6.75	≤ 0.06
Miscellaneous Releases (e.g., 299-H, Containment Hut, Transportation Vehicle)	≤ 1.0	≤ 0.01

3.4.2.19.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Wildland Fire event do not challenge the Offsite or exceed the Onsite EGs and also to further reduce the associated risk (as discussed earlier in the mitigated accident progression) or establish the initial conditions at the time of the Wildland Fire event (e.g., HLLCPs, Flammability Control Program, Event Response Program).

3.4.2.19.5.1 Safety Class Controls

299-H Inventory Control Program: The 299-H Inventory Control Program shall address the controls required to maintain the 299-H inventory within HC 3 limits.

Event Response Program: Procedures shall be established governing required actions following a Wildland Fire event. These procedures shall require the following operator actions:

1) Secure liquid transfers (excluding evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs).

2) Shut down evaporators (secure steam to tube bundles and lances) and secure evaporator feed pumps.

3) Secure pump tank agitators and waste tank mixing devices.

4) Secure transfer pumps associated with waste tank recirculation.

5) Restore primary purge ventilation or install/operate portable ventilation systems on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.

6) Restore annulus ventilation or install/operate portable ventilation systems on waste tank annuli on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.

7) If conditions do not permit restoration of primary purge ventilation or annulus ventilation (or installation/operation of portable ventilation) on Type I/II Acidic Chemical Cleaning Waste Tanks, neutralize the waste tank contents to the maximum extent practical (e.g., add inhibitor).

The portable ventilation systems, discussed above, are not required to be functionally classified as SC equipment. Additional information regarding waste tank and waste tank annulus portable ventilation system requirements can be found in Section 5.5.2.13.

Flammability Control Program: The Flammability Control Program provides the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

1) Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification. For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tanks shall be classified as Chemical Cleaning Tanks and the time to LFL (three days) is not calculated.

2) Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50, Very Slow Generation Tanks, and Type I/II Acidic Chemical Cleaning Waste Tanks). The hydrogen concentration LFL limit shall account for potential organics.

3) Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the tank vapor space to reach the LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks).

4) Determine, track, and ensure that only 14 waste tanks can reach LFL in less than seven days including:

   - Effects of post-seismic trapped gas release, assuming no ventilation

- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered "one" waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks to have the potential to become flammable in less than seven days. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCP maximum levels shall be less than or equal to 63.8 inches (Type I) and 64.8 inches (Type II). The HLLCPs are not credited with functioning during or following the Wildland Fire event, but protect assumed initial conditions at the time of the Wildland Fire event. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Waste Tank Chemical Cleaning Program: The Waste Tank Chemical Cleaning Program shall require the following during operations associated with Chemical Cleaning Transfers (or related vent/drain operations) to protect initial conditions for corrosion induced hydrogen generation rate assumptions:

- Chemical Cleaning Transfers (or related vent/drain operations) are only permitted through FDB-2, FDB-3, FDB-4, HDB-2, HDB-7, VB-2, VB-4, VB-5, VB LDB-17, Tank 51 VB, Tank 51 Drain VB, FPP-1, FPP-2, and HPP-3. Chemical Cleaning Transfers (or related vent/drain operations) are also permitted in transfer paths that may leak from primary containment to VB-1, VB-3, H-Area Catch Tank, and LDB Drain Cell.
- Prior to initiation of a Chemical Cleaning Transfer (or related vent/drain operations), isolation (i.e., single leak-tested valve, double valve isolation, blank) shall be established to preclude acidic material from entering pump tanks, waste tanks, or transfer facilities outside of the intended transfer path.
- During Chemical Cleaning Transfers, acidic waste material from the vent and drain shall only be permitted to FPT-1, HPT-3, and the waste tanks associated with the vent/drain path.

- Prior to initiation of a vent and drain operation associated with a Chemical Cleaning Transfer, sufficient inhibitors shall be present in the applicable pump tank (FPT-1, HPT-3) to ensure neutralization of the acidic waste.
- Acidic material that leaks to a transfer facility (associated with Chemical Cleaning Transfers or related vent/drain operations) shall be neutralized. The acidic material shall be neutralized prior to the time corrosion induced hydrogen generation from OA would contribute to total flammable vapor concentration. The acidic material shall also be neutralized prior to transferring the contents of the applicable transfer facility.
- Chemical Cleaning Transfers shall contain less than or equal to 4 wt. % OA.
- Prior to transfer initiation of a Chemical Cleaning Transfer (or related vent/drain operations), verification shall be performed to ensure that sufficient inhibitors are present in the applicable receipt waste tank to ensure neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers (or related vent/drain operations), at least one waste tank mixing device shall be operating in the applicable receipt waste tank to ensure adequate mixing and neutralization of the acidic waste.
- During receipt of Chemical Cleaning Transfers, acidic waste shall enter the receipt tank via a flowpath that is below the waste tank liquid level.

Waste Tank Temperature Monitoring: Temperature monitoring shall be performed to verify the average bulk waste temperature is less than or equal to 60°C prior to transfers from Type I/II Acidic Chemical Cleaning Waste Tanks to protect initial conditions for corrosion induced hydrogen generation rate assumptions.

3.4.2.19.5.2 Safety Significant Controls

242-16H/242-25H Evaporator Cells: The evaporator cell structure is qualified to withstand a Wildland Fire (constructed of non-combustible material) and provides airborne waste confinement following an explosion in the evaporator or evaporator cell.

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Wildland Fire initiated event and response to the event to minimize the potential release/personnel exposure.

Pump Pit: The PP structures are qualified to withstand a Wildland Fire (constructed of non-combustible material) and provide airborne waste confinement following an explosion in a PP or pump tank.

Pump Tank Passive Vents: The Pump Tank Passive Vents provide a flowpath between the pump tank vapor space and PP vapor space to extend the time to reach LFL in the pump tank. (not applicable to HPT-7, HPT-8, HPT-9, and HPT-10.)

Transfer Facility Structures (DBs, HPFP, VBs): The Transfer Facility structures are qualified to withstand a Wildland Fire (constructed of non-combustible material) and provide airborne waste confinement following an explosion event.

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank structure is qualified to withstand a Wildland Fire (constructed of non-combustible material, below grade location) and provides airborne waste confinement following an explosion in the waste tank.

Waste Tank Annulus: The Type I and Type II Waste Tank Annulus structure provides airborne waste confinement following an explosion in the waste tank annulus and provides liquid waste containment to support conductivity probe functionality (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Conductivity Probes: The Type I and Type II Waste Tank Annulus Conductivity Probes provide control room alarm following a waste tank annulus high level condition to protect assumed initial tank annulus conditions. The Type I and Type II Waste Tank Annulus Conductivity Probes are not credited with functioning during or following the Wildland Fire event, but protect assumed initial conditions at the time of the Wildland Fire event (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

3.4.2.20 Loss of Offsite Power

3.4.2.20.1 SCENARIO DEVELOPMENT

3.4.2.20.1.1 Background

A Loss of Offsite Power has the potential to affect multiple process areas and can affect a wide array of equipment. The purpose of this AA is to identify locations of hazardous materials or safety-related SSCs that are considered susceptible to a Loss of Offsite Power. As used in this accident, Loss of Offsite Power is defined as the complete loss of alternating current electric power from sources external to the CSTF for up to 12 hours. The longest time power has been lost to SRS is less than 12 hours (Ref. 176).

For further detail on the CSTF electrical system design, refer to Chapter 2.

3.4.2.20.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Loss of Offsite Power that have non-negligible risk. Reference 1 did not identify any events uniquely associated with a Loss of Offsite Power. A review of the other DBAs has identified three accidents with controls that are vulnerable to Loss of Offsite Power: Waste Tank Explosion, Waste Tank Annulus Explosion (for Type I/II Acidic Chemical Cleaning Waste Tanks), and Pump Tank Explosion. Two other accidents, Tank Overheating and 299-H WCT Explosion are unaffected because of the limited event duration. The waste tank heat sources would not be increased by the 12-hour loss of power, and no credited mitigation would be affected. The accident of concern in 299-H is a WCT Explosion (analyzed in Section 3.4.2.16). Unloading vehicles are only in the 299-H

truckwell for a short duration, making it unlikely that a loss of power would occur simultaneously and cause a diesel fuel spill that drains to the WCT and ignites (diesel fuel will not flash at temperatures below 125°F [52°C]).

3.4.2.20.1.3 Unmitigated Accident Progression

Loss of Offsite Power is assumed to affect both HTF and FTF. The effect of Loss of Offsite Power at the CSTF has been assessed by general location/process area. Using the other DBAs as guidance, each area was evaluated to determine which progressions would be vulnerable to Loss of Offsite Power.

As noted earlier, the three accidents of concern are Waste Tank Explosion, Waste Tank Annulus Explosion (for Type I/II Acidic Chemical Cleaning Waste Tanks), and Pump Tank Explosion. Since the unmitigated consequences of these accidents exceed the EGs, Loss of Offsite Power is assumed to exceed the EGs; therefore, mitigated analysis is required.

3.4.2.20.1.4 Mitigated Accident Progression

The Waste Tank Explosion, Waste Tank Annulus Explosion (for Type I/II Acidic Chemical Cleaning Waste Tanks), and Pump Tank Explosion accident progressions could be affected by a Loss of Offsite Power. The compensatory controls required to address Loss of Offsite Power vulnerability and prevent these accidents are discussed in the following.

Waste Tank Explosion (except Type I/II Acidic Chemical Cleaning Waste Tanks)

A Loss of Offsite Power is not an initiator for a Waste Tank Explosion in Closure Waste Tanks. The related initial conditions established in Section 3.4.1.5.2 for these tanks prevent a Waste Tank Explosion, and the controls discussed below do not apply to Closure Waste Tanks.

For Waste Tank Explosion, Loss of Offsite Power is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). The Flammability Control Program is the first level of control and ensures that the time to reach 100% of the LFL (CLFL for Tank 50) following Loss of Offsite Power event is at least seven days in every waste tank. The seven days allows time to restore power, provide alternate power, or provide alternate ventilation that does not require normal power. Any of these three options will prevent the waste tanks from reaching 100% of the LFL (CLFL for Tank 50). Also part of the first level of control is the Event Response Program (operator response) following the Loss of Offsite Power event. Operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons), waste tank mixing devices, and transfer pumps associated with waste tank recirculation. These actions will stop sludge agitation, bulk saltcake dissolution, or saltcake interstitial liquid removal activities which will minimize additional trapped hydrogen release. The actions will also ensure additional hydrogen-generating waste (or waste containing Isopar® L) is not added to the tank, ensure minimal additional hydrogen will be released from the waste (dissolved and trapped), and limit the reduction of the available tank vapor space volume. It is assumed that the average bulk

waste temperature for Tank 50 is within limits prior to the Loss of Offsite Power event; however, these actions prevent additional heat input to the waste.

The waste tank confinement and controls supporting waste tank confinement integrity provide a second level of control. The controls supporting waste tank confinement integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Explosion with a Loss of Offsite Power initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, a Loss of Offsite Power is not assumed to cause a Waste Tank Explosion.

Waste Tank Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

For Waste Tank Explosion, Loss of Offsite Power is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank active ventilation). For Type I/II Acidic Chemical Cleaning Waste Tanks, the time to reach 100% of the LFL may be three days. The first level of control is the Event Response Program (operator response) following the Loss of Offsite Power event. Operator response will be to restore ventilation prior to the time to reach 100% of the LFL. The operator actions may include restoring power, providing alternate power, or providing alternate ventilation that does not require normal power. Any of these three options will prevent the waste tanks from reaching 100% of the LFL. Additional operator response will be to secure liquid transfers (excluding evaporator GDL flushes, in-progress pot lifts/pump-outs, and in-progress pot siphons) and waste tank mixing devices.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank confinement and controls supporting waste tank confinement integrity provide a second level of control. The controls supporting waste tank confinement integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program,

which will govern personnel evacuation following the Waste Tank Explosion with a Loss of Offsite Power initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, a Loss of Offsite Power is not assumed to cause a Waste Tank Explosion.

Waste Tank Annulus Explosion (Type I/II Acidic Chemical Cleaning Waste Tanks)

For the purposes of this analysis, it is assumed at the initiation of event the annulus contains the residual volume of Chemical Cleaning waste with OA. At this residual volume and including the effects of radiolytic production and corrosion induced hydrogen generation (accounting for atmospheric breathing) the time to 100% of the LFL is five days (see Section 3.4.2.12). For Waste Tank Annulus Explosion, Loss of Offsite Power is assumed to fail the installed equipment credited for explosion prevention during normal operation (e.g., waste tank annulus active ventilation). The first level of control is the Event Response Program (operator response) following the Loss of Offsite Power event. Operator response will be to restore ventilation prior to the time to reach 100% of the LFL. The operator actions may include restoring power, providing alternate power, or providing alternate ventilation that does not require normal power. Any of these three options will prevent the waste tank annulus from reaching 100% of the LFL.

The Flammability Control Program is also inherently included as part of the first level of control for all tanks, and is credited with determining/tracking the time to reach LFL and ensuring that only 14 waste tanks can reach LFL in less than seven days and including (based on methodology described in Section 3.4.2.11.1):

- Effects of post-seismic trapped gas release, assuming no ventilation
- Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

Additionally, as part of the first level of control, the portable ventilation systems necessary to prevent the annulus of Type I/II Acidic Chemical Cleaning Waste Tanks from becoming flammable are maintained functional and available (see Section 5.5.2.13).

The waste tank annulus confinement and controls supporting waste tank annulus confinement integrity provide a second level of control. The controls supporting waste tank annulus confinement integrity include critical lift controls, structural integrity controls, corrosion controls, traffic controls, and tank top/secondary containment loading controls. The third level of control is the Emergency Response Program, which will govern personnel evacuation following the Waste Tank Annulus Explosion with a Loss of Offsite Power initiated event and response to the event to minimize the potential release/personnel exposure. Therefore, a Loss of Offsite Power is not assumed to cause a Waste Tank Annulus Explosion.

Pump Tank Explosion

The first level of control is the Event Response Program (operator response) following the Loss of Offsite Power event. Operator response will be to secure pump tank liquid transfers and pump tank agitators. These actions will ensure additional hydrogen-generating waste is not added to the tank, ensure minimal additional hydrogen will be released from the waste, and limit the reduction of the available tank vapor space volume. Operator response shall also ensure HDB-8 PVV exhaust fan inlet damper position alignment to prevent bypass flow conditions associated with an open inlet damper on the idle exhaust fan. Pump tanks (excluding the HDB-8 Complex pump tanks) have a passive vent, which allows vapor communication between the pump tank and PP, and serves as a second level of control. The passive vent extends the time to reach 100% of the LFL, thereby allowing time to restore power, provide alternate power, or provide alternate ventilation that does not require normal power. Any of these three options will prevent the pump tanks from reaching 100% of the LFL. The HDB-8 Complex pump tanks do not have passive vents, but the HDB-8 PVV System is supplied power via a diesel generator, independent of the normal power. These controls serve as the second level of control for the HDB-8 Complex pump tanks. Additionally, other diesel generators (non-credited) are available to provide power to purge systems for HTF process areas with flammable vapor concerns (e.g., waste tanks, pump tanks). The HDB-8 Complex PPs/pump tanks support ventilation system operation. The mitigative capabilities of the PP structures and controls supporting confinement integrity provide a third level of control for the pump tanks. The controls supporting confinement integrity include critical lift controls, structural integrity controls, traffic controls, and tank top/secondary containment loading controls. Based on the above, a Loss of Offsite Power is not assumed to cause a Pump Tank Explosion.

3.4.2.20.2 FREQUENCY DETERMINATION

Excluding Type I/II Acidic Chemical Cleaning Waste Tanks, Loss of Offsite Power was analyzed as a DBA independent of the HA process; however, a Loss of Offsite Power event is assumed to be in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.20.3 SOURCE TERM ANALYSIS

The Loss of Offsite Power accident affects the Waste Tank Explosion, Waste Tank Annulus Explosion (for Type I/II Acidic Chemical Cleaning Waste Tanks), and Pump Tank Explosion accident progressions. No unique accident STs result from the Loss of Offsite Power. The STs of concern (Pump Tank Explosion, Waste Tank Explosion, and Waste Tank Annulus Explosion) are discussed in Sections 3.4.2.8, 3.4.2.11, and 3.4.2.12, and will not be discussed here.

3.4.2.20.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of a Loss of Offsite Power event are given in Table 3.4-7 (the reported unmitigated consequences are assumed to exceed the EGs, since unmitigated consequences were not calculated).

The mitigated Offsite (0.0 rem) consequences do not challenge the EGs, since release of hazardous material is prevented. Based on the controls described in Section 3.4.2.20.5, a Loss of Offsite Power is not assumed to cause Offsite consequences due to a Waste Tank Explosion, Waste Tank Annulus Explosion, and Pump Tank Explosion.

The mitigated Onsite (0.0 rem) consequences do not exceed the EGs, since release of hazardous material is prevented. Based on the controls described in Section 3.4.2.20.5, a Loss of Offsite Power is not assumed to cause Onsite consequences due to a Waste Tank Explosion, Waste Tank Annulus Explosion, and Pump Tank Explosion. The consequences to the immediate vicinity worker are also zero because the event is prevented.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.20.5.

3.4.2.20.5 SUMMARY OF CONTROLS

In addition to the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2, the following controls are required to ensure that the consequences of a Loss of Offsite Power event do not challenge the Offsite or exceed the Onsite EGs. The following controls are not required for Closure Waste Tanks.

3.4.2.20.5.1 Safety Class Controls

Event Response Program: Procedures shall be established governing required actions following a Loss of Offsite Power event. These procedures shall require the following operator actions:

1) Secure liquid transfers (excluding evaporator GDL flushes and in-progress pot siphons/lifts/pump-outs).

2) Secure pump tank agitators and waste tank mixing devices.

3) Secure transfer pumps associated with waste tank recirculation.

4) Ensure HDB-8 PVV System exhaust fan inlet damper position alignment to prevent bypass flow conditions associated with an open inlet damper on the idle exhaust fan in response to a loss of air or power.

5) Restore primary purge ventilation or install/operate portable ventilation systems on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.

6) Restore annulus ventilation or install/operate portable ventilation systems on waste tank annuli on Type I/II Acidic Chemical Cleaning Waste Tanks, prioritized on a time to LFL basis.

The portable ventilation systems, discussed above, are not required to be functionally classified as SC equipment. Additional information regarding waste tank and waste tank annulus portable ventilation system requirements can be found in Section 5.5.2.13.

Flammability Control Program: The Flammability Control Program provides the following functions to protect the assumed times to LFL (CLFL for Tank 50) in individual waste tanks. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

1) Determine and track the time to LFL (CLFL for Tank 50) in each waste tank to determine the individual waste tank flammability classification. For Type I/II Acidic Chemical Cleaning Waste Tanks, the waste tanks shall be classified as Chemical Cleaning Tanks and the time to LFL (three days) is not calculated.

2) Determine the hydrogen concentration safety analysis value for individual waste tanks and, based on this value, determine and track the hydrogen concentration LFL limit (excluding Tank 50, Very Slow Generation Tanks, and Type I/II Acidic Chemical Cleaning Waste Tanks). The hydrogen concentration LFL limit shall account for potential organics.

3) Ensure that it takes a minimum of seven days following loss of waste tank forced ventilation (based on the methodology for waste tank flammability classification) for the tank vapor space to reach the LFL (CLFL for Tank 50) (excluding Type I/II Acidic Chemical Cleaning Waste Tanks).

4) Determine, track, and ensure that only 14 waste tanks can reach LFL in less than seven days including:

   - Effects of post-seismic trapped gas release, assuming no ventilation

   - Number of Type I/II Acidic Chemical Cleaning Waste Tanks. Although the primary and annulus each have less than seven days to LFL for an individual Type I/II Acidic Chemical Cleaning Waste Tank, this is only considered “one” waste tank for the purposes of counting/tracking the number of waste tanks that can reach LFL in less than seven days.

   Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a waste tank leak causes additional waste tanks to have the potential to become flammable in less than seven days. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), the path forward is not required to be provided to DOE prior to initiating the transfer.

High Liquid Level Conductivity Probes: The waste tank HLLCPs provide control room alarm following a waste tank high level condition to protect assumed initial tank conditions. For Type I/II Acidic Chemical Cleaning Waste Tanks, the Waste Tank HLLCP maximum levels shall be less than or equal to 63.8 inches (Type I) and 64.8 inches (Type II). The HLLCPs are not credited with functioning during or following the Loss of Offsite Power event, but protect assumed initial conditions at the time of the Loss of Offsite Power event. (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

Tank Fill Limits Program: The Tank Fill Limits Program provides controls to protect assumed initial tank conditions (excluding Type I/II Acidic Chemical Cleaning Waste Tanks). (For Type IV Waste Tanks and Tank 50, this control is required to be SS only)

3.4.2.20.5.2 Safety Significant Controls

Emergency Response Program: A facility specific annex to the Site Emergency Plan (SCD-7) shall be established to govern personnel evacuation following a Waste Tank Explosion/Waste Tank Annulus Explosion with a Loss of Offsite Power initiated event and response to the event to minimize the potential release/personnel exposure.

HDB-8 Diesel Generator: The HDB-8 Diesel Generator supplies power to the PP/pump tank active ventilation system upon loss of normal power.

HDB-8 PVV System: The HDB-8 PVV System shall provide a minimum flow through the HDB-8 Complex pump tanks to prevent accumulation of a flammable mixture of hydrogen.

Pump Pit: The PP structure provides airborne waste confinement following an explosion in the pump tank. The HDB-8 Complex PPs also support ventilation system operation.

Pump Tank: The HDB-8 Complex pump tanks support ventilation system operation.

Pump Tank Passive Vents: The Pump Tank Passive Vents provide a flowpath between the pump tank vapor space and PP vapor space to extend the time to reach LFL in the pump tank. (not applicable to HPT-7, HPT-8, HPT-9, and HPT-10.)

Waste Tank: The Type I, Type II, Type III, Type IIIA, and Type IV Waste Tank structure provides airborne waste confinement following an explosion in the waste tank.

Waste Tank Annulus: The Type I and Type II Waste Tank Annulus structure provides airborne waste confinement following an explosion in the waste tank annulus and provides liquid waste containment to support conductivity probe functionality (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

Waste Tank Annulus Conductivity Probes: The Type I and Type II Waste Tank Annulus Conductivity Probes provide control room alarm following a waste tank annulus high level condition to protect assumed initial tank annulus conditions. The Type I and Type II Waste Tank Annulus Conductivity Probes are not credited with functioning during or following the

Loss of Offsite Power event, but protect assumed initial conditions at the time of the Loss of Offsite Power event (applicable to Type I/II Acidic Chemical Cleaning Waste Tanks).

3.4.2.21 Chemical Release

3.4.2.21.1 SCENARIO DEVELOPMENT

3.4.2.21.1.1 Background

A number of chemicals are stored and used in the CSTF, including mercury, OA, caustic (sodium hydroxide), uranyl carbonate, uranyl nitrate, and nitric acid. Release of various chemicals is addressed in the HA.

3.4.2.21.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with a Chemical Release that have non-negligible risk. One event concerned release of mercury vapor from the 242-25H Evaporator (the largest of the three evaporators) and required further analysis. All other events have either a negligible risk, have FW related controls stated in Tables 3.3-13, 3.3-14, and 3.3-15, or are considered SIH.

During operation of the evaporators, mercury accumulates in the Evaporator Overheads Receiver Systems and has the potential for chemical release during certain events. However, controls (Mercury Management Program and Evaporator Mercury Monitoring) are in place to limit the quantity of mercury in the Evaporator MRTs and the associated collection systems. Limiting the mercury inventory to less than 1.3 liters ensures that mercury quantity meets the "Quantity Exclusion" screening criteria of Reference 211 (Ref. 290). Based on these controls, events associated with mercury release will not exceed the EGs. No controls other than those protecting the assumed initial conditions are required.

3.4.2.21.1.3 Unmitigated Accident Progression

- Evaporator overheads condenser temperature increases due to cooling water loss, personnel error, equipment failure, etc.
- The overheads system is breached releasing mercury vapors to the evaporator or overheads receiver cell
- No credit taken for filtration/deposition
- Mercury vapors are released to the environment

3.4.2.21.1.4 Mitigated Accident Progression

The unmitigated consequences of the analyzed mercury vapor release do not exceed either the Offsite or Onsite EGs (in Section 3.4.2.21.4). Because the unmitigated accident scenarios do not exceed the EGs, no mitigated analysis is required.

3.4.2.21.2 FREQUENCY DETERMINATION

The HA classifies the Chemical Release event (release of mercury vapor from the evaporator) in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.21.3 SOURCE TERM ANALYSIS

Offsite and Onsite ST and consequence calculations are based on reasonably conservative values. Background information regarding the methodologies used to calculate STs is given in Section 3.4.1.1. Specific use of these methodologies for this accident is discussed in detail below.

3.4.2.21.3.1 Source Term Inputs and Assumptions

In addition to the general inputs and assumptions stated in Section 3.4.1.5, the following inputs and assumptions were used in determining the chemical release STs and are all taken from Reference 85, unless otherwise stated:

- 242-25H Evaporator mercury concentration is ≤ 340 mg/L (ST calculation assumes all liquid is converted to vapor)

3.4.2.21.3.2 Source Term Derivation

The unmitigated STs are derived using the standard ST equation (ST = MAR x DR x ARF x RF x LPF) described in Section 3.4.1.1.1. The derivation of the values for each of the terms in the five-factor ST formula is detailed in the following (Ref. 85).

Material at Risk

The MAR is assumed to be elemental and inorganic mercury. The mercury (Hg) is released from the evaporator due to loss of overheads condenser cooling, equipment malfunction, personnel error, or system failure. From the ST inputs, 35 gpm of overheads with a Hg concentration of 340 mg/L are bounding values for production. Therefore, the amount of Hg coming out in the overheads per minute is:

(35 gpm) x (340 mg/L) x (1 g/1,000 mg) x (3.78 L/gal) = 45 g/min Hg

For comparison to ERPG values (which are based on a fifteen minute exposure), the mercury exposure is calculated over a 15-minute period:

(45 g/min) x (15 min) = 675 g Hg released into the atmosphere

Damage Ratio

The DR is assumed to be one.

Airborne Release Fraction

The ARF is set equal to 1.0 for the released mercury vapor.

Respirable Fraction

The RF for chemical vapor is considered to be one.

Leak Path Factor

The LPF is assumed to be one for the released mercury vapor.

Dispersion Factor (χ/Q)

The dispersion factor (χ/Q) also called the relative concentration is the dilution determined from relative site meteorology and distance to receptors. The dispersion factor is defined as:

$$(\chi / Q) = \frac{C_x}{ST / \Delta T}$$

Where:

C_x = concentration of the chemical at distance X in mg/m^3

ST = source term in mg

ΔT = time of release in seconds

The values used in this analysis are for a light (buoyant) gas. While mercury itself is a heavy metal, the mercury vapor concentration is so low that evaporator gas releases on loss of cooling will be thermally expanded and act like a light or buoyant gas (Ref. 85).

3.4.2.21.3.3 Source Term Calculation

The ST was calculated using the five-factor ST formula and the values discussed above. Using Reference 28 and the dispersion factor (χ/Q) equation discussed previously, the mercury concentration was calculated for a 15-minute exposure duration to compare against ERPG values (Ref. 85).

3.4.2.21.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of the bounding Chemical Release event are given in Table 3.4-7 (Ref. 85).

The unmitigated and mitigated Offsite consequences (0.0012 mg/m^3) do not exceed the 2.0 mg/m^3 Offsite EGs (ERPG-2) for mercury (elemental, inorganic).

The unmitigated and mitigated Onsite consequences (0.404 mg/m^3) do not exceed the 4.0 mg/m^3 Onsite EGs (ERPG-3) for mercury (elemental, inorganic). The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs due to the presence of the evaporator cell and the Industrial Hygiene Program.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.21.5. Since the mercury release is the only chemical release DBA, chemical release consequences are not addressed cumulatively with other NPH events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.21.5 SUMMARY OF CONTROLS

Since the unmitigated Chemical Release event consequences do not exceed the Offsite or Onsite EGs (as discussed in Section 3.4.2.21.4), no controls are required beyond the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2. Additionally, the analysis assumes a maximum amount of mercury within the MRTs and associated collection systems. The controls required to protect the initial assumptions are described below.

3.4.2.21.5.1 Safety Significant Controls

242-16H/242-25H Evaporator Mercury Monitoring: The Evaporator Mercury Monitoring provides local indication of mercury quantity to verify mercury inventory initial conditions are protected. Periodic mercury monitoring shall be performed to verify the mercury inventory is less than 1.3 liters in the MRT and associated collection system.

Mercury Management Program: The Mercury Management Program shall ensure contaminated mercury is not stored in the 242-16H and 242-25H Evaporator Mercury Collection Stations when not collecting mercury. This program limits the quantity of mercury available for release from the MRT and associated collection system.

3.4.2.22 Transportation Accident

3.4.2.22.1 SCENARIO DEVELOPMENT

3.4.2.22.1.1 Background

Various containers (e.g., shipping casks, B-25s) are used in the CSTF to store and transport contaminated material/equipment. The containers typically contain contamination generated during normal operations, material/equipment contaminated during maintenance/repair activities, multiple spent HEPA filters, as well as waste samples taken from tanks, evaporators, etc. for corrosion control, waste characterization, etc. This accident addresses transportation events that could cause release of the storage container contents.

3.4.2.22.1.2 Accident Initiators

Table 3.3-17 identifies the HA events associated with Transportation Accidents that have non-negligible risk.

3.4.2.22.1.3 Unmitigated Accident Progression

- A transport vehicle with a storage container crashes (the size of the CSTF containers and equipment involved is assumed to limit the MAR involved during Transportation Accidents to ≤ 100 liters)
- The storage container opens
- The storage container cask contents catch on fire
- The storage container contents are released

3.4.2.22.1.4 Mitigated Accident Progression

The unmitigated consequences of the Transportation Accident do not challenge either the Offsite or exceed the Onsite EGs (as documented in Section 3.4.2.22.4). Since the unmitigated accident scenarios do not challenge the Offsite or exceed the Onsite EGs, no mitigated analysis is required.

3.4.2.22.2 FREQUENCY DETERMINATION

The HA classifies Transportation Accident events in the anticipated frequency bin. No detailed frequency analyses were performed to lower the assumed frequency.

3.4.2.22.3 SOURCE TERM ANALYSIS

No unique ST analysis was performed for this accident. A Transuranic (TRU) transport analysis (Ref. 84) showed that a Transportation Accident of an identical nature to the Transportation Accident DBA would have consequences below the Offsite and Onsite EGs. A Transportation Accident, applying DOE-EM Interim Guidance methodology (Ref. 255) involving 101 liters of MAR (in a feed pump cask) would have a consequence of ≤ 50 rem at 100 meters and ≤ 0.06 rem Offsite.

The TRU transport analysis inputs and method vary slightly from those used throughout this DSA. For example, the TRU transport analysis used a different radionuclide distribution and ICRP Inhalation CED DCFs than those used in this DSA (discussed in Section 3.4.1.5.1), with the TRU transport analysis being more conservative in both instances. The TRU transport analysis Onsite and Offsite dose calculations are based on best-estimate and bounding values (versus reasonably conservative values).

Even allowing for the slightly different calculation inputs and methods, Transportation Accidents can be assumed to not challenge the Offsite or exceed the Onsite EGs based on the previous TRU transport analysis and the reasonably conservative CSTF storage container waste volumes.

3.4.2.22.4 CONSEQUENCE ANALYSIS

The unmitigated and mitigated consequences of a Transportation Accident event, applying DOE-EM Interim Guidance methodology are given in Table 3.4-7 (Ref. 84, 255).

The unmitigated and mitigated Offsite (≤ 0.1 rem) and Onsite (≤ 50 rem) consequences for the bounding scenario (feed pump cask in a transport accident) do not challenge the Offsite or exceed the Onsite EGs. These documented unmitigated consequence values are not based on a unique ST analysis performed for this DSA, but are instead assumed bound by a previous TRU transport analysis (Ref. 84). The immediate vicinity worker risk is also judged not to exceed the applicable Onsite EGs.

The controls credited in preventing the event or in reducing the consequences are described in Section 3.4.2.22.5. The consequences of a Transportation Accident event following an NPH event are addressed cumulatively with other events in the NPH accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19).

3.4.2.22.5 SUMMARY OF CONTROLS

Since the unmitigated consequences do not challenge the Offsite or exceed the Onsite EGs (as discussed in Section 3.4.2.22.4), no controls are required beyond the general controls stated in Section 3.4.1.5.6 and the prohibited operations stated in Section 3.4.1.5.2.

3.4.3 BEYOND DESIGN BASIS ACCIDENTS

BDBAs are accidents of the same type as a DBA (e.g., spill, explosion, earthquake), but defined by parameters that exceed in severity the parameters defined for the DBA. This category also includes those accidents whose consequences were not evaluated because the likelihood of occurrence for the event was categorized as BEU (frequency of occurrence less than 1.0E-06/yr) for external and NPH events, and not credible for internal events.

DOE-STD-3009-94 (Ref. 4) requires the evaluation of accidents beyond the design basis to provide a perspective of the residual risk associated with the operation of a facility. Such BDBAs are not required to provide assurance of public health and safety. An additional enhanced evaluation is required to be performed on accidents that exceed evaluation guidelines (Ref. 299). The enhanced evaluation has been performed and found that Section 3.4.3 meets the requirements outlined in Enclosure 2 of Reference 299. The BDBAs analyzed consist of operational-related events (i.e., Large Liquid Waste Release) and natural phenomena events (e.g., seismic). The consequences of the Large Liquid Waste Release (Section 3.4.3.1) and Secondary Containment Explosion (Section 3.4.3.2) BDBAs were compared against the EGs to demonstrate the sensitivity of the related DBAs to changes in the unmitigated DBA progressions.

For consequences stated in the following subsections, accident analysis may not have been performed for the BDBA scenario-specific parameters (e.g., 100,000-gallon spill for Large Liquid Release scenario). Consequences may be approximated by applying the ratio of the difference in the specific parameter (e.g., 100,000/15,000 gallons for waste volume release) and multiplying the calculated consequence (e.g., 15,000-gallon spill consequence) by this ratio. Consequences may also be approximated by using the ST model for the applicable scenario, and adjusting parameters as appropriate.

3.4.3.1 Large Liquid Waste Release

A Large Liquid Waste Release (i.e., greater than 15,000 gallons spilled material) is not a credible event for the CSTF waste streams (except for the slow Evaporator System leak inside the evaporator cell [see Sections 3.4.1.5.2 and 3.4.2.3], a slow leak due to SMP Riser Overflow/SMP Column Spill scenarios [see Section 3.4.2.9], or Tank 50 to the Saltstone Facility transfer error events [see Section 3.4.2.9]). These events are included as a BDBA to (1) ensure that no new SC controls are warranted, and (2) ensure the selected SS controls are adequate to mitigate a large spill from a Transfer Error assuming the selected SC controls function.

One of the BDBA large liquid release scenario is assumed to result in 100,000 gallons of Bounding Sludge Slurry being released from primary containment to above-ground in eight hours. This is a result from a breach of a transfer line. The sludge slurry quantity is limited to 100,000 gallons of Bounding Sludge Slurry because this volume is greater than the equivalent volume of Bounding Sludge Slurry in any single waste tank in the Tank Farms (Ref. 88). The inhalation dose potential of this assumed quantity of sludge slurry is sufficiently bounding such that no additional supernate need be considered. Using the methodology stated in Section 3.4.3 and the consequences from Section 3.4.2.9, the approximate consequences for this scenario would be ≤ 3.0 rem (Offsite) and > 100 rem (Onsite). This release is considered to be not credible. Section 3.4.3.2 addresses the impact of releasing this large liquid release on potential secondary containment explosions.

The other BDBA large liquid release scenario is associated with the SMP. Waste has the potential to be released from primary containment and overflow the SMP riser or spill from the column. Using the methodology stated in Section 3.4.3 and the consequences from Section 3.4.2.9, the approximate consequences for each of these scenarios would be ≤ 3.0 rem (Offsite) and > 100 rem (Onsite). These releases are considered to be not credible.

These BDBAs bound the credible scenarios discussed in Section 3.4.2.9. The difference between the large liquid waste release and the assumed Transfer Error event is the amount of material released to the environment. The consequences from these spill sizes do not challenge the Offsite EGs, but exceed the Onsite EGs (this is the same result as for the 15,000 gallon spill size evaluated in Section 3.4.2.9). Thus, no new SC controls are warranted.

Assuming the SC core pipe performs its function of liquid waste containment, the Transfer Error events that could result in a release outside of primary containment would be the overflow of a pump tank into the PP and the SMP Waste Releases. The analysis in Section 3.4.2.9 also assumes 15,000 gallons spill for the pump tank overflow scenario. The PP leak detection probes

are SS and are required any time waste is being transferred to/through the PPs. These probes are positioned to detect leakage well before 15,000 gallons is spilled. Thus, no new SS controls are necessary for the overflow of a pump tank into the PP. The SMP Waste Release events that could result in a release outside of primary containment would be the SMP column spill and the SMP riser overflow. The SMP SS controls credited in Section 3.4.2.9 are ARMs, SMP riser (waste confinement), equipment needed to stop SMP operation, SMP flush/motor pressure boundary, controls on SMP operation for external water source connection, and conductivity probes.

Thus, as shown above, the identified SC and SS controls identified in Section 3.4.2 are adequate to address large liquid releases. In addition to the controls credited in the analysis for the Transfer Error events, the Contingency Plan for Large Radioactive Spills from SRS Tank Farms provides additional mitigation (Ref. 201).

This BDBA also bounds the credible scenarios discussed in Section 3.4.2.3. The differences between the large liquid waste release and the assumed leak/spill in the evaporator cell is the amount of material released to the environment and the type of material at risk. Using the methodology stated in Section 3.4.3 and the consequences from Section 3.4.2.3, the approximate consequences from a 100,000 gallon sludge slurry spill (which bounds a 1.3 million gallon Bounding Supernate spill) in the Evaporator Cell would not challenge the Offsite EGs. Thus, no new SC controls are warranted.

The other liquid release event associated with 15,000 gallons of maximum missing waste is the Diaphragm Pump Aerosolization event in Section 3.4.2.10. However, using 15,000 gallons in this scenario resulted in an Offsite consequence of ≤ 0.1 rem. Thus, even if this pump were used to transfer 100,000 gallons, the resulting Offsite consequences would be ≤ 0.5 rem, well below the Offsite EG. Thus, no SC controls are warranted.

3.4.3.1.1 STORMWATER SYSTEM

A site action plan was developed for the prevention and control of radioactive liquid releases (Ref. 44). The plan includes stormwater runoff control. The stormwater system is diverted to the retention basins for processing at the ETP.

3.4.3.1.2 SPILL PREVENTION AND CONTINGENCY PLAN

The Contingency Plan for Large Radioactive Spills from SRS Tank Farms shows all potential liquid run-off pathways leading to the waters of South Carolina and Georgia (Ref. 201). The plan identifies impoundment areas where dams can readily be formed. The Contingency Plan minimizes the amount of waste released Offsite by event response to a liquid waste spill.

3.4.3.2 Secondary Containment Explosion

Sections 3.4.2.2, 3.4.2.6, 3.4.2.7, 3.4.2.8, and 3.4.2.12 address explosions within secondary containment locations which use a maximum missing waste (sludge slurry) input of

15,000 gallons. As discussed in Section 3.4.3.1, spilling greater than 15,000 gallons is considered to be not credible. However, to ensure no new SC controls would result if greater than 15,000 gallons were spilled in these scenarios, this BDBA is evaluated. Additionally, this BDBA assesses whether the existing SS controls are adequate assuming the SC controls function, even if greater than 15,000 gallons were spilled.

Section 3.4.2.2 addresses explosions within evaporator cells, using a maximum missing waste (Bounding Supernate) input of 15,000 gallons for leaks from an evaporator cell transfer jumper (242-16H only) and leak sizes up to 36,803 gallons for leaks from the Evaporator System. Section 3.4.2.2 concludes that the worst case Evaporator Cell Explosion does not challenge the Offsite EG. Using the same model as in Section 3.4.2.2, the approximate worst case consequence (based on the bounding consequence from Reference 188 for a cell 2/3 the size of the 242-25H Evaporator Cell), is ≤ 5.0 rem Offsite. Even if this explosion leads to a subsequent spill of 100,000 gallons of sludge slurry (which bounds a 1.3 million gallon Bounding Supernate spill, as discussed in Section 3.4.3.1), the combined consequence would be ≤ 8 rem. Thus, this scenario does not dictate the need for SC controls.

Section 3.4.2.6 concludes that, limiting the leak volume to 15,000 gallons, the worst case jacket/encasement explosion is ≤ 10 rem. Even if the resulting jacket/encasement explosion occurred (should be readily detectable) and resulted in the subsequent spilling of 100,000 gallons (discussed in Section 3.4.3.1), the maximum consequence would be ≤ 13 rem, which does not challenge the Offsite EG. Thus, no SC controls are warranted.

Section 3.4.2.7 concludes that, limiting the leak volume to 15,000 gallons, the worst case Transfer Facility Explosion (excluding PPs/pump tanks) does not challenge the Offsite EG. Using the same model as in Section 3.4.2.7, except not limiting the spilled volume to 15,000 gallons, the worst case consequence is shown to be ≤ 3.0 rem Offsite (Ref. 188). As in Section 3.4.2.7, even if this explosion leads to a subsequent spill of 100,000 gallons (discussed in Section 3.4.3.1), the combined consequence would be ≤ 6 rem. Thus, this scenario does not dictate the need for SC controls.

Section 3.4.2.8 concludes that, limiting the leak volume to 15,000 gallons, the worst case PP/Pump Tank Explosion does not challenge the Offsite EG. Using the same model as in Section 3.4.2.8, except not limiting the spilled volume to 15,000 gallons, the worst case consequence is shown to be ≤ 3.0 rem Offsite (Ref. 188). As in Section 3.4.2.8, even if this explosion leads to a subsequent spill of 100,000 gallons (discussed in Section 3.4.3.1), the combined consequence would be ≤ 6 rem. Thus, this scenario does not dictate the need for SC controls.

Section 3.4.2.12 concludes that, limiting the leak volume from a transfer line spill to 15,000 gallons, the annulus vapor space does not reach LFL and no explosion occurs (with one exception). The one event from Section 3.4.2.12 that could reach LFL (CLFL for Tank 50) with less than a 15,000 gallon spill is an annulus explosion due to a transfer line spill in Tank 50. Nevertheless, the core pipe traversing the annulus used for waste transfers is SC, has a secondary jacket, and is open-ended into the waste tank. Thus, leakage, if any, from this core pipe into the annulus of more than 15,000 gallons is not credible. Thus, no additional SC controls are warranted for this scenario.

Assuming the SC core pipe performs its function in the locations above, the only credible explosion involving a large spill (greater than 15,000 gallons) would be due to a pump tank overflow into the surrounding PP. However, as discussed in Section 3.4.3.1, the leak detection probes in the PPs are SS and required for all transfers into/through the PP. These probes are set such that they would detect much less than 15,000 gallons spilled from a pump tank overflow.

Thus, as shown above, the identified SC and SS controls identified in Section 3.4.2 are adequate to address secondary containment explosions due to large liquid releases greater than 15,000 gallons.

3.4.3.3 Evaporator Vessel Overpressurization

An evaporator overpressurization due to a double-ended guillotine break of all the tube bundles in the evaporator vessel is not a credible event for the CSTF. This event is included as a BDBA for identifying existing controls for mitigating an evaporator overpressurization from a double-ended guillotine break of the tube bundles.

The evaporator overpressurization following a Seismic event was determined to be the bounding case and is the case that is analyzed for the BDBA evaporator overpressurization event.

It is assumed in a BDBA evaporator overpressurization event that all steam/air PCVs and PRVs that supply the evaporator tube bundles fail during a Seismic event in the worst condition, thus providing the maximum pressure to the tube bundle. It is also assumed in the Seismic event that the steam/air piping to the tube bundle as well as the evaporator vessel remains intact. This equipment (e.g., piping, PCVs) may not be designed to SC or SS standards. If the piping remains intact, it is likely that at least one of the PCVs or PRVs would continue to work. Multiple tubes are also assumed to fail from a double-ended guillotine break in the Seismic event. Rupture of multiple tube bundles will lead to pot failure from overpressurization. The failure location is assumed to be above the liquid level and below the demister. Therefore, the demister is bypassed and gas from jet entrainment is released directly to the evaporator cell. There is no credit taken for any aerosol removal mechanism in the top head of the evaporator or in the evaporator cell.

Although the 242-16H tube bundle is not qualified for a Seismic event, the tube bundle is a robust unit designed to flex due to cyclic thermal stresses. It is assumed that the 242-16H pot would fail before the tube bundle; thus, an overpressure event is not credible. The 242-25H tube bundle was fabricated to withstand a Seismic event. Therefore, this accident is considered to be a BEU event.

This BDBA bounds the credible scenario discussed in Section 3.4.2.4. The difference between the double-ended guillotine break evaporator overpressurization and the postulated Evaporator Overpressure DBA is the tube bundle crack size, and, hence, the amount of material released to the environment (no jet entrainment with a tube bundle crack). As discussed in Section 3.4.2.4, the consequences from this size tube bundle crack are within the EGs. Controls that would prevent/mitigate this BDBA are described in Section 3.4.2.4.

In addition to the controls credited in the analysis for the evaporator overpressurization event, the Evaporator Cells and ventilation system (includes all the ventilation ducting/pipes including the inlet and outlet HEPA filter assemblies) would provide airborne waste confinement capabilities for additional mitigation.

3.4.3.4 Seismic

The BDBA Seismic event is more severe than a DBE. The BDBA Seismic event is assumed severe enough that all major systems would fail (i.e., waste tanks, transfer systems, evaporators). These systems are discussed further in the sections below.

For the BDBA Seismic event, it is assumed that no human actions are taken to mitigate the event and no credit was taken for seismically qualified SSCs. The process SSCs are assumed to fail in the BDBA Seismic event. Service systems (i.e., steam, power, water) are assumed to be in a state that results in the worse scenario for the process. The frequency for the BDBA Seismic event is assumed to be less than the frequency of a DBE of unlikely and for comparison to EGs, a frequency of extremely unlikely is used.

Overall facility operations are analyzed to determine what equipment/processes could be ongoing at the time of the event. In addition to the effects of the DBE event described in Section 3.4.2.18, the BDBA Seismic event assumes the following events occur during the BDBA Seismic event (but does not assume multiple failures in one location) and results in the following releases:

- Steam/Air Lines and Jets Failure – Failure of the steam/air lines and jets leading to aerosolization inside the waste tank.
- Waste Tank Failure – Catastrophic failure of the tank wall. All waste tanks are considered to be below ground. Therefore, a waste tank failure can only occur into the ground via a rupture of the tank wall/bottom.
- Transfer Line Failure – Any transfer operations occurring during the BDBA Seismic event are assumed to fail. Transfers of various waste types and quantities could be occurring concurrently during the BDBA Seismic event.
- Waste Tank Annulus Explosion (excluding Tank 50) – These events involve leak from the tank wall or from the side-wall penetration transfer line leading to an annulus explosion. The DBE leak rate from the tank into the annulus is 4-gpm and is expected to be small enough such that the annulus will not reach LFL, excluding Type I/II Acidic Chemical Cleaning Waste Tanks. The BDBA Seismic event assumes a catastrophic failure of the tank wall or transfer line leading to a leak of 15,000 gallons of waste spilled into the annulus leading to an annulus explosion.
- Waste Tank Siphon Through the CRW Systems – A leak in Type IIIA CRW cooling coil inside a waste tank coincident with a leak in a CRW System line outside the tank at a lower elevation than the leak in the cooling coil is assumed to occur due to the BDBA Seismic event. In addition, siphon breakers are assumed to fail.

- Evaporator – The evaporator tube bundles are assumed to catastrophically fail leading to an overpressurization and breach of the evaporator vessels.
- 299-H – The 299-H Maintenance Facility is a HC 3 facility. The maximum inventory for the 299-H Maintenance Facility poses an insignificant Offsite risk for the BDBA Seismic event.
- Stored Waste Boxes – The transport casks are the site equivalent of DOT, Type B containers. Although the waste boxes (e.g., B-25s, B-12s) are not qualified Type B containers (able to withstand a 60 miles per hour crash), the release from these containers during a Seismic event would only cause localized consequences (and negligible Offsite consequences).

The unmitigated consequences of the Seismic event are assumed to exceed the Offsite and Onsite EGs. Since the EGs are exceeded, SC and SS controls are required. SC and SS SSCs are described in Section 3.4.2.18.

3.4.3.5 Criticality

Fissile materials are stored in and transferred through the CSTF. The fissile material quantities can be above single-parameter criticality safety limits. Criticality prevention is generally assured by the low fissile concentration of the waste streams and the abundant neutron poisons present in the waste. As discussed in detail in Chapter 6, criticality is not a credible event for the CSTF. Further details regarding inadvertent criticality events (including locations of concern and criticality prevention) are provided in Chapter 6.

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3.6 TABLES

Table 3.3-1 HAZOP Guide Words

Guide Words	Process Parameters	Possible Meaning of Deviation (example of cause)
Deviations are created by combining Guide Words with Process Parameters		
Buildup	Static	Potential ignition sources for fire or explosion (e.g., pump motor)
High Low Reverse No	Flow	Change in quantity or speed. Inadvertent transfer (e.g., pump failure, human error transfers through wrong path)
High Low Reverse No Buildup	Pressure	Change in pressure (e.g., excessive steam)
High Low	Temperature	Change in temperature (e.g., freezing)
High Low	Concentration	Change in concentration (e.g., wrong concentration of chemical put into a system)
High Buildup	Contaminants	Inadvertent contamination (e.g., oil, wrong chemical)
Direct Indirect	Radiation/Exposure	Exposure to radiation, radiological contamination, or chemicals (e.g., improper protective equipment)
Inadvertent	Criticality	Inadvertent criticality (e.g., scale buildup)
Heavy Too high	Mass/Height	Mass impact (e.g., dropped equipment, overloading)

Table 3.3-1 HAZOP Guidewords (continued)

Guide Words	Process Parameters	Possible Meaning of Deviation (example of cause)
Deviations are created by combining Guide Words with Process Parameters		
Direct Indirect	External Impact	Vehicle impact (e.g., truck, crane, train, airplane, helicopter, excavation)
Direct	Natural Phenomena	NPH impact (e.g., tornado/high wind, seismic, flood, lightning)

Table 3.3-2 Frequency Evaluation Levels

Acronym	Description	Frequency Level ($year^{-1}$)
A	Anticipated, Expected	$f \geq 10^{-2}$/yr
U	Unlikely	$10^{-4} \leq f < 10^{-2}$/yr
EU	Extremely Unlikely	$10^{-6} \leq f < 10^{-4}$/yr
BEU	Beyond Extremely Unlikely	$f < 10^{-6}$/yr

Table 3.3-3 Radiological Consequence Evaluation Levels for Hazard Receptors

	Receptor (considered location)		
Consequence Level (Abbreviation) ↓	Offsite	Onsite-1 (Facility Worker)	Onsite-2 (Co-Located Worker)
High (H)	≥ 25.0 rem	≥ □100 rem	≥ 100.0 rem
Moderate (M)	5.0 rem ≤ C < 25.0 rem	25 ≤ C < 100 rem	25.0 rem ≤ C < 100.0 rem
Low (L)	0.5 rem ≤ C < 5.0 rem	5 rem ≤ C < 25 rem	5 rem ≤ C < 25.0 rem
Negligible (N)	< 0.5 rem	< 5.0 rem	< 5.0 rem

Table 3.3-4 Chemical Consequence Evaluation Levels for Hazard Receptors

	Receptor (considered location)		
Consequence Level (Abbreviation) ↓	**Offsite**	**Onsite-1 (Facility Worker)**	**Onsite-2 (Co-Located Worker)**
High (H)	≥ ERPG-2	uniform distribution of total release ≥ ERPG-3	≥ ERPG-3
Moderate (M)	ERPG-1 ≤ C < ERPG-2	uniform distribution of total release ERPG-2 ≤ C < ERPG-3	ERPG-2 ≤ C < ERPG-3
Low (L)	PEL-TWA ≤ C < ERPG-1	uniform distribution of total release ERPG-1 ≤ C < ERPG-2	ERPG-1 ≤ C < ERPG-2
Negligible (N)	< PEL-TWA	< ERPG-1	< ERPG-1

Definition of Terms (Ref. 17):

	EFFECTS (Most People)	EFFECTS (A Few People)
ERPG-3	No life-threatening health effects, but could experience irreversible or other serious health effects or symptoms which could impair ability to take protective action.	Life-threatening health effects, as well as other serious health effects or symptoms which could impair ability to take protective action.
ERPG-2	No irreversible or other serious health effects or symptoms which could impair ability to take protective action.	Irreversible or other serious health effects or symptoms which could impair ability to take protective action.
ERPG-1	Mild transient adverse health effects or perception of a clearly defined objectionable odor.	Potential health effects.
PEL-TWA	No appreciable risk of health effects.	Potential health effects.

Table 3.3-5 Hazardous Chemical Inventories

The storage of hazardous cold chemicals in the locations listed in Table 3.3-5 support processes within the CSTF. The chemical concentrations listed in the table are nominal values. The maximum hazardous chemical inventories (in pounds) were calculated using derived chemical concentrations and densities as stated in Reference 288. Additionally, the nominal inventory (in gallons) stated in the table are the values used in Reference 288 for the chemical. The maximum inventory in pounds (chemical weight, not solution weight) for each storage location will be used as the point of compliance when comparing inventories as part of the Chemical Inventory Control Program.

Chemical	Storage Location	Nominal Inventory (gal)	Nominal Conc	Maximum Inventory (lbs)	RQ (lbs)	TQ (lbs)	TPQ (lbs)
F-Area							
Gasoline	Tanker	1,600	---	10,020	NL	NL	NL
Benzene (from Gasoline)	Tanker	---	5%	501	10	NL	NL
Diesel Fuel	Tanker	2,400	N/A	17,636	NL	NL	NL
Oxalic Acid	8,000-gal Tanker	24,000	8%	16,032	NL	NL	NL
Sodium Hydroxide	10,000 gal IW Tank	55	25%	152	1,000	NL	NL
	DIWF Caustic Tank	2,760	50%	18,824			
	FTF Tank 1 Bearing Water Tank	55	25%	152			
	Drum/Tote	1,000	50%	6,820			
	Tanker	50,000	50%	340,999			
Sodium Nitrite	10,000 gal IW Tank	55	20%	131	100	NL	NL
	DIWF Caustic Tank	2,760	40%	13,077			
	FTF Tank 1 Bearing Water Tank	55	20%	131			
	Drum/Tote	1,000	30%	4,738			
	Tanker	50,000	40%	236,898			

Table 3.3-5 Hazardous Chemical Inventories (continued)

Chemical	Storage Location	Nominal Inventory (gal)	Nominal Conc	Maximum Inventory (lbs)	RQ (lbs)	TQ (lbs)	TPQ (lbs)
H-Area							
Alumine Activated Alumina	241-102H	---	---	250	NL	NL	NL
Gasoline	241-242H	120	---	752	NL	NL	NL
	Tanker	1,600	---	10,020			
Benzene (from Gasoline)	241-242H	---	5%	38	10	NL	NL
	Tanker	---	5%	501			
Boric Acid	CFA-MCU Strip Feed Tank / Tanker	5,097	0.062%	33	NL	NL	NL
Calcium Hypochlorite (from HTH™ Dry Chlorine Granular)	241-102H	---	70%	80	10	NL	NL
Diesel Fuel	Tanker	2,400	N/A	17,636	NL	NL	NL
MCU Solvent							
Isopar L	CFA-MCU Solvent Drum	440	619.4 g/L	2817	NL	NL	NL
Cs-7SB	CFA-MCU Solvent Drum	440	254 g/L	2,800	NL	NL	NL
BOBCalix C6	CFA-MCU Solvent Drum	440	8.05 g/L	88.7	NL	NL	NL
MaxCalix	CFA-MCU Solvent Drum	440	47.8 g/L	526	NL	NL	NL
TOA	CFA-MCU Solvent Drum	440	1.06 g/L	11.7	NL	NL	NL
TiDG	CFA-MCU Solvent Drum	440	1.55 g/L	17.1	NL	NL	NL
Monosodium Titanate	241-96H	500	15%	798	NL	NL	NL
Nitric Acid	CFA-MCU Strip Feed Tank	5,097	0.01%	17	1,000	NL	NL
	CFA-MCU Scrub Feed Tank	6,914	0.31%	601			
	CFA-MCU Chemical Cleaning Totes	1,100	13%	1,451			
	299-H Nitric Acid Tank	500	50%	2,975			
	299-H Drum	550	50%	3,272			
	Tanker	4,630	9%	3,995			

Table 3.3-5 Hazardous Chemical Inventories (continued)

Chemical	Storage Location	Nominal Inventory (gal)	Nominal Conc	Maximum Inventory (lbs)	RQ (lbs)	TQ (lbs)	TPQ (lbs)
H-Area (continued)							
Oxalic Acid	8,000-gal Tanker	24,000	8%	16,032	NL	NL	NL
Sodium Chromate	241-102H	---	---	250	10	NL	NL
Sodium Hydroxide	CFA-MCU Scrub Feed Tank	6,914	0.1%	232	1,000	NL	NL
	CFA-MCU Chemical Cleaning Totes	900	30%	3,185			
	CFA-MCU Caustic Super Wash Totes	900	1.19%	95			
	CFA-MCU Caustic Storage Tank	9,014	0.12%	121			
	10,000 gal IW Tank	55	25%	152			
	HTF West Caustic Tank	1,337	50%	9,119			
	HTF DWPF Inhibited Flush Water Tank	55	25%	152			
	HTF Tank 9 Bearing Water Tank	55	25%	152			
	HTF Tank 24 Bearing Water Tank	55	25%	152			
	HTF Tank 42 Bearing Water Tank	55	25%	152			
	HTF Cold Feeds IW Tank	55	25%	152			
	HTF Cold Feeds IW NaOH Storage Tank	9,520	50%	64,927			
	299-H Sodium Hydroxide Tank	500	50%	3,410			
	Drum/Tote	1,000	50%	6,820			
	Tanker	50,000	50%	340,999			

Table 3.3-5 Hazardous Chemical Inventories (continued)

Chemical	Storage Location	Nominal Inventory (gal)	Nominal Conc	Maximum Inventory (lbs)	RQ (lbs)	TQ (lbs)	TPQ (lbs)
H-Area (continued)							
Sodium Nitrite	10,000 gal IW Tank	55	20%	131	100	NL	NL
	HTF West Caustic Tank	1,337	40%	6,335			
	HTF DWPF Inhibited Flush Water Tank	55	20%	131			
	HTF Tank 9 Bearing Water Tank	55	20%	131			
	HTF Tank 24 Bearing Water Tank	55	20%	131			
	HTF Tank 42 Bearing Water Tank	55	20%	131			
	HTF Cold Feeds IW Tank	55	20%	131			
	HTF Cold Feeds IW NaOH Storage Tank	9,520	40%	45,106			
	Drum/Tote	1,000	30%	4,738			
	Tanker	50,000	40%	236,898			

Notes:
NL - Not Listed

Table 3.3-6 Deleted

Table 3.3-7 Risk Binning Matrix in Frequency-Consequence Space – Offsite Receptor (Ref. 1)

Frequency → **Consequence ↓**	**Beyond Extremely Unlikely** **$< 10^{-6}$ /yr**	**Extremely Unlikely** **$10^{-6} \le f < 10^{-4}$ /yr**	**Unlikely** **$10^{-4} \le f < 10^{-2}$ /yr**	**Anticipated** **$\ge 10^{-2}$ /yr**
High Radiological ≥ 25 rem Chemical ≥ ERPG-2	**10**	**7**	**4**	**1**
Moderate Radiological 5 rem ≤ C < 25 rem Chemical ERPG-1 ≤ C < ERPG-2		**8**	**5**	**2**
Low Radiological 0.5 rem ≤ C < 5 rem Chemical PEL-TWA ≤ C < ERPG-1		**9**	**6**	**3**
Negligible Radiological < 0.5 rem Chemical < PEL-TWA			**11**	

Key:

→ **Risk Bins 1, 2, 3, 4, 5, 7**
exceed Functional Classification evaluation guidelines for offsite receptors
* "unique" events, individual examination needed

→ **Risk Bins 6, 8, 9**
* "representative" events, examined to the extent that they are not bounded by unique events, at least one bounding event from the each event category (fires, explosions, etc.)

Table 3.3-8 Risk Binning Matrix in Frequency-Consequence Space – Onsite 1 Receptor (Ref. 1)

Frequency → **Consequence ↓**	**Beyond Extremely Unlikely** **$< 10^{-6}$ /yr**	**Extremely Unlikely** **$10^{-6} \leq f < 10^{-4}$ /yr**	**Unlikely** **$10^{-4} \leq f < 10^{-2}$ /yr**	**Anticipated** **$\geq 10^{-2}$ /yr**
High Radiological: ≥ 100 rem Chemical: uniform distribution of total release ≥ ERPG-3	**10**	**7**	**4**	**1**
Moderate Radiological: 25 rem ≤ C < 100 rem Chemical: uniform distribution of total release ERPG-2 ≤ C < ERPG-3		**8**	**5**	**2**
Low Radiological: 5 rem ≤ C < 25 rem Chemical: uniform distribution of total release ERPG-1 ≤ C < ERPG-2		**9**	**6**	**3**
Negligible Radiological: < 5 rem Chemical: < ERPG-1		**11**		

Key:

→ **Risk Bins 1, 4, 7**

* exceed Functional Classification evaluation guidelines for Onsite 1 receptors

Table 3.3-9 Risk Binning Matrix in Frequency-Consequence Space – Onsite 2 Receptor (Ref. 1)

Frequency → **Consequence ↓**	**Beyond Extremely Unlikely** $< 10^{-6}$ /yr	**Extremely Unlikely** $10^{-6} \le f < 10^{-4}$ /yr	**Unlikely** $10^{-4} \le f < 10^{-2}$ /yr	**Anticipated** $\ge 10^{-2}$ /yr
High Radiological: ≥ 100 rem Chemical: ≥ ERPG-3	**10**	**7**	**4**	**1**
Moderate Radiological: 25 rem ≤ C < 100 rem Chemical: ERPG-2 ≤ C < ERPG-3		**8**	**5**	**2**
Low Radiological: 5 rem ≤ C < 25 rem Chemical: ERPG-1 ≤ C < ERPG-2		**9**	**6**	**3**
Negligible Radiological: < 5 rem Chemical: < ERPG-1	**11**			

Key:

→ **Risk Bins 1, 4, 7**

* exceed Functional Classification evaluation guidelines for Onsite 2 receptors

Table 3.3-10 CSTF Hazard Category

Facility/Segment	Radiological Hazard Category	Chemical Hazard Category
Nuclear Facilities:		
Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, 11, 13, 14, 15, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51	2	Moderate
Waste Tanks 5, 6, 12, 16, 17, 18, 19, 20 (Closed)	Radiological	--
Waste Transfer System including pump tanks, PPs, DBs, transfer lines including secondary containment (e.g., LDBs, MLDBs, LPSs, COPs, jackets, drain VBs, LDB drain cell, and HPFP), VBs, inter-area lines (H to Z, H/F to F/H)	2	Moderate
299-H Maintenance Facility	3	Low
Evaporators	2	Moderate
241-96H ARP Facility	2	Low
241-278H MCU Facility	3 [(a)]	Low
Non-Nuclear Facilities:		
Various Chemical Storage Tanks in the Tank Farms and Cold Feeds Area (excludes 299-H)	--	Low

Notes:

(a) The maximum Strip Effluent stream concentration of 16.5 Ci/gal (Cs-137) was used as input for the design of MCU. Reference 242 identified process upsets that could cause the strip effluent stream to exceed this maximum, that were expected to challenge the Hazard Categorization of MCU (HC 3). However, as discussed in References 236, 237, and 238, there are multiple engineered and procedural controls in place to detect the upset conditions. Even if the numerous controls in place to detect upset conditions were to fail, it would still take more than 40 hours at the extreme Strip Effluent concentration before MCU could reach an inventory that would challenge the HC 2 threshold. It is concluded that a process upset would be detected and actions would be taken to shutdown the process within this time and it is not deemed credible for these upsets in the MCU process to challenge the Hazard Categorization of the facility (Ref. 236, 237, 238). In addition to the ability to detect upset conditions within MCU, the ability to not challenge the HC 2 thresholds relies on the effective operation of the ARP. Several key operating parameters and the attribute of the ARP process having two in-line filters at 512-S protect the MCU HC 3 determination (Ref. 254).

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk

HA Event Numbers	Basis for Not Requiring Controls
EV2-11, EV3-11, EV2-19, EV3-19, EV2-20, EV3-20, EV2-21, EV2-58, EV2-58a, EV3-60, EV3-60a	The inlet and outlet of the warming coils for the 242-16H and 242-25H Evaporators have been permanently isolated.
EV2-27, EV3-27	A tube bundle leak check would detect any leak during pressurization and the evaporator would not be placed back into service.
EV2-29, EV3-29, EV2-30, EV3-30, PP-72, PP-73, DB-33, VB-28, WT-50	Design and configuration of the dip tubes, i.e., length and size of dip tubes, limits flow.
EV2-32, EV3-32	Design and configuration of the Evaporator steam lance prevents the steam lance from rupturing.
EV2-33, EV3-33	Design and configuration of the Evaporator steam lift prevents the steam lift from rupturing.
EV2-35, EV3-35, EV2-36	According to M-CLC-G-00301 (Ref. 148), design and configuration of Evaporator Demister prevents pluggage of the demister.
EV3-42, EV3-43	Design and configuration of the 242-25H Evaporator 6-inch overheads condenser non-condensable vent prevents backup in the overheads condenser.
EV2-2, EV2-69, EV2-70, EV2-78, EV2-79, EV3-2, EV3-71, EV3-72, EV3-73, EV3-75, EV3-80, EV3-81	Design and configuration of the evaporator cell (building primarily concrete with a stainless steel liner) prevents breach of the evaporator vessel.
WCT-6	Design and configuration of the air system and truckbay area in the 299-H Building prevents antifreeze from draining into the Waste Collection Tank.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
EV2-11a, EV3-11a, PP-31, PP-32a, PP-32b, PP-33a, PP-34, PP-34a, PP-35, PP-36, PP-37, PP-50, PP-111, DB-24, DB-25, DB-26, DB-27, DB-28, DB-31, DB-70, VB-23, VB-25, TL-32, TL-66, WT-32, WTE-14, WTE-17, WTE-32, WRE-25, WRE-26, WRE-27, WRE-28, WRE-29, VB17-12, VB17-13, VB17-14	Duration of the event prior to becoming a hazard is long enough not to require controls. Events would also require continuous failure of multiple facility features and absence of operations personnel for a significant time prior to the event.
LP-10, PP-18, PP-51, PP-60, PP-61, PP-64a, PP-70, PP-71, CT-7	Design and configuration of the Low Point Drain Tank, pump tank, and catch tank prevents the tanks from being airtight.
LP-16, LP-16a, PP-93, PP-98, DB-55, DB-61, VB-44, VB-50	Design and configuration of the PP, DB, VB, or LPDT Cell (cell primarily metal and concrete) prevents breach of the cell.
LDB-1	Insufficient combustible loading inside LDB/MLDB prevents fire inside LDB/ MLDB.
EV2-42, EV2-43, EV3-44, EV3-45, HPP5-1, HPP5-2, HPP5-3, HPP5-4, DB-12, DB-12a, DB-13, DB-14, DB-19, VB-11, VB-11a, VB-12, VB-13, VB-18, VB17-2, CT-3, CT-4, PP-19, PP-19a, PP-19b, PP-20, PP-20a, PP-45, TL-5, TL-6, TL-16, TL-17, TL-18, WT-6, WTE-12	Generic safety programs including Chemical Inventory Control Program, WAC, Conduct of Operations, and Health and Safety prevent addition of material or flow streams not permitted in the process.
PP-42, PP-43	Design and configuration of the agitator, i.e., small, low speed, prevents damage to the pump tank.
PP-46	Design and configuration of the sump pump discharge line, i.e., above the overflow line, prevents siphoning of waste out of the pump tank.
PP-48, DB-22, VB17-9, VB17-10	VB, DB, and PP Spray Nozzles have been isolated from all possible sources.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
VB-26	Dip tubes in the VBs do not have flushwater connections.
PP-49, DB-29, HDB4-1, WT-31, WT-33, WT-34, WT-38, WT-39, WTE-24, WTE-24a, WTE-29, WRE-19	Event requires multiple consecutive manual batching of surge tank.
VB17-14a, VB17-14b	Vapor/heat loads are negligible heat sources.
TL-34	Design and configuration of the transfer line allows the jacket to fail before the core line.
WRE-40, WRE-41, WRE-42, WRE-43, WRE-44, WRE-45, WRE-45a, WRE-46, WRE-51, WRE-52, WRE-53	Pitbull will not be used. Therefore, no analysis is required.
PP-22a	Design and configuration of the pump prevents overspeed.
PP-71a	Design and configuration of Steam System prevents aerosolization (configuration of pump tank transfer jets is such that the jet suction line is the only part of the jet that lies within the pump tank - the steam line to the jet lies outside the tank).
DC-1, DC-2, DC-3	An installed blank prevents inadvertent waste transfer from the LDB Drain Cell to the 242-16H Evaporator overheads receiver tanks.
WT-48	Past operating history has shown these routine operations do not produce any release.
WT-49, WT-53, WT-54	Design and configuration of the ventilation system, i.e., low airflow, prevents a release from the waste tank.
WTE-20	Design and configuration of transfer line, i.e., siphon plugs on jets and sidewall penetrations, allows waste to continuously discharge.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
WTE-21	Design and configuration of the centrifugal transfer pump prevents deployment inside waste tank, i.e., cannot fit through riser.
WRE-10, WRE-11, WRE-12, WRE-13, WRE-14, WRE-30	Equipment is used for heel removal. The inventory of waste and the tank vapor volume results in insufficient consequences to require controls.
WRE-17	Design and configuration of the crawler, i.e., small, prevents damage to the waste tank.
WRE-18, WRE-22	Pressurized water will not be used for bulk saltcake removal.
DS-6, DS-7, DS-8	The jets in Closure Waste Tanks are isolated. Waste Tanks mixing device operation and transfers from Closure Waste Tanks are prohibited. Therefore, no analysis is required.
DS-9	Vacuum does not disturb the dry sludge.
DS-5, DS-10	Events addressed unique aspects for Tank 15 (when a dry sludge tank) and are no longer applicable.
FS-1, FS-2, FS-3, FS-4, FS-5, FS-6, FS-7, FS-8, FS-9, FS-10, FS-12	Fluidic Sampler will not be used. Therefore, no analysis is required.
WT-26, WT-27	Design and configuration of a closed riser will prevent passage of major leaks. An open riser requires Radcon or other personnel to be present, which will ensure the detection of any leak and immediate spill response. Any flammable vapors pulled into the tank or annulus via the ventilation will also be purged out by the same ventilation system. In addition, the large volume would require a large volume of flammable liquid or vapor to cause any significant impact.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
DS-2	It has been shown that shock sensitive compounds do not exist in quantities significant enough to have any major impact (Ref. 1).
DS-17, DS-18	Tank design precludes external fire from causing a release from dry sludge tank.
WT-45	Design and configuration of annulus, i.e., not sealed, prevents pressurization of the annulus.
DS-10a	Tank 15 (when a dry sludge tank) was without cooling for over a year and did not heat up to boiling. Past data have shown maximum dry sludge temperature of 90°C (based on 1 year w/o cooling). Addition of liquid will not increase evaporation. Closure Waste Tanks contain quantities of waste far less than Tank 15. Therefore, the event is not credible.
WT-46	For Type I and II Tanks, calculations (Ref. 177) have shown that the annulus fans are not capable of collapsing the annulus or failing the primary tank due to positive pressure.
WT-1, WT-2, WT-3, WT-4, WT-5, WT-5a, WTE-1, WTE-2, WRE-1	Waste does not contain significant combustibles to support a sustained fire. For Tank 50/MCU facilities, organic solids fire is incredible. The MCU solvent does contain other organics; however, due to their masses and vapor pressures, they are not considered to be fire or explosive hazards. Potentially combustible solids also require a sustained flame to ignite. For liquid fire aspects, spark energy alone is considered insufficient to ignite Isopar® L. Liquid fire scenarios also do not challenge Offsite or Onsite EGs.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
HC-1, HC-2, HC-11, HC-12, HC-13, HC-14a, WCT-1, WCT-2, WCT-13, WCT-28	The 299-H Inventory Control Program shall address the controls required to maintain the 299-H inventory within HC 3 limits. It is recognized that these events were evaluated using the assumed maximum inventory 5 gallons of Bounding Sludge Slurry and 10 gallons of High Activity Supernate as the MAR. However, given the nature of the 299-H process (both physically and operationally) and protecting HC 3 limits, the HA assumption is inherently protected.
WOW-14a	The STP mast will either be designed such that a screen is located above the surface of the waste to prevent waste accumulation inside the mast or ensure the annular space between the mast and the riser is sufficient to drain the accumulated waste.
DB-62, DB-63, EV2-72, EV3-74, PP-99, PP-100, TL-55, TL-56, VB-51, VB-52, WT-87, WT-88, DS-14, DS-15, TT-13, TT-14, B25-15, B25-16	Evaluation of a similar sized structure in DWPF (Low Point Pump Pit) indicated an impact frequency of 2.8E-07/year (Ref. 285).
PP-2, PP-3	Liquid waste does not burn.
DB-2, EV2-1, EV2-1a, EV3-1, EV3-1a, HDB8-2, HDB8-3, LP-1, PP-2a, PP-3a, VB-2	Structures are non-combustible, and postulated fires are due to transient combustibles only, in which there is insufficient material to produce the heat necessary for the required length of time to fail robust steel structures.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
TL-3, TL-4	Organic aspects for non-Tank 50/MCU facilities are addressed by Section 3.4.1.5.3. For Tank 50/MCU facilities, organic solids fire is incredible. The MCU solvent does contain other organics; however, due to their masses and vapor pressures, they are not considered to be fire or explosive hazards. Potentially combustible solids also require a sustained flame to ignite. For liquid fire aspects, spark energy alone is considered insufficient to ignite Isopar® L. Liquid fire scenarios also do not challenge Offsite or Onsite EGs.
DB-35, PP-76, VB-29, WT-64	The underground location of these cells precludes a leak from being an immediate Onsite or Offsite radiological hazard.
CCH-1, CCH-2, CCH-4, CCH-5, DIWF-15, DIWF-17, DIWF-18, CW-13, CF-28, CF-31, CF-32	CST facilities are designed to handle Standard Industrial Chemical Hazard as described under Procedure Manual 4Q, WSRC-IM-95-58, and Engineering Standards Manual WSRC-TM-95-1 which specifies various consensus standards for chemical hazards, storage tanks, chemical process components, etc. regardless of functional classification.
DS-11	This is a routine activity and normal Radcon practices will prevent radiation and/or contamination exposure during HEPA filter replacement.
DS-20	Generic safety programs including Conduct of Operations, Fire Protection Program, Radiological Protection Program, NMMP, HEPA Filter Program, and Emergency Response Program are sufficient to prevent/mitigate the release of hazardous materials.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
TL-33a	The event is not credible because too many failures would be required for the event. First, the pressure test fails. Second, residual waste is not expected in the jacket, so a failure led to getting the waste there. Third, vapor space sniffing is performed after sludge slurry transfers and a pressure test would not be performed on a line with residual waste in it.
WRE-5, WRE-6, WRE-7, WRE-8, WRE-9, WRE-33, WRE-35, WRE-36, WRE-37, WRE-39, WRE-57, WRE-58, WRE-62	The ADMP is no longer used and is grouted in place. Therefore, no analysis is required.
WTE-10, WTE-28, WTE-30	The Flygt Mixer (submersible ducted turbine mixer) is no longer used and is permanently disabled / de-energized.
CT-35	Tank design and configuration (located below grade) precludes external fire from causing a release.
CF-13a, CF-22, CF-23, CF-24, CF-25, CF-26, CF-29, CF-33, CW-1, CW-5, CW-7, OH2-26, OH3-27	Generic safety programs including Conduct of Operations, Critical Lift Program, Fire Protection Program, Industrial Hygiene Program, and Traffic Control Program are sufficient to prevent/mitigate the release of hazardous material.
TL-22	The normal steam supply pressure to transfer jets is such that the transfer system design pressure will not be exceeded. Event would also require failure of multiple facility features and absence of operations personnel for a significant time prior to the event.
VB-59	Initial waste (residual) volumes are maintained less than or equal to the values stated on Table 3.4-1 for all VBs. The largest initial waste (residual) volume is less than 40 gallons.

Table 3.3-11 HA Events Not Requiring Controls Due to Configuration/Low Risk (continued)

HA Event Numbers	Basis for Not Requiring Controls
WT-100	Loss of a control room by itself does not result in the event. Operator response actions from the Severe Weather Response Program and Event Response Program preclude a waste tank overflow event from occurring. These actions are required prior to Tornado/High Winds Event or following a Seismic Event. Even if a control room is lost, the post-seismic required actions (e.g., secure liquid transfers) can be accomplished through multiple means (credited and non-credited) outside of a control room.
TL-34a	The event is only applicable to secondary containments that drain to transfer line jackets (i.e., HPFP, VB-15/16). The transfer lines/jackets that go to and from the HPFP never go above grade and precludes a leak from being an immediate Onsite or Offsite radiological hazard. The design configuration of VB-15/16 is such that waste is no longer capable of being leaked to or transferred through the box.

Table 3.3-12 HA Events Not Requiring Controls Due to Further Analysis

DBA DSA Section	Type of Event	HA Events Not Requiring Controls Due to Further Analysis
3.4.1.5.3	Organics	WT-7
3.4.2.1	Evaporator Pot Explosion	EV2-3a, EV2-4, EV2-77, EV3-3a, EV3-4, EV3-79
3.4.2.2	Evaporator Cell Explosion	EV2-77, EV3-4a, EV3-79
3.4.2.3	Evaporator Overflow, Leaks, and Spills	EV2-5, EV2-6, EV2-7, EV2-8, EV2-17, EV2-18, EV2-28, EV2-38, EV2-41, EV2-44, EV2-44b, EV2-68, EV3-5, EV3-6, EV3-7, EV3-8, EV3-10, EV3-12, EV3-13, EV3-14, EV3-15, EV3-16, EV3-46, EV3-46a, EV3-70, EV3-78a, EC2-16, EC3-16
3.4.2.4	Evaporator Overpressure	EV2-26, EV2-34, EV2-37, EV2-39, EV2-40, EV3-17, EV3-18, EV3-26, EV3-28, EV3-34, EV3-37, EV3-38, EV3-39, EV3-40, EV3-41
3.4.2.7	Transfer Facility Explosions	LP-2, LP-3
3.4.2.8	Pump Pit Explosion	PP-4a, PP-5a, PP-11, PP-12, PP-14, PP-16, PP-18b, PP-19d
3.4.2.9	Transfer Error/SMP Waste Release	LP-14
3.4.2.10	Aerosolization Events – Diaphragm Pump	WTE-27
3.4.2.10	Aerosolization Events – LPDT Portable Pump	LP-9
3.4.2.11	Slurry Pump Column Explosion	WTE-4
3.4.2.11, 3.4.1.5.3	Waste Tank Explosion (due to dissolved hydrogen release from mixing device operation)	WTE-6, WTE-8, SMP-30

Table 3.3-12 HA Events Not Requiring Controls Due to Further Analysis

DBA DSA Section	Type of Event	HA Events Not Requiring Controls Due to Further Analysis
3.4.2.12	Waste Tank Annulus Explosion	WT-20, WT-22, WT-26a
3.4.2.13	Waste Tank/Pump Tank Overheating	WT-40, WT-91
3.4.2.14	Waste Tank Wall Failure	WT-94, WT-98
3.4.2.16	299-H Events	WCT-3, WCT-4, WCT-5
3.4.2.17	Tornado and High Winds Event	LP-3
3.4.2.18	Seismic Event	LP-3, LP-18, TL-61, EV2-77, EV3-78a, EV3-79, TT-16, WT-20, TT-20, WCT-3, WCT-31, B25-20, B25-25
3.4.2.19	Wildland Fire	LP-3, TT-17, CH-7a
3.4.2.21	Chemical Release	EV2-46, EV3-48, OH2-3a, OH3-3a
3.4.2.22	Tanker Truck/Waste Boxes	TT-1, TT-2, TT-3, TT-4, TT-5, TT-9, TT-10, TT-11, TT-12, TT-12a, TT-16, TT-18, TT-18a, TT-19, TT-21, B25-1, B25-2, B25-3, B25-3a, B25-4, B25-5, B25-6, B25-7, B25-7a, B25-8, B25-10, B25-12, B25-13, B25-14, B25-17, B25-18, B25-19, B25-20, B25-21, B25-21a, B25-22, B25-23, B25-24, B25-26, B25-27
U-CHA-G-00003 (Ref. 307)	Trapped Gas Release	(a) DS-3, DS-4, DS-23, PP-17, PP-106, SD-1, WRE-2, WRE-3, WRE-4, WT-97, WTE-3, WTE-5, WTE-7, WTE-9
Chapter 6	Criticality	EV2-65, EV2-65a, EV2-66, EV2-67, EV3-67, EV3-67a, EV3-68, EV3-69, WT-83, SD-3

Notes:

(a) These events are not listed on Table 3.3-17, as the events were superseded (or determined to not be a concern) based on Reference 307.

Table 3.3-13 Evaporator Mitigated HA and SS Controls

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EC2-1	A fire in evaporator cell results in release from HEPA bank plus residual U / H / 4 (unmitigated) BEU / H / 10 (mitigated)	SS	Fire Protection Program	Minimize the amount of combustibles; provide controls to minimize hazards associated with a fire
EC3-1	A fire in evaporator cell results in release from HEPA bank plus residual U / H / 4 (unmitigated) BEU / H / 10 (mitigated)	SS	Fire Protection Program	Minimize the amount of combustibles; provide controls to minimize hazards associated with a fire
EV2-74	Wildland fire engulfs evaporator building and results in the release of radiological/hazardous material during operation A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event covers both radiological releases and cell/pot explosions, and contains all related controls.	SC	Event Response Program	Shut down evaporators, secure feed pumps, and secure liquid transfers following a wildland fire event
		SS	Evaporator Cell	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV3-76	Wildland fire engulfs evaporator building and results in the release of radiological/hazardous material during operation A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event covers both radiological releases and cell/pot explosions, and contains all related controls.	SC	Event Response Program	Shut down evaporators, secure feed pumps, and secure liquid transfers following a wildland fire event
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Evaporator Cell	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
EV2-4a	Deflagration in the evaporator cell damages evaporator vessel and causes release of radiological/ hazardous material due to a waste leak A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Evaporator cell sump level verification	Detect release of material
		SS	Evaporator Cell	Provide airborne confinement
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
EAC-2-001	Flammable gas, such as hydrogen gas, accumulates in pot and is ignited resulting in an explosion (energetic reaction) in the evaporator vessel causing a release of radiological/hazardous material A / M / B1 (unmitigated) A / M / B1 (mitigated)	SS	Transfers through 242-16H Evaporator Cell transfer jumpers are prohibited during 242-16H Chemical Cleaning operations	Ensures material is not transferred through evaporator cell during chemical cleaning

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV2-44a	Leak from pipes, jumpers, valves to the evaporator vessel (away from evaporator vessel) causes release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event only contains controls related to a transfer line jumper leak in the 242-16H Evaporator Cell. Leaks from pipes, jumpers, valves to/from the evaporator vessel do not require controls due to further analysis.	SS	Transfer Line Core Pipe	Transfer Line integrity shall ensure primary waste containment
		SS	Evaporator Cell	Provide airborne confinement; provide liquid waste containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
EV2-22	Tube bundle ruptures ejecting high pressure steam and/or air to the evaporator and causes the vessel to overpressurize and releases radiological/ hazardous material during operation A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV2-25	Tube bundle breaks during steam shocking to remove scale and results in the overpressurization of the evaporator vessel when the evaporator goes back into service. Note: During steam shocking (a maintenance activity), steam is applied for short durations A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV2-31	High flow through the steam lance (steam and/or air) results in overpressurization of the evaporator and leads to evaporator breach resulting in release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV2-37	Low or no cooling water flow to the overhead condenser results in the buildup of back pressure to the evaporator and the overpressurization of the evaporator vessel leading to a release of radiological/ hazardous material during operation A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV3-22	Tube bundle ruptures ejecting high pressure steam and/or air to the evaporator and causes the vessel to overpressurize and releases radiological/ hazardous material during operation A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV3-25	Tube bundle breaks during steam shocking to remove scale and results in the overpressurization of the evaporator vessel when the evaporator goes back into service. Note: During steam shocking (a maintenance activity), steam is applied for short duration A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV3-31	High flow through the steam lance (steam and/or air) results in overpressurization of the evaporator and leads to evaporator breach resulting in release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV2-23	Low liquid level in evaporator uncovers the tube bundle resulting in a mechanical failure (rupture) of the tube and the overpressurization of the evaporator [High pressure steam/air] A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV2-24	Instrument air freezes and results in an incorrect evaporator level reading which leads to an uncovered tube bundle which induces tube failure and causes the evaporator vessel to overpressurize (See loss of instrument air event OH2-10) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV3-23	Low liquid level in evaporator uncovers the tube bundle resulting in a mechanical failure (rupture) of the tube and the overpressurization of the evaporator [High pressure steam/air] A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV3-24	Instrument air freezes and results in an incorrect evaporator level reading which leads to an uncovered tube bundle which induces tube failure and causes the evaporator vessel to overpressurize (See loss of instrument air event OH3-10) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EAC-3-003	Tube bundle ruptures ejecting high pressure steam and/or air to the evaporator and causes the vessel to overpressurize and releases radiological/ hazardous material during chemical cleaning operations A / H / A1 (unmitigated) Prevented (mitigated)	SS	Tube Bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EAC-3-004	High flow through the steam lance (steam and/or air) results in overpressurization of the evaporator and leads to evaporator breach resulting in release of radiological/ hazardous material A / H / A1 (unmitigated) Prevented (mitigated)	SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
EV2-75	Tornado causes structural damage to evaporator building and release of radiological/ hazardous material during operation U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event covers both radiological releases and cell/pot explosions, and contains all related controls.	SC	Evaporator Cell	Provide protection from tornado driven missiles and high winds and provide airborne confinement
		SC	Severe Weather Response Program	Shut down evaporators and secure feed pumps during a tornado watch/warning or high wind warning
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
EV3-77	Tornado causes structural damage to evaporator building and release of radiological/ hazardous material during operation U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event covers both radiological releases and cell/pot explosions, and contains all related controls.	SC	Evaporator Cell	Provide protection from tornado driven missiles and high winds and provide airborne confinement
		SC	Severe Weather Response Program	Shut down evaporators and secure feed pumps during a tornado watch/warning or high wind warning
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV2-75a	Earthquake causes structural damage to evaporator building and release of radiological/ hazardous material during operation U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event only contains controls related to a transfer line jumper leak in the 242-16H Evaporator Cell from Section 3.4.2.18. Leaks from pipes, jumpers, valves to/from the evaporator vessel do not require controls due to further analysis.	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event
		SS	Event Response Program	Secure liquid transfers following a seismic event
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
EV2-76	Earthquake causes rupture of tube bundle, and/or other related evaporator components ejecting high pressure steam and/or air into the evaporator results in overpressurization leads to evaporator breach during operation U / H / 4 (unmitigated) U / M / 5 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV and Tube Bundle Steam PRV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EV3-78	Earthquake causes rupture of tube bundle, and/or other related evaporator components ejecting high pressure steam and/or air into the evaporator results in overpressurization leads to evaporator breach during operation U / H / 4 (unmitigated) U / M / 5 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Lance Steam PCV and Lance Steam PRV	Limit steam pressure and flow to lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-13 Evaporator Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EAC-7-001	Earthquake causes rupture of tube bundle, and/or other related evaporator components ejecting high pressure steam and/or air into the evaporator results in overpressurization leads to evaporator breach during chemical cleaning operations U / H / A1 (unmitigated) U / M / B1 (mitigated)	SS	Tube bundle	Provide containment for steam and air; no catastrophic failure
		SS	Tube Bundle Steam PCV	Limit steam pressure and flow to tube bundle and lance line
		SS	Lance orifice (air/steam)	Limit air/steam pressure and flow to pot
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	NMMP	Ensure functionality of safety SSCs
OHHG-1-001	A fire starts in the evaporator service building, spreads to overheads receiver cell and damages MRT, overheads receiver tanks, and related components and causes release of mercury vapor during operation A / M / B1 (unmitigated) A / M / B1 (mitigated) Note: This event is not applicable to the 242-25H Evaporator.	SS	Evaporator Mercury Monitoring	Provides local indication of mercury quantity in the MRT and associated collection system to verify mercury inventory initial conditions are protected
		SS	Mercury Management Program	Limits quantity of mercury in the MRT and associated collection system
OHHG-1-002	A fire starts in the overheads receiver cell damages MRT, overheads receiver tanks, and related components and causes release of mercury vapor during operation A / M / B1 (unmitigated) A / M / B1 (mitigated)	SS	Evaporator Mercury Monitoring	Provides local indication of mercury quantity in the MRT and associated collection system to verify mercury inventory initial conditions are protected
		SS	Mercury Management Program	Limits quantity of mercury in the MRT and associated collection system
OHHG-1-003	A fire starts in the 242-16H Evaporator Mercury Collection Station Enclosure damages MRT drain line and related components and causes release of mercury vapor A / M / B1 (unmitigated) A / M / B1 (mitigated)	SS	Evaporator Mercury Monitoring	Provides local indication of mercury quantity in the MRT and associated collection system to verify mercury inventory initial conditions are protected
		SS	Mercury Management Program	Limits quantity of mercury in the MRT and associated collection system

* Functional Classification

SS SSCs may be required to be SC for other functions/events. SSCs are denoted as SC or SS according to the highest classification of the function they perform for the specific event. Although Administrative Programs are not functionally classified, they are denoted as SC or SS according to the highest classification of the function they perform for the specific event. SC/SS is only denoted when classification varies depending upon process area (e.g., SC for Type III waste tanks, SS for Type IV waste tanks).

** Onsite 1 Frequency/Consequence/Bin#

Frequency Acronym (see Table 3.3-2)		Consequence Acronym (see Table 3.3-3)	
A -	Anticipated	H -	High
U -	Unlikely	M -	Moderate
EU -	Extremely Unlikely	L -	Low
BEU -	Beyond Extremely Unlikely	Neg -	Negligible

For Risk Bins 1-11 Acronyms, see Tables 3.3-7, 3.3-8, and 3.3-9.

For Risk Regions A1, A2, A3, B1, B, and C Acronyms, see Tables 3.3-20 and 3.3-21.

Table 3.3-14 Transfer System Mitigated HA and SS Controls

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
LDB-1a	Maintenance activity on LDB/ MLDB results in a fire that damages the transfer line and results in a release of residual contamination from the line	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
	A / H / 1 (unmitigated) BEU / L / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
TL-2	Cathodic protection of DB-8 Inter-area lines (IAL) leads to fire inside the IAL line	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
	A / H / 1 (unmitigated) BEU / L / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-1	Incipient fire in the diversion box results in the release of residual material from the diversion box (no breach of transfer lines) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC	Fire Protection Program	Minimize the amount of combustibles; provide controls to minimize hazards associated with a fire
		SS	Transfer Control Program	Verify fire loading energy contribution prior to High-Rem transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
VB-1	Incipient fire in the valve box results in a release of residual radiological/ hazardous waste from the valve box (no breach of transfer lines) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC	Fire Protection Program	Minimize the amount of combustibles; provide controls to minimize hazards associated with a fire
		SS	Transfer Control Program	Verify fire loading energy contribution prior to High-Rem transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
PP-1	Incipient fire in the pump pit results in the release of residual material from the pump pit (no breach of tank) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC	Fire Protection Program	Minimize the amount of combustibles; provide controls to minimize hazards associated with a fire
		SS	Transfer Control Program	Verify fire loading energy contribution prior to High-Rem transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-8	Explosion inside transfer line secondary containment or jacket damages the transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space
TL-9	Sump drains to jacket/encasement and builds up residual contamination which leads to hydrogen buildup and explosion in jacket which damages the core line and releases waste during a transfer (only applies to High Point Flush Pit and Valve Boxes 15 and 16) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-10	Explosion from hydrogen buildup inside the transfer line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; flushing core pipe following a waste transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Diversion box	Provide airborne confinement
		SS	Evaporator Cell	Provide airborne confinement
		SS	High Point Flush Pit	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-13	No/Low waste flow through line (i.e., waste stagnant in line) during a transfer results in buildup of hydrogen/ organic vapor which leads to an explosion in the transfer line (assumes line is not full to provide vapor space) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; flushing core pipe following a waste transfer; prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SS	WAC	Ensure feed is maintained within assumptions (i.e., organic, hydrogen concentration)
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Diversion box	Provide airborne confinement
		SS	Evaporator Cell	Provide airborne confinement
		SS	High Point Flush Pit	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-14	Starting an intended sludge/organic transfer leads to transfer to an inadvertent path which causes hydrogen or other flammable gas buildup inside transfer line and results in an explosion inside the transfer line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, independent verification of correct transfer path alignment; govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; and flushing core pipe following a waste transfer; prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SS	WAC	Ensure feed is maintained within assumptions (i.e., organic, hydrogen concentration)
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Diversion box	Provide airborne confinement
		SS	Evaporator Cell	Provide airborne confinement
		SS	High Point Flush Pit	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-15	Accidental (unintended) sludge/organic transfer leads to hydrogen or other flammable gas buildup of unattended transfer line and results in an explosion inside the transfer line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, independent verification of correct transfer path alignment; govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; and flushing core pipe following a waste transfer; prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SS	WAC	Ensure feed is maintained within assumptions (i.e., organic, hydrogen concentration)
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Diversion box	Provide airborne confinement
		SS	Evaporator Cell	Provide airborne confinement
		SS	High Point Flush Pit	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
LDB-2	Explosion inside LDB/ MLDB damages transfer line during a transfer	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space
LDB-3	Failure of the Conductivity probe in LDB/ MLDB/ LPS leads to no indication of waste and hydrogen buildup which results in explosion and damage to transfer line during a transfer	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-3	Flammable gas (hydrogen vapor) build up in the diversion box ignites resulting in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event bounds an explosion in the High Point Flush Pit and contains controls related to that event.	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Sump (DBs, HPFP) conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	High Point Flush Pit	Provide airborne confinement; support conductivity probe functionality
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-6	Inaccurate or loss of diversion box sump level indication (i.e., dip tubes) prevents the sump from being pumped out allowing the build up of hydrogen which results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-7	The conductivity probe in the diversion box cell sump is unable to detect the presence of liquid waste inside the sump and prevents the sump from being pumped out; hydrogen build up results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SC	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation; support transfer line integrity (II/I)
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-8	The sump drain becomes plugged and prevents the sump from draining; build up of hydrogen results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-9	Low or no flow through the diversion box sump pump allows liquid waste to collect in the sump and cell allowing the build up of hydrogen which results in an explosion and breach of transfer lines	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-10	Low or no flow of steam through the sump steam jet allows liquid waste to remain in the sump and cell allowing the build up of hydrogen which results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-11	Loss of ventilation system results in a higher concentration of hydrogen in the diversion box and, eventually, leads to an explosion and damage to the transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-12b	Inadvertent addition of lubricant oil in the diversion box results in an explosion and breach of transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Oil Control Program	Prevent introduction of significant flammable vapors from oil
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Diversion box active ventilation system	Prevent accumulation of flammable vapor
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Diversion box	Provide airborne confinement; support conductivity probe functionality; support ventilation system operation
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-4	Flammable gas (hydrogen vapor) build up in the valve box ignites resulting in an explosion and breach of transfer lines	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-8	Inaccurate or loss of valve box sump level indication (i.e., dip tubes) prevents the sump from being pumped out allowing the build up of hydrogen which results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-9	The conductivity probe in the valve box is unable to detect the presence of liquid waste and prevents the valve box from being pumped out; hydrogen build up results in an explosion and breach of transfer lines during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Valve box	Provide airborne confinement; support conductivity probe functionality; support transfer line integrity (II/I)

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-10	The sump drain becomes plugged and prevents the valve box from draining; build up of hydrogen results in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-11b	Inadvertent addition of lubricant oil in the valve box results in an explosion and breach of transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Oil Control Program	Prevent introduction of significant flammable vapors from oil
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Conductivity probe with control room alarm	Detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CT-5	Radiological/hazardous waste flows into catch tank from Type I transfer line encasement and collects inside the catch tank; this results in hydrogen generation (radiolysis) in the tank which leads to an explosion	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
	EU / H / 7 (unmitigated) BEU / L / 11 (mitigated)	SS	H-Area Catch Tank Encasement and ground cover	Provide airborne confinement
	Note: This event bounds an explosion in the LDB Drain Cell and contains controls related to that event.	SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Transfer Line Encasement	Provide airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SS	Conductivity probe (LDBs along leak path to LDB Drain Cell) with control room alarm	Detect release of material
		SS	Transfer Line Jacket and LDBs (along leak path to LDB Drain Cell)	Provide airborne confinement and support conductivity probe functionality
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-4	Flammable gas (hydrogen/organic vapor) builds up in the pump tank and ignites resulting in an explosion and breach of pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic, hydrogen concentration)
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-5	Flammable gas (hydrogen/organic vapor) builds up in the pump tank and ignites resulting in an explosion and breach of pump tank or transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic, hydrogen concentration)
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-10	Inaccurate or loss of pump tank level indication (dip tubes) prevents waste from being pumped out allowing the build up of hydrogen which results in an explosion and damages the pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-13	Low or no flow through the pump tank pump allows liquid waste to remain in the pump tank which results in the build up of hydrogen and an explosion and breach of pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-15	Low or no flow of steam through the pump tank steam jet allows liquid waste to remain in the pump tank allowing the build up of hydrogen which results in an explosion and breach of pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-18a	Loss of ventilation system results in a higher concentration of hydrogen in the pump tank and eventually leads to an explosion and damage to the pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-19c	Inadvertent addition of lubricant oil in the pump tank results in an explosion and breach of pump tank during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Oil Control Program	Prevent introduction of significant flammable vapors from oil
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-23	Waterhammer leads to leak/rupture of the transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-24	Material degradation leads to leak/rupture of the line during a transfer U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-25	Leak/rupture of Inter-area lines (IAL) due to ground vibration during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-26	Cathodic protection of DB-8 IAL leads to leak/rupture of adjacent line during a transfer U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-27	Microbial Induced Corrosion (MIC) degrades transfer line which results in leak/rupture of transfer line during a transfer U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-28	The Canyons send unapproved waste/ material through the transfer line causing corrosion of lines and eventually leads to release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Conductivity probes with control room alarm	Detect release of material
TL-29	Contaminants (e.g., nitric acid, etc.) are transferred from the 299-H building through the transfer line causing corrosion of lines and eventually leads to release of waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-31	Flushing transfer line leads to surface release (may result in siphon of waste tank) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; identify potential siphons and methods to stop siphons; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-34b	Inadvertent transfer during maintenance activity on transfer line results in release of waste from the core line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
LDB-4	High waste flow into LDB/ MLDB leads to overfill of LDB/ MLDB which results in surface airborne release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Conductivity probe in LDB/MLDB/LPS with control room alarm	Detect release of material
		SS	Transfer line jacket	Provide airborne confinement and support conductivity probe functionality
		SS	LDB/MLDB/LPS	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
LDB-5	Failure of the Conductivity probe in LDB/ MLDB/ LPS leads to no indication of waste and overflow of waste from LDB/ MLDB A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Conductivity probe in LDB/MLDB/LPS with control room alarm	Detect release of material
		SS	Transfer line jacket	Provide airborne confinement and support conductivity probe functionality
		SS	LDB/MLDB/LPS	Provide airborne confinement and support conductivity probe functionality

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-15	The transfer line, jumper, gasket and/or valve, etc. fails and leaks either directly into the diversion box or into the transfer line jacket which drains into the diversion box during a transfer leading to an overfill of the diversion box due to human failure A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event bounds an overfill in the High Point Flush Pit and contains controls related to that event.	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes (DBs and HPFP) with control room alarm	Detect release of material
		SS	High Point Flush Pit	Provide airborne confinement; support conductivity probe functionality
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-16	The transfer line, jumper, gasket, and/or valve, etc. fails and leaks either directly into the diversion box or into the transfer line jacket which drains into the diversion box during a transfer leading to an overfill of the diversion box due to mechanical failure or material degradation U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-17	Transfer line connections, valves, or jumpers fail upon installation and results in liquid waste being spilled into the diversion box during a transfer which leads to overfill of diversion box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-18	Microbial Induced Corrosion (MIC) degrades the jumpers and transfer lines in the diversion box and eventually lead to a leak or rupture that overfills the diversion box U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-20	A manual valve fails closed during a transfer and overpressurizes the jumper or transfer lines which drains to jacket which leads to a line or gasket breach and an overfill of diversion box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-21	Waste in the transfer line is pushed back into the flush water piping during a transfer which leads to overfill of diversion box	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-23	Flushing transfer line causes water to leak into diversion box which results in an overfill of diversion box (may result in siphon of waste tank) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; identify potential siphons and methods to stop siphons; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-26a	Condensation in the transfer line followed by a high steam flow causes a water hammer effect and transfer line rupture which eventually leads to overfill of the diversion box during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-14	Transfer line, jumper, valve, gasket, etc. fails and leaks either directly into the valve box or into the transfer line jacket which drains into the valve box during a transfer leading to an overfill of the valve box due to human failure	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-15	Transfer line, jumper, valve, gasket, etc. fails and leaks either directly into the valve box or into the transfer line jacket which drains into the valve box during a transfer leading to an overfill of the valve box due to mechanical failure or material degradation U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-16	Transfer line connections, valves, or jumpers fail upon installation and results in liquid waste being spilled into the valve box during a transfer which leads to an overfill of the valve box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-17	Microbial Induced Corrosion (MIC) degrades the jumpers and associated piping and eventually leads to a leak and/or rupture that overfills the valve box U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-19	A manual valve fails closed during a transfer and overpressurizes the jumper or transfer lines which drains to jacket which leads to a line or gasket breach and an overfill of the valve box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-20	Air operated isolation valve fails shut during a transfer and the transfer line, jumper, or gasket fails from a water hammer or overpressurization which leads to overfill of valve box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Valve box	Provide airborne confinement; support conductivity probe functionality; support transfer line integrity (II/I)
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-21	Waste in the transfer line is pushed back into the flush water piping during a transfer which leads to overfill of the valve box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-22	Flushing transfer line causes water to leak into valve box which results in an overfill of valve box A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-24	Water leak testing of valve causes water to leak into valve box which results in an overfill of valve box U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-25a	Condensation in the transfer line followed by a high steam flow causes a water hammer effect and transfer line rupture which eventually leads to overfill of the valve box during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
VB-27	Flushing transfer line jacket for an extended period of time causes water to flow into valve box which results in an overfill of valve box A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CT-6	Radiological/ hazardous waste flows into catch tank from Type I transfer line encasement and results in an overfill of the catch tank (only applies to H-Area Catch Tank) EU / H / 7 (unmitigated) BEU / M / 11 (mitigated) Note: This event bounds an overfill in the LDB Drain Cell and contains controls related to that event.	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	H-Area Catch Tank	Provide waste containment and airborne confinement
		SS	Transfer Line Encasement	Provide airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SS	Conductivity probe (LDBs along leak path to LDB Drain Cell) with control room alarm	Detect release of material
		SS	Transfer Line Jacket and LDBs (along leak path to LDB Drain Cell)	Provide airborne confinement and support conductivity probe functionality
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-21	Waste transfer to the pump tank causes an overfill and release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-22	Waste is pumped into the pump tank faster than it is pumped out and results in overfill of the pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-23	Loss of instrument air through the dip tubes leads to an inaccurate or loss of tank level indication during a transfer and causes the pump tank to overflow; this prevents the level instruments from alerting the operator in the event that the sump and pump pit cell is overfilling with waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-24	Failure of dip tube weight factor leg during a transfer leads to an inaccurate or loss of tank level indication and causes the pump tank to overflow A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-25	Failure to isolate a manual valve (before or during a transfer) leads to overfill of unintended pump tank during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-26	Siphon flow through the transfer line leads to an overfill of unintended pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type/path, perform independent verification of correct transfer path alignment, and identify potential siphons and methods to stop siphons

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-27	Starting an intended transfer leads to transfer to an inadvertent path and causes an overfill of unintended pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-28	Accidental (unintended) waste transfer leads to overfill of unintended pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-29	Flush water or inhibited water flow through the inhibited water line or flush water line overfills the pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-30	Flush water or inhibited water flow through the inhibited water line or flush water line overfills the pump tank during a transfer U / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-30a	Flushing transfer line causes water to leak through the valve in the core line which results in an overfill of pump tank (may result in siphon of waste tank) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type/path, perform independent verification of correct transfer path alignment, and identify potential siphons and methods to stop siphons

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-32	Water leak testing of valve causes water to leak through the valve in the core line which results in an overfill of pump tank or out of the line which results in overfill of pump pit (may result in siphon of waste tank) U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; identify potential siphons and methods to stop siphons
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-33	Flushing steam jet line results in an overfill of pump tank releasing radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-39	Transfer line, jumper, gasket, valve, etc. fails and leaks either directly into the pump pit cell or into the transfer line jacket which drains into the pump pit cell sump during a transfer and leads to an overfill of the pump pit cell due to human failure A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-40	Transfer line, jumper, gasket, valve, etc. fails and leaks either directly into the pump pit cell or into the transfer line jacket which drains into the pump pit cell sump during a transfer and leads to an overfill of the pump pit cell due to mechanical failure or material degradation U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-41	Connections to pump tank (including jumpers) fails upon installation and results in liquid waste being spilled into the pump pit cell sump during a transfer which leads to overfill of pump pit cell U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-44	Microbial Induced Corrosion (MIC) degrades the pump tank, or related components and eventually lead to a leak or rupture that overfills the pump pit cell during a transfer U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump tank	Provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
PP-103	A tornado or high winds lead to an overfill of pump tank and results in surface airborne release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-107	A seismic event leads to overfill of pump tank during a transfer U / H / 4 (unmitigated) U / L / 6 (mitigated)	SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
PP-51a	Added vapor/ heat load (from steam jet, pump motor, decay heat etc.) in the pump tank results in overheating in the pump tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Verify jet discharge path valve position and evaluation of core pipe pluggage
		SS	Pump pit/ pump tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	HDB-8 PVV System	Purge airborne releases through HEPA filtration
		SS	Pump pit/ pump tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-19	Transfer pump overspeed during a transfer results in overpressurization of the transfer line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-20	No/Low waste flow through line results in overpressurization of the transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-21	Automatic/ manual valve closes during a transfer and overpressurizes the transfer line A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer line jacket/ encasement	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
LDB-7	High waste flow into LDB/ MLDB leads to overpressurization of LDB/ MLDB A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Conductivity probe in LDB/MLDB/LPS with control room alarm	Detect release of material
		SS	LDB/MLDB/LPS	Provide airborne confinement and support conductivity probe functionality
		SS	Transfer line jacket	Provide airborne confinement and support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-3	Transfer line, jumper, valve, gasket, etc. fails and leaks directly into LDB-17 during a transfer leading to an overpressurization of LDB-17 due to human failure A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-4	Transfer line, jumper, valve, gasket, etc. fails and leaks directly into LDB-17 during a transfer leading to an overpressurization of LDB-17 due to mechanical or material failure U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-5	Transfer line connections, valves, or jumpers fail upon installation and results in liquid waste being spilled into the LDB-17 during a transfer which leads to overpressurization of the LDB-17 A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-7	Waste in the transfer line is pushed back into the open-ended flush water piping during a transfer which leads to overpressurization of LDB-17 A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-11	Flushing transfer line causes flush water to leak into LDB-17 which results in an overpressurization of LDB-17 (10K inhibited water storage tank can be used to flush)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB17-17	A seismic event damages the transfer lines in the LDB-17 during a transfer and results in an overpressurization of the LDB-17 (cell is intact) U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Valve box	Support transfer line integrity (II/I)
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-34	Air or steam aerosolization of residual waste in the sump from the steam jet results in release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Steam jet and piping	Maintain structural integrity against failure/ provide containment
		SS	Diversion box (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Diversion box active ventilation system	Purge airborne releases through HEPA filtration
		SS	HDB-8 PVV System	Purge airborne releases through HEPA filtration
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SC	Connector Installation Program	Ensure connections are installed properly to maintain containment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
FPP1-1	High air flow through the pulse tube agitator aerosolizes the waste in the pump tank and results in a radioactive airborne release	SS	PTA Liquid Level Interlock	Ensure a minimum liquid cover over the potential sparging location
		SS	Pump pit (including HEPAs)	Provide airborne confinement; support ventilation system operation
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump pit/pump tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Severe Weather Response Program	Ensure functionality of safety SSCs during freezing conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
FPP1-3	Waste is drawn into the charge vessel and the reverse flow eductor of the pulse tube mixer aerosolizes waste into the cell and results in an airborne release	SS	PTA Air Supply PRV	Prevent waste aerosolization
		SS	Pump pit (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Pump pit/pump tank active ventilation system	Purge airborne releases through HEPA filtration
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	NMMP	Ensure functionality of safety SSCs
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-74	Air or steam aerosolization/ sparging of waste in the pump tank from the steam jet results in release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer Control Program	Pump tank transfer jet discharge path valve position verification and evaluation of core pipe pluggage
		SC	Pump Tank Transfer Jet Control Program	Pump tank transfer jet isolation when not in use
		SS	Pump pit (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Pump pit/pump tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	HDB-8 PVV System	Purge airborne releases through HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-75	Air or steam aerosolization of residual waste in the sump from the steam jet results in release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Steam jet and piping	Maintain structural integrity against failure/ provide containment
		SS	Pump pit (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Pump pit/pump tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	HDB-8 PVV System	Purge airborne releases through HEPA filtration
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-1	Large fire in vicinity of the transfer line engulfs line and results in a radiological/ hazardous material release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-7	Maintenance activity on transfer lines results in explosion and breaches line releasing residual material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; flushing core pipe following a waste transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Diversion box	Provide airborne confinement
		SS	Evaporator Cell	Provide airborne confinement
		SS	High Point Flush Pit	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-47	Pressurized gas cylinder impacts exposed transfer lines and leads to leak or rupture of piping and results in surface airborne release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
TL-48	Explosion event followed by fire in the vicinity of a transfer line damages the exposed transfer line and causes catastrophic damage to the line resulting in a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-49	An external fire spreads to the transfer line and damages the line resulting in the release of radiological/ hazardous material U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-64	Lightning followed by explosion and subsequent fire causes structural damage to transfer lines during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-54	Explosion event followed by fire in the vicinity of diversion box damages diversion box during a transfer causing damage to the jumpers and transfer lines and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-67	A seismic event induced explosion followed by a fire in or around the diversion box during a transfer causes a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Diversion box	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-43	Explosion event followed by fire in the vicinity of the valve box damages the valve box during a transfer causing damage to the jumpers and transfer lines and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-56	A seismic event induced explosion followed by a fire in or around the valve box during a transfer causes a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Valve box	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-92	Explosion event followed by fire in the vicinity of pump pit damages pump pit during a transfer causing damage to the pump tank and transfer lines and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-105	A seismic event induced explosion followed by a fire in or around the pump pit or pump tank during a transfer causes a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SC	Pump pit	Provide airborne confinement; support ventilation system operation; support transfer line integrity (II/I)
		SS	HDB-8 diesel generator	Provide power to the PVV System upon loss of normal power
		SS	HDB-8 PVV System	Prevent accumulation of flammable vapor
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Pump tank	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC/SS	Event Response Program	Secure liquid transfers and pump tank agitators; restore pump tank ventilation; and ensure HDB-8 PVV System exhaust fan inlet damper position following a seismic event
		SS	Pump Tank Backup Ventilation Systems Program	Provide backup portable ventilation (with power supply) for non-HDB-8 Complex pump tanks
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-12	The conductivity probe in the pump pit cell sump is unable to detect the presence of liquid waste inside the sump and prevents the sump from being pumped out; hydrogen build up results in an explosion and damages the pump tank and transfer line during a transfer A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Pump pit	Provide airborne confinement; support ventilation system operation; support transfer line integrity (II/I)
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Pump tank	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CT-49	A seismic event induced explosion followed by a fire in or around the catch tank cell or catch tank causes a release U / Neg / 11 (unmitigated) BEU / Neg / 11 (mitigated) Note: This event bounds an explosion in the LDB Drain Cell and contains controls related to that event.	SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	H-Area Catch Tank	Provide waste containment and airborne confinement
		SS	H-Area Catch Tank Encasement	Provide airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-52	Vehicular traffic impacts the exposed transfer lines causing structural damage which results in a leak or rupture and release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
TL-53	Vehicle impacts the exposed transfer line and ignites during a transfer resulting in a release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-54	During excavation, the transfer line is damaged by digging during a transfer which results in a leak or rupture and release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-60	Vehicular traffic or excavation equipment causes structural damage to diversion box during a transfer which causes structural damage to the jumpers and results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
HDB8-4	Stack collapse causes structural damage to the HDB-8 Complex releasing radiological/ hazardous waste EU / H / 7 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump tank	Provide containment
		SS	Diversion box	Provide waste containment and airborne confinement
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-49	Vehicular traffic or excavation equipment causes structural damage to the valve box, jumpers, and/or transfer lines during a transfer; resulting in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-97	Vehicular traffic or excavation equipment causes structural damage to pump pit, pump tank, and/or transfer lines during a transfer resulting in a release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-51	Crane or load impacts a transfer line causing a leak or rupture of the line resulting in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
DB-59	During maintenance procedures, a cell cover or load (crane, equipment, etc.) is dropped into the diversion box causing damage to the jumpers and releases residual waste (cell cover is off) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-96	During maintenance procedures, a cell cover or load (crane, equipment, etc.) is dropped into the pump pit causing damage to the pump tank, transfer lines and/or cell and releases radiological/ hazardous waste (cell cover is off) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-58	The cell cover is overloaded and collapses into the cell during a transfer damaging the jumpers and transfer lines which results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-47	The cell cover is overloaded and collapses into the valve box cell during a transfer damaging the jumpers and transfer lines which results in the release of radiological/ hazardous waste	SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-95	The cell cover is overloaded and collapses into the cell during a transfer and damages the pump tank and transfer lines which results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Pump pit	Provide waste containment and airborne confinement
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
TL-50	A wildland fire spreads to the transfer line and damages the line resulting in the release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Event Response Program	Secure liquid transfers following a wildland fire event
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-56	A wildland fire spreads to the diversion box, damages the jumpers and transfer lines during a transfer and results in the release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event covers both radiological releases and explosions, and contains all related controls.	SC	Event Response Program	Secure liquid transfers following a wildland fire event
		SS	Diversion box	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
VB-45	A wildland fire spreads and engulfs the valve box and damages the transfer lines during a transfer causing a release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event covers both radiological releases and explosions, and contains all related controls.	SC	Event Response Program	Secure liquid transfers following a wildland fire event
		SS	Valve box	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-93a	A wildland fire spreads to the pump pit, damages the pump tank and transfer lines during a transfer and results in the release of radiological/hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated) Note: This event covers both radiological releases and explosions, and contains all related controls.	SC	Event Response Program	Secure liquid transfers and pump tank agitators following a wildland fire event
		SS	Pump pit	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-60	Seismic event leads to leak or rupture of a transfer line during a transfer U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SS	Transfer line encasement	Provide airborne confinement
		SC	Diversion box	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	High Point Flush Pit	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Pump pit	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Valve box	Provide airborne confinement; support transfer line integrity (II/I)
		SS	H-Area Catch Tank	Provide waste containment and airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-66	A seismic event causes catastrophic damage to the diversion box during a transfer and results in a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Diversion box	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
HDB8-6	A seismic event causes stack collapse and subsequent structural damage to the HDB-8 Complex releasing radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Pump tank	Provide containment
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Diversion box	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Pump pit	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-55	A seismic event causes catastrophic structural damage to the valve box during a transfer and results in a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Valve box	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-104	A seismic event causes catastrophic damage to the pump pit during a transfer and results in a release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Pump tank	Provide containment
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Pump pit	Provide waste containment and airborne confinement; support transfer line integrity (II/I)
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
TL-58	A tornado/ high winds cause catastrophic damage to the transfer lines during a transfer resulting in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
DB-65	A tornado/ high winds causes catastrophic damage to diversion box and related transfer lines during a transfer and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
HDB8-5	Tornado or high winds causes stack collapse and subsequent structural damage to the HDB-8 Complex releasing radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
VB-54	Tornado or high wind causes catastrophic damage to the valve box and related transfer lines during a transfer and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
PP-102	A tornado/ high winds cause catastrophic damage to the pump tank and transfer lines during a transfer and results in the release of radiological/ hazardous waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
TL-63	Lightning strike causes structural damage to exposed transfer lines during a transfer A / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-68	Lightning strike causes structural damage to the diversion box during a transfer which causes structural damage to the jumpers and transfer lines and results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DB-69	Lightning followed by explosion and subsequent fire causes structural damage to diversion box during a transfer and results in the release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Diversion box	Provide airborne confinement; provide waste containment; support conductivity probe functionality
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-57	Lightning strike causes structural damage to the valve box during a transfer causing structural damage to the jumpers and/or transfer lines and results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-58	Lightning followed by explosion and subsequent fire causes structural damage to valve box and results in the release of radiological/ hazardous material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Valve box	Provide airborne confinement and support conductivity probe functionality
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-109	Lightning strike causes structural damage to the pump pit during a transfer which causes structural damage to the pump tank and/or transfer lines and results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump pit	Provide waste containment and airborne confinement
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-110	Lightning followed by explosion and subsequent fire causes structural damage to the pump tank and transfer lines and results in the release of radiological/ hazardous waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Pump pit	Provide waste containment and airborne confinement
		SS	Pump tank	Provide containment
		SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Fire Protection Program	Provide controls to minimize hazards associated with a fire
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
TL-67	Flooding of transfer line jacket/encasement releases residual material from jacket/encasement A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
TL-11	Explosion from organic buildup inside the transfer line A / H / 1 (unmitigated) Tank 50 related lines A / N / 11 (mitigated) Other lines BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
TL-12	High temperature causes organic vapors to ignite in the transfer line leading to an explosion in the transfer line A / H / 1 (unmitigated) Tank 50 related lines A / N / 11 (mitigated) Other lines BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
DB-4	Flammable gas (organic vapor) builds up in the diversion box and ignites resulting in an explosion and breach of transfer lines A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
DB-5	High temperature along with organics present in the diversion box can result in an explosion and damage the transfer lines A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VB-5	Flammable gas (organic vapor) builds up in the valve box and ignites resulting in an explosion and breach of transfer lines A / H / 1 (unmitigated) Tank 50 VB A / N / 11 (mitigated) Other VBs BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
VB-6	High temperature along with organics present in the valve box can result in a fire or explosion and damages the transfer line A / H / 1 (unmitigated) Tank 50 VB A / N / 11 (mitigated) Other VBs BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer lines and prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering the Tank 50/MCU transfer lines
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
PP-6	Flammable gas (organic vapor) builds up in the pump tank and ignites resulting in an explosion and breach of pump tank A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
PP-6a	Flammable gas (organic vapor) builds up in the pump pit and ignites resulting in an explosion and breach of pump tank A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
PP-7	Flammable gas (organic vapor) builds up in the pump tank and ignites resulting in an explosion and breach of pump tank or transfer line during a transfer A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
PP-7a	Flammable gas (organic vapor) builds up in the pump pit and ignites resulting in an explosion and breach of pump tank or transfer line during a transfer	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
	A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
PP-8	High temperature along with organics present in the pump tank can result in fire or explosion which damages the pump tank	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
	A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
PP-9	High temperature along with organics present in the pump pit cell can result in explosion which damages the pump tank or transfer line during a transfer	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-Tank 50/MCU transfer facilities
	A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-2-001	Explosion in the pump tank results in the release of the radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Pump pit/pump tank active ventilation system	Prevent accumulation of flammable vapor
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-3-001	Leak of acidic waste into pump pit results in the airborne release of radiological acidic waste	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-3-006	Overflow of the Pump Tank into Pump Pit resulting in an airborne radiological release A / H / A1 (unmitigated) U / N / C (mitigated)	SS	Pump tank	Provide containment
		SS	Pump pit	Provide airborne confinement and support conductivity probe functionality
		SS	Pump pit conductivity probes with control room alarm	Detect release of material
		SS	Pump pit/pump tank active ventilation system	Ensure airborne releases are mitigated via HEPA filtration
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-4-002	Direct chemical (mercury) exposure to personnel from release of vapor due to breach of ventilation system downstream of fan A / H / A1 (unmitigated) Prevented (mitigated)	SS	Pump pit/pump tank active ventilation system	Maintain structural integrity against failure / provide confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical hazards are within safe levels

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-7-002	Seismic event causes pump tank/pump pit ventilation failure, causing a buildup of hydrogen gas (corrosion induced), resulting in an explosion in the pump tank and subsequent release of the radiological acidic waste U / H / A1 (unmitigated) Prevented (mitigated)	SS	Pump pit	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SC/SS	Event Response Program	Secure liquid transfers and pump tank agitators following a seismic event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-7-003	Seismic event causes a leak into the pump pit causing a buildup of hydrogen gas (corrosion induced) resulting in an explosion in the pump pit with a subsequent release of radiological acidic waste U / H / A1 (unmitigated) Prevented (mitigated)	SC	Pump tank	Maintain structural integrity against failure/ provide containment
		SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Pump pit	Provide airborne confinement; support transfer line integrity
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-7-006	Wildland Fire event ignites combustibles inside the Pump Pit and fails the Pump Tank/Pump Pit ventilation system, resulting in a Pump Pit explosion	SC	Event Response Program	Secure liquid transfers and pump tank agitators following a wildland fire event
		SS	Pump pit	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRPP-7-007	Tornado/High Winds Fails the ventilation system causing an explosion in the pump tank (due to corrosion induced hydrogen) and subsequent release of the radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers and pump tank agitators during a tornado watch/warning or high wind warning
		SS	Pump pit	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SS	Pump tank passive vent	Extend time to LFL for the pump tanks
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-2-001	Explosion in the diversion box due to generation of corrosion-induced hydrogen results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Diversion box	Provide airborne confinement
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-2-002	Explosion in the valve box due to generation of corrosion-induced hydrogen results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Valve box	Provide airborne confinement
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-2-008	Explosion in the Catch Tank due to corrosion induced hydrogen generation results in the release of radiological acidic waste	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	H-Area Catch Tank Encasement and ground cover	Provide airborne confinement
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Transfer Line Encasement	Provide airborne confinement
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-2-011	Explosion in the LDB Drain Cell due to generation of corrosion-induced hydrogen results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	LDB Drain Cell	Provide airborne confinement
		SS	Transfer Line Jacket and LDBs (along leak path to LDB Drain Cell)	Provide airborne confinement
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-3-001	Leak of acidic waste into diversion box due to failure of transfer line results in the release of radiological acidic waste, overflowing the diversion box A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-3-002	Leak of acidic waste into valve box due to failure of transfer line results in the release of radiological acidic waste overflowing the valve box A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-3-005	Overflow of the Catch Tank resulting in an airborne radiological release A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	H-Area Catch Tank	Provide waste containment and airborne confinement
		SS	Transfer Line Encasement	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-3-006	Overflow of the LDB Drain Cell resulting in an airborne radiological release A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-4-002	Release of mercury into Diversion box due to Transfer Line leak results in personnel exposure A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-4-003	Release into the Pump Pit with subsequent jetted sump transfer into the Pump Tank results in a mercury release A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Pump pit/pump tank active ventilation system	Ensures adequate dispersion of chemical vapors
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical hazards are within safe levels

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-4-004	Release into the HDB-7 with subsequent jetted sump transfer into Tank 38 results in a mercury release A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical hazards are within safe levels

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-4-005	Release of waste into Pump tank releases mercury resulting in personnel exposure A / H / A1 (unmitigated) A / L / B (mitigated)	SS	Pump pit/pump tank active ventilation system	Ensures adequate dispersion of chemical vapors
		SS	Pump pit	Provide airborne confinement; support ventilation system operation
		SS	Pump tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical hazards are within safe levels

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-7-007	Seismic event causes a leak into the Catch Tank /Diversion Box/Valve Box/LDB Drain Cell causing a buildup of hydrogen gas (corrosion induced) resulting in an explosion with a subsequent release of radiological acidic waste U / H / A1 (unmitigated) Prevented (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Valve box	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Diversion box	Provide airborne confinement; support transfer line integrity (II/I)
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	LDB Drain Cell	Provide airborne confinement
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SS	H-Area Catch Tank Encasement	Provide airborne confinement
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-7-008	Tornado/High Winds event causes a leak into the Catch Tank/ Diversion Box/Valve Box/LDB Drain Cell causing a buildup of hydrogen gas (corrosion induced) resulting in an explosion with a subsequent release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Valve box	Provide airborne confinement
		SS	Diversion box	Provide airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SS	H-Area Catch Tank Encasement	Provide airborne confinement
		SS	Transfer Line Encasement	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTF-7-009	Wildland Fire event causes a leak into the Diversion Box/Valve Box causing a buildup of hydrogen gas (corrosion induced) resulting in an explosion with a subsequent release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Event Response Program	Secure liquid transfers following a wildland fire event
		SS	Valve box	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Diversion box	Structure is qualified to withstand a wildland fire (constructed of non-combustible material) and provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTL-2-002	Explosion in the carbon steel transfer line due to generation of corrosion-induced hydrogen results in the release of residual radiological acidic waste	SS	Transfer Control Program	Flushing core pipe following a waste transfer
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
	A / H / A1 (unmitigated)	SS	Diversion box	Provide airborne confinement
	A / M / B1 (mitigated)	SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTL-2-003	Explosion in the transfer line jacket/encasement/ LDB/ MLDB/ LPS due to generation of corrosion-induced hydrogen results in the release of residual radiological acidic waste	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space of jacket
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTL-2-005	Explosion in the transfer line due to radiolytic generation of hydrogen results in the release of residual radiological acidic waste A / H / A1 (unmitigated) A / M / B1 (mitigated) Note: This event includes all transfer lines existing or new (e.g., hose-in-hose transfer lines)	SS	Transfer Control Program	Flushing core pipe following a waste transfer
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Transfer line jacket/ encasement	Provide airborne confinement
		SS	LDB/MLDB/LPS/COP	Provide airborne confinement
		SS	Diversion box	Provide airborne confinement
		SS	Pump pit	Provide airborne confinement
		SS	Valve box	Provide airborne confinement
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTL-2-006	Explosion in the transfer line jacket/encasement/ LDB/ MLDB/ LPS due to radiolytic generation of hydrogen results in the release of residual radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space of jacket
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTL-2-007	Explosion in the hose in hose transfer line jacket resulting from radiolytic generation of hydrogen A / H / A1 (unmitigated) Prevented (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space of jacket
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTL-3-002	Transfer line loss of containment (primary and secondary) results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated) Note: This event includes all transfer lines existing or new (e.g., hose-in-hose transfer lines)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTL-7-002	Transfer line loss of containment due to a seismic event results in the release of radiological acidic waste U / H / A1 (unmitigated) Prevented (mitigated) Note: This event includes all transfer lines existing or new (e.g., hose-in-hose transfer lines) and associated controls for core pipe transfer errors (i.e., above-ground core pipe release, core pipe release into secondary containments)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions following a seismic event
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SS	Transfer line encasement	Provide airborne confinement
		SC	Diversion box	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Pump pit	Provide airborne confinement; provide waste containment; support transfer line integrity (II/I)
		SC	Valve box	Provide airborne confinement; support transfer line integrity (II/I)
		SS	H-Area Catch Tank	Provide waste containment and airborne confinement
		SS	LDB Drain Cell	Provide airborne confinement
		SC	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SC	Corrosion Control Program	Establish controls to control corrosion; flushing core pipe following an acidic waste transfer
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-14 Transfer System Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTL-7-004	Transfer line loss of containment due to a wildland fire event results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated) Note: This event includes all transfer lines existing or new (e.g., hose-in-hose transfer lines)	SC SS	Event Response Program Emergency Response Program	Secure liquid transfers following a wildland fire event Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTL-7-006	Transfer line loss of containment due to a tornado/high winds event results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated) Note: This event includes all transfer lines existing or new (e.g., hose-in-hose transfer lines)	SC SS	Severe Weather Response Program Emergency Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTL-7-007	Explosion in a carbon steel transfer line due to a tornado/high winds event result in a radiological release A / H / A1 (unmitigated) A / M / B1 (mitigated)	SS SS SS SS SS SS SS SS SS SS SS	Transfer Control Program Connector Installation Program Transfer line jacket/ encasement LDB/MLDB/LPS/COP Diversion box Pump pit Valve box Traffic Control Program Structural Integrity Program Tank Top/Secondary Containment Loading Program Critical Lift Program Emergency Response Program	Flushing core pipe following a waste transfer Ensure connections are installed properly to maintain transfer line containment Provide airborne confinement Provide airborne confinement Provide airborne confinement Provide airborne confinement Provide airborne confinement Control vehicle movements near safety SSCs Ensure structural integrity is maintained on safety SSCs Ensure that loads on tank tops and secondary containments do not compromise the structural integrity Control lifts to minimize potential for damaging safety SSCs Evacuate personnel and minimize potential release/personnel exposure following the event

* Functional Classification

SS SSCs may be required to be SC for other functions/events. SSCs are denoted as SC or SS according to the highest classification of the function they perform for the specific event. Although Administrative Programs are not functionally classified, they are denoted as SC or SS according to the highest classification of the function they perform for the specific event. SC/SS is only denoted when classification varies depending upon process area (e.g., SC for Type III waste tanks, SS for Type IV waste tanks).

** Onsite 1 Frequency/Consequence/Bin#

Frequency Acronym (see Table 3.3-2)		Consequence Acronym (see Table 3.3-3)	
A -	Anticipated	H -	High
U -	Unlikely	M -	Moderate
EU -	Extremely Unlikely	L -	Low
BEU -	Beyond Extremely Unlikely	Neg -	Negligible

For Risk Bins 1-11 Acronyms, see Tables 3.3-7, 3.3-8, and 3.3-9.

For Risk Regions A1, A2, A3, B1, B, and C Acronyms, see Tables 3.3-20 and 3.3-21.

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-11	Unintentional transfer of sludge to another waste tank leads to unexpected hydrogen buildup due to greater volume of sludge which results in an explosion in the waste tank A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC/SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-12	Steam enters the annulus which leads to heating of waste tank contents increasing the hydrogen release rate and results in an explosion in the waste tank U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event is not applicable to Tank 50.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC/SS	Flammability Control Program	Protect assumed time to LFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-13	Steam enters the annulus through the annulus transfer steam jet (annulus to tank jet) which leads to localized boiling of waste tank contents increasing the hydrogen release rate and results in an explosion in the waste tank U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event is not applicable to Tank 50 or Type IV waste tanks.	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Protect initial tank conditions
		SC	Tank Fill Limits Program	Protect initial tank conditions
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-14	Steam enters the waste tank which leads to heating of waste increasing hydrogen release rate and resulting in an explosion in the waste tank U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event is not applicable to Tank 50.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC/SS	Flammability Control Program	Protect assumed time to LFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-15	Steam enters the waste tank through the waste tank steam jet (tank to transfer system jet) which leads to heating of waste increasing the hydrogen release rate and results in an explosion in the waste tank U / H / 4 (unmitigated) BEU / H / 10 (mitigated) Note: This event is not applicable to Tank 50.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC/SS	Flammability Control Program	Protect assumed time to LFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-16	Steam enters the waste tank through the annulus transfer steam jet (annulus to tank jet) which leads to heating of waste increasing the hydrogen release rate and results in an explosion in the waste tank	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
	U / H / 4 (unmitigated)	SC	Flammability Control Program	Protect assumed time to LFL
	BEU / H / 10 (mitigated)	SC	HLLCP with alarm	Protect initial tank conditions
		SC	Tank Fill Limits Program	Protect initial tank conditions
	Note: This event is not applicable to Tank 50 or Type IV waste tanks.	SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-17	Loss of tank cooling (i.e., reduced or no flow through the cooling coils) results in waste tank temperature increase, increasing the hydrogen release rate and leads to an explosion in the waste tank A / H / 1 (unmitigated) BEU / H / 10 (mitigated) Note: This event is not applicable to Tank 50 or Type IV waste tanks.	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SC	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Protect initial tank conditions
		SC	Tank Fill Limits Program	Protect initial tank conditions
		SC	Event Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation; install/operate portable ventilation; perform manual hydrogen monitoring
		SC	Severe Weather Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation during a tornado watch/warning or high wind warning
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-18	Loss of primary waste tank ventilation system leads to hydrogen buildup and explosion in the waste tank A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SC/SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC	Event Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation; install/operate portable ventilation; perform manual hydrogen monitoring
		SC	Severe Weather Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation during a tornado watch/warning or high wind warning
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-19	Waste is transferred into a tank for too long resulting in reduced vapor space; this reduces the time to reach the lower flammability limit resulting in an explosion A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Transfer Control Program	Govern monitoring of liquid transfers
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
WT-44	Steam enters the annulus though the annulus transfer steam jet (annulus to tank jet) which results in localized boiling/pressurization and release of annulus residual though openings U / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank annulus jet and piping	Maintain structural integrity against failure/ provide containment
		SS	Transfers from Waste Tank Annuli Program	Ensure negative pressure filtered ventilation is operating
		SS	Waste Tank Annulus	Provide airborne confinement
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Transfer Control Program	Govern liquid transfers (water hammer evaluations) to ensure structural integrity is maintained on SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-99	Lightning strikes the ground and is conducted through the waste tanks resulting in a fire or explosion in the waste tank and release of waste	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Maintain structural integrity against failure; provide airborne confinement; support ventilation system operation
	A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-23	The waste tank leaks into the annulus resulting in hydrogen buildup and explosion in the annulus which breaches the tank (can re-activate old leak sites) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Type I/II/III/IIIA waste tank annulus	Support conductivity probe functionality; provide containment and airborne confinement
		SS	Type I/II/III/IIIA waste tank annulus conductivity probes with alarm	Maintain liquid level to protect initial tank annulus conditions
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-24	Waste leaks into the annulus from sidewall penetrations resulting in hydrogen buildup and explosion in the annulus which breaches the tank (can re-activate old leak sites) U / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC/SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Type I/II/III/IIIA waste tank annulus	Support conductivity probe functionality; provide airborne confinement
		SS	Type I/II/III/IIIA waste tank annulus conductivity probes with alarm	Maintain liquid level to protect initial tank annulus conditions
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment; provide airborne confinement
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-28	Explosion in Type IV tank leak detection sump or sidewall sump due to hydrogen generation following a leak (i.e., explosion in the sump increases leak potential) U / H / 4 (unmitigated) BEU / H / 10 (mitigated)	SC	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space
WT-28a	Explosion in Type III/IIIA tank underliner sump, a tertiary confinement (i.e., explosion in the sump increases leak potential) A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SC	Flammable Vapor Sampling Program	Prevent buildup of flammable vapor in the vapor space

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-29	Waste is transferred into a tank for too long resulting in an overflow of the waste tank (i.e., waste exits through the top of the tank) and leads to a surface release A / H / 1 (unmitigated) BEU / H / 10 (mitigated)	SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Transfer Control Program	Govern liquid transfers to determine transfer type, transfer path, and independent verification of correct transfer path alignment; verifies waste tank space availability
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
WT-30	Waste is transferred into a tank for too long resulting in an overfill of the waste tank (i.e., above the structural fill limit) and subsequent waste tank leak A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-30a	Siphon through the chromate cooling line (assumes line is full) results in an overfill of the waste tank (i.e., above the structural fill limit) with subsequent waste tank leak U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	CRW Coils	Maintain pressure boundary, provide containment
		SS	CRW Header Isolation Valves	Isolate CRW headers and stop siphon
		SS	Event Response Program	Closes isolation valves upon identification of boundary breaks
		SC/SS	Siphon Breakers	Prevent siphon from waste tank via the CRW system
		SS	CRW Coil Isolation Valves	Isolate CRW coils and stop siphon
		SS	NMMP	Ensure functionality of safety SSCs
		SC/SS	Severe Weather Response Program	Ensure functionality of safety SSCs during freezing conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm (Waste Tanks 1, 2, 3, 4, 7, 8, 9, 10, and 11 only)	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SC	Waste Tank mixing device operation in Waste Tank 39 is prohibited	Minimize potential for siphon/ pump-out of sludge solids from Waste Tank 39
		SC	Sludge slurry transfers out of Waste Tanks 32 and 35 are prohibited	Ensure sludge solids are not transferred to locations without SC controls to prevent siphon

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-35	Failure on the discharge side of chromate cooling water pump allows waste to enter the pump house or the environment resulting in a direct release of contamination A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	CRW Coils	Maintain pressure boundary, provide containment
		SS	CRW Header Isolation Valves	Isolate CRW headers and stop siphon
		SS	Event Response Program	Closes isolation valves upon identification of boundary breaks
		SC/SS	Siphon Breakers	Prevent siphon from waste tank via the CRW system
		SS	CRW Coil Isolation Valves	Isolate CRW coils and stop siphon
		SS	NMMP	Ensure functionality of safety SSCs
		SC/SS	Severe Weather Response Program	Ensure functionality of safety SSCs during freezing conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm (Waste Tanks 1 and 2 only)	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SC	Waste Tank mixing device operation in Waste Tank 39 is prohibited	Minimize potential for siphon/ pump-out of sludge solids from Waste Tank 39
		SC	Sludge slurry transfers out of Waste Tanks 32 and 35 are prohibited	Ensure sludge solids are not transferred to locations without SC controls to prevent siphon
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-35a	Siphon through the chromate cooling line leads to release of radiological and hazardous material (assumes line is full) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	CRW Coils	Maintain pressure boundary, provide containment
		SS	CRW Header Isolation Valves	Isolate CRW headers and stop siphon
		SS	Event Response Program	Closes isolation valves upon identification of boundary breaks
		SC/SS	Siphon Breakers	Prevent siphon from waste tank via the CRW system
		SS	CRW Coil Isolation Valves	Isolate CRW coils and stop siphon
		SS	NMMP	Ensure functionality of safety SSCs
		SC/SS	Severe Weather Response Program	Ensure functionality of safety SSCs during freezing conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm (Waste Tanks 1 and 2 only)	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SC	Waste Tank mixing device operation in Waste Tank 39 is prohibited	Minimize potential for siphon/ pump-out of sludge solids from Waste Tank 39
		SC	Sludge slurry transfers out of Waste Tanks 32 and 35 are prohibited	Ensure sludge solids are not transferred to locations without SC controls to prevent siphon
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-36	The above ground portion of the annulus to tank transfer jet line leaks or ruptures during an annulus transfer resulting in a release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SC	Severe Weather Response Program	Secure liquid transfers during a tornado watch/warning or high wind warning
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level or following a seismic event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-37	Waste leaks into the annulus from sidewall penetrations resulting in an overflow of the annulus and release to the surface U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Type I/II waste tank annulus with HEPA filters	Provide airborne confinement
		SS	Type III/IIIA waste tank annulus	Support conductivity probe functionality; provide airborne confinement
		SS	Type III/IIIA annulus conductivity probes with control room alarm	Detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTE-19	Centrifugal transfer pump/transfer jet discharge line leaks in the riser resulting in an overflow of the riser (i.e., the portion of transfer line in the riser) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SS	Waste tank transfer pump/jet riser conductivity probes with control room alarm	Detect release of material into the riser
		SS	Waste tank transfer pump/jet riser	Provide airborne confinement; support conductivity probe functionality; prevent overflow via drain
		SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Connector Installation Program	Ensure connections are installed properly to maintain transfer line containment
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTE-26	Waste is pushed back to the flush water system from the evaporator feed pump resulting in a release of waste (via flush water header drain, overflow of riser, above grade flush water line leak) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Transfer line core pipe	Maintain structural integrity against failure/ provide containment
		SC/SS	Transfer Control Program	Govern liquid transfers (water hammer and pump speed evaluations) to ensure structural integrity is maintained on SSCs; monitor waste transfers to detect release of material
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Severe Weather Response Program	Ensure functionality of safety SSCs during freezing conditions; secure liquid transfers during a tornado watch/warning or high wind warning
		SC	Event Response Program	Secure liquid transfers following a seismic event
		SC	Evaporator feed pump backflow prevention devices (242-16H only)	Provide containment of liquid waste to mitigate an above-ground radioactive material release or spill via the Flush Water System
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-41	Steam enters the waste tank through the waste tank transfer steam jet (tank to transfer system jet) which results in localized boiling/ pressurization and release of waste through openings U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Verify jet discharge path valve position and evaluation of core pipe pluggage
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
WT-42	Steam enters the waste tank through the annulus transfer steam jet (annulus to tank jet) which results in localized boiling/ pressurization and release of waste through openings U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Transfer Control Program	Verify jet discharge path valve position and evaluation of core pipe pluggage
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-47	Steam enters the waste tank through the waste tank transfer steam jet (tank to transfer system jet) which results in aerosolization or sparging of waste in the waste tank U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank transfer jet and piping	Maintain structural integrity against failure/ provide containment
		SC/SS	Transfer Control Program	Verify jet discharge path valve position and evaluation of core pipe pluggage
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
WT-51	Steam enters the annulus through the annulus transfer steam jet (annulus to tank jet) which results in aerosolization or sparging of residual waste in the annulus U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Waste tank annulus jet and piping	Maintain structural integrity against failure/ provide containment
		SS	Waste tank annulus	Provide airborne confinement
		SS	Transfers From Waste Tank Annuli Program	Ensure negative pressure filtered ventilation is operating
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-52	Excessive air flow through the annulus transfer steam jet (annulus to tank jet) results in aerosolization of waste in the annulus U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Waste tank annulus jet and piping	Maintain structural integrity against failure/ provide containment
		SS	Waste tank annulus	Provide airborne confinement
		SS	Transfers From Waste Tank Annuli Program	Ensure negative pressure filtered ventilation is operating
		SS	Transfer Control Program	Govern liquid transfers (water hammer evaluations) to ensure structural integrity is maintained on SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
WTE-15	The centrifugal long shafted mixing pump (liquid filled column) aerosolizes the contents of the waste tank resulting in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Waste Tank Mixing Device Operation	Control equipment operation to prevent aerosolization
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-43	Waste is transferred into a tank for too long resulting in an overfill (i.e., above the structural fill limit) and collapse of waste tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-56	Waste tank leaks into the annulus leading to a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-57	Moisture accumulates in the annulus due to loss of ventilation system which induces corrosion or reinitiates former tank leak sites and causes the waste tank to leak into the annulus leading to a potential surface release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-58	Loss of air flow through the inner annulus air inlet line (i.e., stagnant air) leads to increase moisture in the inner annulus which induces corrosion and causes the waste tank to leak into the annulus leading to a potential surface release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-59	Moisture accumulates in the annulus due to rupture of the heating coils which induces corrosion or reinitiates former tank leak sites and causes the waste tank to leak into the annulus leading to a potential surface release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-60	Moisture accumulates in the annulus through the dip tubes which induces corrosion or reinitiates former tank leak sites and causes the waste tank to leak into the annulus leading to a potential surface release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-61	Moisture accumulates in the annulus through steam jet which induces corrosion or reinitiates former tank leak sites and causes the waste tank to leak into the annulus leading to a potential surface release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment)
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-62	Annulus ventilation system fails and steel wall temperature of the waste tank drops below the Nil Ductility Transition Temperature (NDTT) resulting in brittle fracture of the waste tank and a leak into the annulus leading to a potential surface release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-63	Waste tank is damaged due to degradation of concrete resulting in a leak or collapse of waste tank which results in a release U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WTE-13	The centrifugal long shafted mixing pump (liquid filled column) impinges the tank wall causing failure of the waste tank or reinitiates former tank leak sites resulting in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTE-16	Vibration from centrifugal long shafted mixing pump (liquid filled column) or centrifugal long shafted telescoping transfer pumps (liquid filled column) operation causes failure of the pump support and/or waste tank resulting in a release A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WTE-31	The Submersible Ducted Turbine Mixer itself impacts the waste tank resulting in failure of the tank or reinitiates former tank leak sites resulting in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WRE-20	Addition of inhibited/ well water through the water lance impinges or erodes the waste tank wall resulting in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WRE-21	Addition of inhibited/ well water through the water lance lowers the steel wall temperature below the Nil Ductility Transition Temperature (NDTT) and localized waste tank failure resulting in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
WT-84	Overloading of the waste tank top with equipment results in collapse of the top and breach of the waste tank A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DS-12	Overloading of the waste tank top with equipment results in collapse of the top and release of dry sludge particles A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
WT-85	A crane drops a heavy load or its boom on the tank top which breaches the waste tank and results in a release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
DS-13	A crane drops a heavy load or its boom on the tank top which breaches the waste tank and results in a release of dry sludge particles A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
WT-86	Excavation near a waste tank causes a breach of the waste tank and release of waste A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
WT-92	External explosion event in the vicinity of a waste tank creates missiles or directly damages the tank top which results in a release of waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
DS-19	External explosion event in the vicinity of a waste tank damages the tank top which results in a release of dry sludge U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
WT-93	Waste tank is damaged due to void space in ground leading to a leak or collapse of waste tank and a release of waste U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
WT-95	Tornado/high wind causes catastrophic damage to a waste tank which results in a release of waste (multiple tanks may be affected) U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
DS-21	Tornado/high wind causes catastrophic damage to a waste tank which results in a release of dry sludge particles U / H / 4 (unmitigated) BEU / L / 11 (mitigated)	SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
DS-22	Tornado/high wind causes damage to the ventilation system resulting in a release from the HEPA filter U / H / 4 (unmitigated) BEU / L / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-96	Seismic event causes catastrophic damage to a waste tank which results in a release of waste (multiple tanks may be affected) U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
DS-24	Seismic event causes catastrophic damage to a waste tank which results in a release of dry sludge particles U / H / 4 (unmitigated) BEU / L / 11 (mitigated)	SC	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
DS-25	Seismic event causes catastrophic damage to a waste tank ventilation system resulting in a release from the HEPA filter U / H / 4 (unmitigated) BEU / L / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
WTE-39	Crane drops the equipment (e.g., centrifugal long shafted mixing pump, transfer pump, Submersible Ducted Turbine Mixer, etc.) inside of the waste tank causing failure of the waste tank or airborne release through open riser A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank	Maintain structural integrity against failure/ provide containment
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
WTE-40	Structural failure of the "super-structure" causes damage to the waste tank and release of waste (due to equipment impingement inside of waste tank or failure of tank top) A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTE-41	External Event/Tornado/High Winds/Seismic causes structural failure of the "super-structure" causes damage to the waste tank and release of waste (due to equipment impingement inside of waste tank or failure of tank top) U / H / 4 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Waste tank (including tank top)	Maintain structural integrity against failure/ provide containment
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
SMP-2	The SMP aerosolizes the contents of the waste tank resulting in a release of waste A / H / A1 (unmitigated) BEU / H / A3 (mitigated)	SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Waste Tank Mixing Device Operation	Control equipment operation to prevent aerosolization
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Equipment needed to stop waste tank mixing device operation	Stop waste tank mixing device operation upon indication of a primary containment waste release
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
SMP-16	Hydrogen accumulates in SMP pump column causing an explosion and release of waste A / M / B (unmitigated) U / M / B (mitigated)	SS	SMP column pressure boundary	Prevent waste from entering column/prevent column explosion
		SS	SMP flush/motor pressure boundary	Prevent waste from entering column/prevent column explosion
		SS	Waste tank	Provide airborne confinement
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Event Response Program	Secure power to SMPs following a seismic event
		SS	Equipment needed to secure power to SMPs	Secure power to SMPs
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
SMP-18	High flow of IW to SMP results in waste tank overflow U / H / A1 (unmitigated) BEU / L / C (mitigated)	SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SC	Event Response Program	Secure waste tank mixing devices following a seismic event
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Equipment needed to stop transfers, siphons, and liquid additions	Stop transfers, siphons, and liquid additions upon indication of leak/level

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
SMP-22	Flush piping fails inside riser causing the riser to overflow leading to a spill to the environment A / H / A1 (unmitigated) BEU / L / C (mitigated)	SS	SMP riser conductivity probe and interlock	Prevent overflow/interlocked to stop SMP
		SS	SMP riser structure	Provide airborne confinement; support conductivity probe functionality; prevent overflow via drain
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Equipment needed to secure power to SMPs	Secure power to the SMPs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Event Response Program	Secure waste tank mixing devices following a seismic event
SMP-23	Failure of pump column or cable seals at the top of column from overpressurization leads to a spill to the environment A / H / A1 (unmitigated) BEU / L / C (mitigated)	SS	SMP flush/motor pressure boundary	Prevent SMP Column spill
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Equipment needed to secure power to SMPs	Secure power to the SMPs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Event Response Program	Secure waste tank mixing devices following a seismic event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSMP-3-001	CSMP operation results in aerosolization and release of waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste Tank Mixing Device Operation	Control equipment operation to prevent aerosolization
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	Waste tank (including HEPAs)	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system	Purge airborne releases through HEPA filtration
		SS	Critical Lift Program	Control lift to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
EAC-2-002	Inadvertent transfer of acidic waste to Drop Tank, corrodes tank wall, leaks to annulus, produces hydrogen which leads to deflagration and causes release of radiological material A / H / A1 (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Isolation Valves	Provide containment of acidic waste in the evaporator during chemical cleaning
		SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning is not added to a waste tank
		SC	NMMP	Ensure functionality of safety SSCs
EAC-2-005	Transfer of acidic waste from evaporator cell sump to Tank 43, corrodes tank wall, leaks to annulus, produces hydrogen which leads to deflagration and causes release of radiological material A / H / A1 (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning that collects in the sump is not added to a waste tank
EAC-3-027	Inadvertent addition of acidic waste to the Drop Tank damages cooling coil allowing chromate system contamination and release of waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Isolation Valves	Provide containment of acidic waste in the evaporator during chemical cleaning
		SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning is not added to a waste tank
		SC	NMMP	Ensure functionality of safety SSCs

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
EAC-3-028	Inadvertent addition of acidic waste to the Tank 43 damages cooling coil allowing chromate system contamination and release of waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning that collects in the sump is not added to a waste tank
EAC-2-003	Inadvertent addition of acidic waste to Drop Tanks, produces hydrogen by corrosion of the tank walls or increase the hydrogen generation of the waste which leads to deflagration and causes release of radiological material A / H / A1 (unmitigated) Prevented (mitigated)	SC SC SC	242-16H Evaporator Isolation Valves 242-16H Evaporator Chemical Cleaning Program NMMP	Provide containment of acidic waste in the evaporator during chemical cleaning Ensure acidic material from evaporator chemical cleaning is not added to a waste tank Ensure functionality of safety SSCs
EAC-2-004	Inadvertent addition of acidic waste to Waste Tank 43, produces hydrogen by corrosion of the tank walls or increase the hydrogen generation of the waste which leads to deflagration and causes release of radiological material U / H / A1 (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning that collects in the sump is not added to a waste tank
EAC-3-030	Inadvertent addition of acidic waste to Drop Tank damages tank causing release of radiological/ hazardous material to annulus A / L / B (unmitigated) Prevented (mitigated)	SC SC SC	242-16H Evaporator Isolation Valves 242-16H Evaporator Chemical Cleaning Program NMMP	Provide containment of acidic waste in the evaporator during chemical cleaning Ensure acidic material from evaporator chemical cleaning is not added to a waste tank Ensure functionality of safety SSCs
EAC-3-031	Inadvertent addition of acidic waste to Tank 43 damages tank causing release of radiological/ hazardous material to annulus during chemical cleaning A / L / B (unmitigated) Prevented (mitigated)	SC	242-16H Evaporator Chemical Cleaning Program	Ensure acidic material from evaporator chemical cleaning that collects in the sump is not added to a waste tank
EAC-3-026	Inadvertent transfer of hot acidic waste to the waste tank causes high waste tank temperature/boiling associated with hot evaporator contents and heat of reaction in the waste tank A / M / B1 (unmitigated) Prevented (mitigated)	SC SC SC	242-16H Evaporator Isolation Valves 242-16H Evaporator Chemical Cleaning Program NMMP	Provide containment of acidic waste in the evaporator during chemical cleaning Ensure acidic material from evaporator chemical cleaning is not added to a waste tank Ensure functionality of safety SSCs

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-8	Unintentional transfer of organic waste to a non-organic waste tank resulting in an unknown chemical reaction and explosion in the waste tank A / H/ 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Transfer Control Program	Prevent Tank 50/MCU material from entering non-organic waste tanks
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
WT-9	Increase in waste temperature in an organic waste tank results in an explosion A / H/ 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering Tank 50
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Flammability Control Program	Protect assumed time to CLFL
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-10	High temperature inside an organic tank due to reduced or no flow of chromate cooling water results in increased organic vapor loading and an explosion in the waste tank A / H / 1 (unmitigated) BEU / N / 11 (mitigated)	SC	Inhalation Dose Potential Program	Prevent waste (with an inhalation dose potential greater than Tank 50 Supernate) from entering Tank 50
		SC	WAC	Ensure feed is maintained within assumptions (i.e., organic concentration)
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC	Severe Weather Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation during a tornado watch/warning or high wind warning
		SC	Event Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation; install/operate portable ventilation
		SS	Waste Tank Quiescent Time Program	Protect assumed time to CLFL
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
		SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Flammability Control Program	Protect assumed time to CLFL
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRRT-2-003	Explosion in the Receipt Tank due to generation of corrosion-induced hydrogen results in the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Protect initial tank conditions
		SC	Tank Fill Limits Program	Protect initial tank conditions
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation; independent verification of correct acidic transfer path alignment
CSRRT-2-007	Explosion in the Receipt Tank due to heating of waste, leading to the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Protect initial tank conditions
		SC	Tank Fill Limits Program	Protect initial tank conditions
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRRT-2-010	Explosion in a Waste Tank (Non-designated RT) due to acidic waste dissolving the sludge releasing trapped gas which results in the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Flammability Control Program	Protect assumed time to LFL
		SS	Hydrogen Monitoring	Measure hydrogen concentration
		SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation; independent verification of correct acidic transfer path alignment
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level for time to LFL
		SC	Tank Fill Limits	Provide controls to protect initial tank conditions
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRRT-3-003	Aerosolization in the Receipt Tank due to mixer operation results in the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system (including HEPAs)	Purge airborne releases through HEPA filtration
		SS	Waste Tank Mixing Device Operation	Control equipment operation to prevent aerosolization
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRRT-3-008	Aerosolization in the Receipt Tank due to mixer operation results in the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated) Note: This event postulates aerosolization from SMP cooling nozzle discharge above the liquid level.	SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system (including HEPAs)	Purge airborne releases through HEPA filtration
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Equipment needed to stop waste tank mixing device operation	Stop waste tank mixing device operation upon indication of a primary containment waste release
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
CSRRT-4-003	Direct chemical (mercury) exposure to personnel from release of vapor due to breach of ventilation system downstream of fan A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank active ventilation system	Maintain structural integrity against failure / provide confinement
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical are within safe levels

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRRT-4-004	Direct chemical (mercury) exposure to personnel from release of vapor due to breach of tank pressure boundary (maintenance, sampling, etc.) A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank active ventilation system	Maintain negative pressure and appropriate stack height to ensure adequate dispersion of chemical vapors
		SS	Waste Tank	Provide airborne confinement; support ventilation system operation
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical are within safe levels
		SS	Loss of Ventilation Response	Initiate IH monitoring and protective actions
CSRTT-2-003	Explosion in the Treatment Tank due to generation of hydrogen results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SC	Waste Tank Temperature Monitoring	Protects initial conditions for corrosion induced hydrogen generation
		SC	Waste Tank Chemical Cleaning Program	Protects initial conditions for corrosion induced hydrogen generation
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-2-004	Loss of ventilation leads to an explosion in the Treatment Tank due to generation of hydrogen resulting in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Event Response Program	Secure liquid transfers, secure waste tank mixing devices, and restore waste tank ventilation or install/operate portable ventilation following a loss of power event
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Protect assumed time to LFL
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTT-2-006	Loss of ventilation leads to an explosion in the TT Annulus due to buildup of hydrogen from acidic waste leaking from the primary waste tank results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SC	Event Response Program	Restore waste tank annulus ventilation or install/operate portable ventilation following a loss of power event
		SC	Flammability Control Program	Protect assumed time to LFL
		SS	Type I/II waste tank annulus	Provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-2-007	Explosion in the TT Annulus due to buildup of hydrogen from acidic waste leaking from the primary waste tank results in the release of radiological acidic waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Type I/II waste tank annulus active ventilation system (negative pressure)	Prevent accumulation of flammable vapor
		SS	Type I/II waste tank annulus conductivity probes with alarm	Maintain liquid level to protect initial tank annulus conditions
		SS	Type I/II waste tank annulus	Provide containment to support conductivity probe functionality; provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
CSRTT-3-001	Increased corrosion in the primary waste tank leads to waste tank leak into the annulus which results in the release of radiological acidic waste A / H / A1 (unmitigated) A / M / B1 (mitigated)	SS	Type I/II waste tank annulus active ventilation system (including HEPA) (negative pressure)	Purge airborne releases through HEPA filtration
		SS	Type I/II waste tank annulus	Provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-3-004	Aerosolization in the Treatment Tank due to mixer operation results in the release of radiological waste A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system (including HEPA)	Purge airborne releases through HEPA filtration
		SS	Waste Tank Mixing Device Operation	Control equipment operation to prevent aerosolization
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-3-014	Aerosolization in the Treatment Tank due to mixer operation results in the release of radiological waste A / H / A1 (unmitigated) A / N / C (mitigated) Note: This event postulates aerosolization from SMP cooling nozzle discharge above the liquid level.	SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SS	Waste tank active ventilation system (including HEPA)	Purge airborne releases through HEPA filtration
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	ARMs with control room notification	Alert operators to release of radiological material
		SS	ARM Location Program	Ensure proper placement of ARMs and appropriate alarm requirements
		SS	Equipment needed to stop waste tank mixing device operation	Stop waste tank mixing device operation upon indication of a primary containment waste release
		SS	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Ventilation System Performance Monitoring	Ensure HEPA filter is operating properly and capable of performing its credited function
		SS	HEPA Filter Efficiency Testing	Ensure HEPA filters are periodically efficiency tested
CSRTT-4-004	Direct chemical (mercury) exposure to personnel from release of vapor due to unplanned breach of ventilation system (primary and annulus) A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank active ventilation system	Maintain structural integrity against failure/ provide confinement
		SS	Type I/II waste tank annulus active ventilation system	Maintain structural integrity against failure/ provide confinement
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical are within safe levels

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-4-005	Direct chemical (mercury) exposure to personnel from release of vapor due to breach of tank pressure boundary, including ventilation system boundary (maintenance, sampling, etc.) (annulus and primary) A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank active ventilation system	Maintain negative pressure and appropriate stack height to ensure adequate dispersion of chemical vapors
		SS	Type I/II waste tank annulus active ventilation system	Maintain negative pressure and appropriate stack height to ensure adequate dispersion of chemical vapors
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Industrial Hygiene Program	Ensure employee exposure to chemical are within safe levels
		SS	Loss of ventilation response	Stop work and evacuate Tank Top upon loss of tank ventilation
CSRTT-7-001	Explosion in the TT Annulus due to buildup of hydrogen from acidic waste leaking from the primary waste tank results in the release of radiological acidic waste U / H / A1 (unmitigated) Prevented (mitigated)	SC	Event Response Program	Restore waste tank annulus ventilation or install/operate portable ventilation following a seismic event
		SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
		SS	Type I/II waste tank annulus	provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-7-002	Explosion in the TT due to buildup of corrosion-induced hydrogen results in a radiological release	SC	Event Response Program	Secure liquid transfers, secure waste tank mixing devices, and restore waste tank ventilation or install/operate portable ventilation following a seismic event
	U / H / A1 (unmitigated) Prevented (mitigated)	SC	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SC	Traffic Control Program	Control vehicle movements near safety SSCs
		SC	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-7-003	Explosion in the TT due to buildup of corrosion-induced hydrogen results in a radiological release A / H / A1 (unmitigated) Prevented (mitigated)	SC	Event Response Program	Restore waste tank ventilation or install/operate portable ventilation following a tornado / high winds event
		SC	Severe Weather Response Program	Secure liquid transfers and waste tank mixing devices during a tornado watch/warning or high wind warning
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-7-004	Explosion in the TT due to buildup of corrosion-induced hydrogen results in a radiological release	SC	Event Response Program	Secure liquid transfers, secure waste tank mixing devices, and restore waste tank ventilation, install/operate portable ventilation, or neutralize tank following a wildland fire event
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event
CSRTT-7-005	Explosion in the TT Annulus due to buildup of corrosion-induced hydrogen results in a radiological release	SC	Event Response Program	Restore waste tank annulus ventilation or install/operate portable ventilation following a tornado / high winds event
		SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
	A / H / A1 (unmitigated) Prevented (mitigated)	SS	Type I/II waste tank annulus	provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-7-006	Explosion in the TT Annulus due to buildup of corrosion-induced hydrogen results in a radiological release	SC	Event Response Program	Restore waste tank annulus ventilation, install/operate portable ventilation, or neutralize annulus following a wildland fire event
	A / H / A1 (unmitigated) Prevented (mitigated)	SC	Flammability Control Program	Tracks waste tanks which have less than seven days to LFL
		SS	Type I/II waste tank annulus	provide airborne confinement; support ventilation system operation
		SC	HLLCP with alarm	Maintain liquid level to protect initial tank conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
CSRTT-7-008	Direct chemical (mercury) exposure to personnel from release of vapor due to unplanned breach of ventilation system (primary and annulus) U / H / A1 (unmitigated) U / L / B (mitigated) Note: This event is associated with a seismic event	SS SS	Emergency Response Program Industrial Hygiene Program	Evacuate personnel and minimize potential release/personnel exposure following the event Ensure employee exposure to chemical are within safe levels
CSRTT-7-009	Direct chemical (mercury) exposure to personnel from release of vapor due to unplanned breach of ventilation system (primary and annulus) A / H / A1 (unmitigated) A / M / B1 (mitigated) Note: This event is associated with a tornado/high winds event	SS SS	Emergency Response Program Industrial Hygiene Program	Evacuate personnel and minimize potential release/personnel exposure following the event Ensure employee exposure to chemical, physical, and biological hazards are within safe levels
CSRTT-7-010	Corrosion in the primary waste tank leads to waste tank leak into the annulus which results in the release of radiological acidic waste A / H / A1 (unmitigated) A / M / B1 (mitigated)	SS SC SS SS SS SS SS	Type I/II waste tank annulus HLLCP with alarm Traffic Control Program Structural Integrity Program Tank Top/Secondary Containment Loading Program Critical Lift Program Corrosion Control Program	Provide airborne confinement Maintain liquid level to protect initial tank conditions Control vehicle movements near safety SSCs Ensure structural integrity is maintained on safety SSCs Ensure that loads on tank tops and secondary containments do not compromise the structural integrity Control lifts to minimize potential for damaging safety SSCs Establish controls to control corrosion
VS-19	External fire propagates to the ventilation system blinding the HEPA filter with soot which results in HEPA filter blowout A / M / 2 (unmitigated) BEU / M / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
VS-24	Tornado or high winds causes structural damage to the ventilation system which leads to a radiological waste release from the HEPA filter A / M / 2 (unmitigated) BEU / M / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
TVS-8	Loss of chromate cooling water on the condenser leads to moisture in the ventilation system which results in a blowout of the HEPA filter A / Neg / 11 (unmitigated) BEU / Neg / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
TVS-26	External fire propagates to the ventilation system blinding the HEPA filter with soot which results in HEPA filter blowout A / M / 2 (unmitigated) BEU / M / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
TVS-29	Tornado or high winds causes structural damage to the ventilation system which leads to a radiological release from the ventilation system A / M / 2 (unmitigated) BEU / M / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
TVS-29a	A seismic event causes structural damage to the ventilation system which leads to a radiological release from the ventilation system U / M / 5 (unmitigated) BEU / M / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
CT-53	A tornado/ high winds cause damage to the passive vent on the catch tank and results in a release from the HEPA filter U / Neg / 11 (unmitigated) BEU / Neg / 11 (mitigated)	SS	HEPA Filter Program	Limit source term on the filter
HC-14	A wildland fire propagates to the decon cell, repair cell or storage cell resulting in a release of radiological and/or chemical material A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC	299-H Inventory Control Program	Maintain the 299-H inventory within HC 3 limits

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WT-90	A wildland fire spreads to a waste tank and results in a release of waste	SC	Event Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation following a wildland fire event
	A / H / 1 (unmitigated) BEU / M / 11 (mitigated)	SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
	Note: This event covers both radiological releases and explosions, and contains all related controls.	SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Waste tank	Structure is qualified to withstand a wildland fire (constructed of non-combustible material; below grade location) and provide airborne confinement
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-001	Operation of waste tank mixing devices agitates sludge which releases trapped hydrogen and results in an explosion in the waste tank A / H / A1 (unmitigated) Prevented (mitigated) Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Waste tank ventilation low flow interlock	Stop waste tank mixing devices on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Stop waste tank mixing devices on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-002	Operation of waste tank mixing devices dissolves saltcake which releases trapped hydrogen and results in an explosion in the waste tank A / H / A1 (unmitigated) Prevented (mitigated) Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Waste tank ventilation low flow interlock	Stop waste tank mixing devices on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Stop waste tank mixing devices on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-004	Addition of liquid dissolves saltcake which releases trapped hydrogen and results in an explosion in the waste tank	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
	A / H / A1 (unmitigated) Prevented (mitigated)	SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
	Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Waste tank ventilation low flow interlock	Close dissolution liquid addition valves on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Close dissolution liquid addition valves on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-006	Removal of interstitial liquid from saltcake releases trapped hydrogen and results in an explosion in the waste tank	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
	A / H / A1 (unmitigated) Prevented (mitigated)	SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
	Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Waste tank ventilation low flow interlock	Stop transfer pumps associated with saltcake interstitial liquid removal on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Stop transfer pumps associated with saltcake interstitial liquid removal on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-008	Removal of liquid (free supernate removal) from above the solids layers (saltcake/sludge) releases trapped hydrogen and results in an explosion in the waste tank	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
	A / H / A1 (unmitigated) Prevented (mitigated)	SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
	Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-009	Spontaneous liberation of trapped hydrogen from slurried sludge results in a cascade release of additional trapped hydrogen and results in an explosion in the waste tank A / H / A1 (unmitigated) Prevented (mitigated) Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
		SC/SS	Waste Tank Quiescent Time Program (Spontaneous Liberation Protection)	Protect assumed time to LFL/CLFL
		SS	Hydrogen monitoring	Measure hydrogen concentration
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-010	Operational activities in the waste tank cause a localized release of trapped hydrogen resulting in a flammable transient (plume) exceeding the LFL and results in an explosion in the waste tank A / H / A1 (unmitigated) Prevented (mitigated) Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	HLLCP with alarm	Protect initial tank conditions
		SS	Tank Fill Limits Program	Protect initial tank conditions
		SS	Waste tank	Provide airborne confinement
		SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-2-011	Operation of a transfer pump for waste tank recirculation dissolves saltcake which releases trapped hydrogen and results in an explosion in the waste tank	SC/SS	Waste tank active ventilation system	Protect initial flammable vapor concentration; prevent/minimize accumulation of flammable vapor
		SS	Waste tank	Provide airborne confinement; support ventilation system operation
	A / H / A1 (unmitigated) Prevented (mitigated)	SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
		SS	Hydrogen monitoring	Measure hydrogen concentration
	Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SS	Tank 50 Waste Temperature Monitoring	Ensure that equilibrium Isopar® L and trace organics are maintained within initial conditions
		SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC/SS	Waste tank ventilation low flow interlock	Stop transfer pumps associated with waste tank recirculation on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Stop transfer pumps associated with waste tank recirculation on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

Table 3.3-15 Waste Tank and Others Mitigated HA and SS Controls (continued)

HA Event Number	Description **Onsite 1 Frequency/ Consequence/Bin#	*Funct. Class.	Control	Safety Significant Functions
WTTG-7-001	Seismic event induces the release of trapped hydrogen in sludge/saltcake and results in an explosion in the waste tank	SS	Waste tank	Provide airborne confinement
		SC/SS	Gas Release Program	Protect assumed conditions for hydrogen concentration in the waste tank bulk vapor space
	U / H / A1 (unmitigated) U / H / A1 (mitigated)	SC/SS	Waste Tank Quiescent Time Program (Seismic Release Protection)	Protect assumed time to LFL/CLFL
	Note: This event is not applicable to Type I/II Acidic Chemical Cleaning Waste Tanks.	SC/SS	Flammability Control Program	Protect assumed time to LFL/CLFL; tracks waste tanks which have less than seven days to LFL/CLFL
		SC/SS	HLLCP with alarm	Protect initial tank conditions
		SC/SS	Tank Fill Limits Program	Protect initial tank conditions
		SC	Event Response Program	Secure liquid transfers, waste tank mixing devices, and transfer pumps associated with waste tank recirculation; install/operate portable ventilation; perform manual hydrogen monitoring
		SC/SS	Waste tank ventilation low flow interlock	Stop waste tank mixing devices, stop transfer pumps associated with waste tank recirculation, close dissolution liquid addition valves, and stop transfer pumps associated with saltcake interstitial liquid removal on low ventilation flow
		SS	Waste tank hydrogen monitor and high hydrogen concentration interlock	Stop waste tank mixing devices, stop transfer pumps associated with waste tank recirculation, close dissolution liquid addition valves, and stop transfer pumps associated with saltcake interstitial liquid removal on high LFL
		SC/SS	Traffic Control Program	Control vehicle movements near safety SSCs
		SC/SS	Structural Integrity Program	Ensure structural integrity is maintained on safety SSCs
		SC/SS	Tank Top/Secondary Containment Loading Program	Ensure that loads on tank tops and secondary containments do not compromise the structural integrity
		SC/SS	Critical Lift Program	Control lifts to minimize potential for damaging safety SSCs
		SC/SS	Corrosion Control Program	Establish controls to control corrosion
		SS	Emergency Response Program	Evacuate personnel and minimize potential release/personnel exposure following the event

* Functional Classification

SS SSCs may be required to be SC for other functions/events. SSCs are denoted as SC or SS according to the highest classification of the function they perform for the specific event. Although Administrative Programs are not functionally classified, they are denoted as SC or SS according to the highest classification of the function they perform for the specific event. SC/SS is only denoted when classification varies depending upon process area (e.g., SC for Type III waste tanks, SS for Type IV waste tanks).

** Onsite 1 Frequency/Consequence/Bin#

Frequency Acronym (see Table 3.3-2)		Consequence Acronym (see Table 3.3-3)	
A -	Anticipated	H -	High
U -	Unlikely	M -	Moderate
EU -	Extremely Unlikely	L -	Low
BEU -	Beyond Extremely Unlikely	Neg -	Negligible

For Risk Bins 1-11 Acronyms, see Tables 3.3-7, 3.3-8, and 3.3-9.

For Risk Regions A1, A2, A3, B1, B, and C Acronyms, see Tables 3.3-20 and 3.3-21.

Table 3.3-16 Planned Equipment Upgrades

Proposed Improvement Description	Functional Classification	DBA DSA Section(s)	Currently Credited Control(s)	DSA Section(s) Addressing Vulnerability of Existing Control(s)	Justification for Proposed Improvements
Pump Tank Ventilation with flow interlocks supplied by Diesel Generator power to prevent Pump Tank Explosions	SS	3.4.2.8	Pump Tank Ventilation System and supporting Diesel Generator	4.4.9 4.4.10 4.4.11	2, 3, 4
Loss of Power Alarm in Control Room for Leak Detection Conductivity Probes	SS	3.4.2.7 3.4.2.9	Conductivity probes	4.4.4 4.4.13 4.4.7 4.4.28 4.4.8 4.4.30	2, 4
Automatic Isolation of incoming waste streams to Pump Tanks upon high level in Pump Tank to prevent Pump Tank Overflow	SS	3.4.2.9	PP sump conductivity probe alarm and operator action	3.4.2.9	2, 5
Siphon breakers in CRW supply/return headers for Waste Tanks 39, 40, and 51	SC	3.4.2.15	Prohibited operations: 1. Operation of waste tank mixing devices in Waste Tank 39 2. Sludge slurry transfers out of Waste Tanks 32 & 35	3.4.2.15	1, 2, 3, 4, 5

Table 3.3-16 Planned Equipment Upgrades (continued)

Proposed Improvement Description	Functional Classification	DBA DSA Section(s)	Currently Credited Control(s)	DSA Section(s) Addressing Vulnerability of Existing Control(s)	Justification for Proposed Improvements
Interlocks (with alarms) which stop transfers upon identification of a leak from the primary containment. The interlocks shall minimize the quantity of leaked material and provide indication to ensure operator actions to prevent buildup of flammable vapors in secondary containments	SS	3.4.2.6 3.4.2.7 3.4.2.9	Leak detection in secondary containment and operator action	4.4.4 4.4.13 4.4.7 4.4.28 4.4.8 4.4.30	2, 3, 4, 5
Passive ventilation for pump tanks, PPs, VBs, DBs to prevent explosions from leaked material into the boxes. Passive ventilation should be sized to address dissolved and trapped gas release and radiolytically generated hydrogen	SS	3.4.2.7 3.4.2.8	Active pump tank/PP ventilation system	4.4.9 4.4.10	2, 3, 4, 5

Table 3.3-16 Planned Equipment Upgrades (continued)

Proposed Improvement Description	Functional Classification	DBA DSA Section(s)	Currently Credited Control(s)	DSA Section(s) Addressing Vulnerability of Existing Control(s)	Justification for Proposed Improvements
Waste tank ventilation upgrades including flow instrumentation and interlocks, seismic qualification, and backup power, for Waste Tanks which become flammable in 7 days following a seismic event	SC	3.4.2.11	Waste tank ventilation system	4.3.12	2, 3, 4, 5, 6
Waste tank ventilation upgrades including seismic and tornado/ high wind qualification and backup power, for Type I/II Acidic Chemical Cleaning Waste Tanks which become flammable in 3 days	SC	3.4.2.11 3.4.2.17 3.4.2.18 3.4.2.19	Waste tank ventilation system	4.3.12	2, 3, 4, 5, 6
Waste tank annulus ventilation upgrades including seismic and tornado/ high wind qualification and backup power, for Type I/II Acidic Chemical Cleaning Waste Tank annulus which become flammable in 5 days	SS	3.4.2.12 3.4.2.17 3.4.2.18 3.4.2.19	Waste tank annulus ventilation system	4.4.27	2, 3, 4, 5, 6

Table 3.3-16 Planned Equipment Upgrades (continued)

Proposed Improvement Description	Functional Classification	DBA DSA Section(s)	Currently Credited Control(s)	DSA Section(s) Addressing Vulnerability of Existing Control(s)	Justification for Proposed Improvements
NPH qualification of buildings and structures supporting safety related equipment	SC	3.4.2.18	Event Response Program	3.4.2.18	2, 4

BENEFIT NOTES:

1. Reduces consequences to within EGs
2. Eliminates operator intense controls
3. Brings controls in compliance with DOE Order 420.1C (Ref. 18) design requirements
4. Overcomes major equipment vulnerabilities
5. Brings control scheme for affected scenarios in compliance with DOE-STD-3009 (Ref. 4) control selection hierarchy (preventer over mitigator, passive over active, SSCs over administrative control, etc.)
6. Reduces time at risk

Table 3.3-17 Design Basis Accidents to be Analyzed in Section 3.4

Accident Type	DSA Section/ Chapter	Accident	HA Event
Fire	3.4.2.5	Transfer Facility Fire	PP-1, DB-1, VB-1, EC2-1, EC3-1
Explosion	3.4.2.1	Evaporator Pot Explosion	EV2-3a, EV2-4, EV2-77, EV3-3a, EV3-4, EV3-79, EAC-2-001
	3.4.2.2	Evaporator Cell Explosion	EV2-4a, EV2-77, EV3-4a, EV3-79
	3.4.2.6	Transfer Line and Transfer Line Jacket/Encasement Explosions	TL-7, TL-8, TL-9, TL-10, TL-11, TL-12, TL-13, TL-14, TL-15, LDB-2, LDB-3, CSRTL-2-002, CSRTL-2-003, CSRTL-2-005, CSRTL-2006, CSRTL-2-007
	3.4.2.7	Transfer Facility Explosions	CT-5, DB-3, DB-4, DB-5, DB-6, DB-7, DB-8, DB-9, DB-10, DB-11, DB-12b, VB-4, VB-5, VB-6, VB-8, VB-9, VB-10, VB-11b, LP-2, LP-3, CSRTF-2-001, CSRTF-2-002, CSRTF-2-008, CSRTF-2-011
	3.4.2.8	Pump Pit and Pump Tank Explosion	PP-4, PP-4a, PP-5, PP-5a, PP-6, PP-6a, PP-7, PP-7a, PP-8, PP-9, PP-10, PP-11, PP-12, PP-13, PP-14, PP-15, PP-16, PP-18a, PP-18b, PP-19c, PP-19d, CSRPP-2-001

Table 3.3-17 Design Basis Accidents to be Analyzed in Section 3.4 (continued)

Accident Type	DSA Section/ Chapter	Accident	HA Event
Explosion (Continued)	3.4.2.11	Waste Tank Explosion	WT-7, WT-8, WT-9, WT-10, WT-11, WT-12, WT-13, WT-14, WT-15, WT-16, WT-17, WT-18, WT-19, WT-99, WTE-4, WTE-6, WTE-8, SMP-16, SMP-30, EAC-2-003, EAC-2-004, CSRRT-2-003, CSRRT-2-007, CSRRT-2-010, CSRTT-2-003, WTTG-2-001, WTTG-2-002, WTTG-2-004, WTTG-2-006, WTTG-2-008, WTTG-2-009, WTTG-2-010, WTTG-2-011, WTTG-7-001
	3.4.2.12	Waste Tank Annulus Explosion	WT-20, WT-22, WT-23, WT-24, WT-26a, WT-28, WT-28a, EAC-2-002, EAC-2-005, CSRTT-2-007
	3.4.2.16	299-H Events	WCT-3, WCT-4, WCT-5
	3.4.2.20	Loss of Offsite Power	CSRTT-2-004, CSRTT-2-006
Loss of Containment/ Confinement	3.4.2.3	Evaporator Overflow, Leaks, and Spills	EV2-5, EV2-6, EV2-7, EV2-8, EV2-17, EV2-18, EV2-28, EV2-38, EV2-41, EV2-44, EV2-44a, EV2-44b, EV2-68, EV2-75a, EV3-5, EV3-6, EV3-7, EV3-8, EV3-10, EV3-12, EV3-13, EV3-14, EV3-15, EV3-16, EV3-46, EV3-46a, EV3-70, EV3-78a, EC2-16, EC3-16
	3.4.2.4	Evaporator Overpressure	EV2-22, EV2-23, EV2-24, EV2-25, EV2-26, EV2-31, EV2-34, EV2-37, EV2-39, EV2-40, EV3-17, EV3-18, EV3-22, EV3-23, EV3-24, EV3-25, EV3-26, EV3-28, EV3-31, EV3-34, EV3-37, EV3-38, EV3-39, EV3-40, EV3-41, EAC-3-003, EAC-3-004

Table 3.3-17 Design Basis Accidents to be Analyzed in Section 3.4 (continued)

Accident Type	DSA Section/ Chapter	Accident	HA Event
Loss of Containment/ Confinement (Continued)	3.4.2.9	Transfer Error/SMP Waste Release	CT-6, PP-21, PP-22, PP-23, PP-24, PP-25, PP-26, PP-27, PP-28, PP-29, PP-30, PP-30a, PP-32, PP-33, PP-39, PP-40, PP-41, PP-44, PP-92, PP-95, PP-96, PP-97, PP-109, PP-110, DB-15, DB-16, DB-17, DB-18, DB-20, DB-21, DB-23, DB-26a, DB-54, DB-58, DB-59, DB-60, DB-68, DB-69, HDB8-4, VB-14, VB-15, VB-16, VB-17, VB-19, VB-20, VB-21, VB-22, VB-24, VB-25a, VB-27, VB-43, VB-47, VB-49, VB-57, VB-58, VB17-3, VB17-4, VB17-5, VB17-7, VB17-11, TL-1, TL-2, TL-19, TL-20, TL-21, TL-23, TL-24, TL-25, TL-26, TL-27, TL-28, TL-29, TL-31, TL-34b, TL-47, TL-48, TL-49, TL-51, TL-52, TL-53, TL-54, TL-63, TL-64, LDB-1a, LDB-4, LDB-5, LDB-7, WT-29, WT-36, WT-37, WTE-19, WTE-26, SMP-18, SMP-22, SMP-23, LP-14, CSRPP-3-001, CSRPP-3-006, CSRTF-3-001, CSRTF-3-002, CSRTF-3-005, CSRTF-3-006, CSRTL-3-002
	3.4.2.10	Aerosolization Events	PP-74, PP-75, FPP1-1, FPP1-3, DB-34, WT-47, WT-51, WT-52, WTE-15, WTE-27, SMP-2, LP-9, CSRRT-3-003, CSRRT-3-008, CSRTT-3-004, CSRTT-3-014, CSMP-3-001
	3.4.2.13	Waste Tank/Pump Tank Overheating	PP-51a, WT-40, WT-41, WT-42, WT-44, WT-91, EAC-3-026

Table 3.3-17 Design Basis Accidents to be Analyzed in Section 3.4 (continued)

Accident Type	DSA Section/ Chapter	Accident	HA Event
Loss of Containment/ Confinement (Continued)	3.4.2.14	Waste Tank Wall Failure	WT-30, WT-43, WT-56, WT-57, WT-58, WT-59, WT-60, WT-61, WT-62, WT-63, WT-84, WT-85, WT-86, WT-92, WT-93, WT-94, WT-98, WTE-13, WTE-16, WTE-31, WTE-39, WTE-40, WTE-41, WRE-20, WRE-21, DS-12, DS-13, DS-19, EAC-3-030, EAC-3-031, CSRTT-3-001
	3.4.2.15	Waste Tank Siphon/Pump-Out	WT-30a, WT-35, WT-35a, EAC-3-027, EAC-3-028
	3.4.2.21	Chemical Release	EV2-46, EV3-48, OH2-3a,OH3-3a, OHHG-1-001, OHHG-1-002, OHHG-1-003
Criticality	Chapter 6	Criticality	EV2-65, EV2-65a, EV2-66, EV2-67, EV3-67, EV3-67a, EV3-68, EV3-69, WT-83, SD-3
Natural Phenomenon	3.4.2.17	Tornado and High Winds Event	PP-102, PP-103, DB-65, HDB8-5, VB-20, VB-54, TL-58, EV2-75, EV3-77, WT-10, WT-17, WT-18, WT-23, WT-24, WT-35, WT-35a, WT-36, WT-95, WTE-26, WTE-41, DS-21, DS-22, B25-24, LP-3, VS-24, TVS-8, TVS-29, CT-53, CSRPP-7-007, CSRTF-7-008, CSRTL-7-006, CSRTL-7-007, CSRTT-7-003, CSRTT-7-005

Table 3.3-17 Design Basis Accidents to be Analyzed in Section 3.4 (continued)

Accident Type	DSA Section/ Chapter	Accident	HA Event
Natural Phenomenon (Continued)	3.4.2.18	Seismic Event	PP-12, PP-104, PP-105, PP-107, DB-7, DB-66, DB-67, HDB8-6, VB-9, VB-20, VB-55, VB-56, VB17-17, TL-60, TL-61, LDB-3, LDB-5, EV2-37, EV2-75a, EV2-76, EV2-77, EV3-78, EV3-78a, EV3-79, WT-8, WT-10, WT-17, WT-18, WT-20, WT-23, WT-24, WT-30a, WT-35, WT-35a, WT-36, WT-57, WT-62, WT-96, WTE-26, WTE-41, DS-24, DS-25, TT-16, TT-20, B25-20, B25-25, SMP-16, SMP-18, SMP-22, SMP-23, LP-3, LP-18, CT-49, TVS-8, TVS-26, TVS-29a, WCT-3, WCT-31, CSRPP-7-002, CSRPP-7-003, CSRTF-7-007, CSRTL-7-002, CSRTT-7-001, CSRTT-7-002, CSRTT-7-010, EAC-7-001, WTTG-7-001
	3.4.2.19	Wildland Fire	PP-93a, DB-56, VB-45, TL-50, EV2-74, EV3-76, WT-90, TT-17, B25-20, LP-3, VS-19, TVS-26, CH-7a, HC-14, CSRPP-7-006, CSRTF-7-009, CSRTL-7-004, CSRTT-7-004, CSRTT-7-006
Miscellaneous Areas	3.4.2.22	Transportation Accident	TT-1, TT-2, TT-3, TT-4, TT-5, TT-9, TT-10, TT-11, TT-12, TT-12a, TT-16, TT-18, TT-18a, TT-19, TT-21, B25-1, B25-2, B25-3, B25-3a, B25-4, B25-5, B25-6, B25-7, B25-7a, B25-8, B25-10, B25-12, B25-13, B25-14, B25-17, B25-18, B25-19, B25-20, B25-21, B25-21a, B25-22, B25-23, B25-24, B25-26, B25-27

Table 3.3-18 MCU Design Inputs and Assumptions

Parameter or Component	Value
MCU Waste Feed Stream Inhalation Dose Potential	≤ 1.69E+05 rem/gal [(a)]
MCU Waste Feed Stream (From 512-S Actinide Removal Process)	Maintain sum of ratios < 1.0 to protect the HC 3 status [(b)]
Strip Effluent Stream Maximum Concentration	≤ 16.5 Ci/gal (Cs-137)
Solvent Component Maximum Concentrations [(c)]	
Isopar L	767 g/L
Cs-7SB	761 g/L
BOBCalix C6	24.1 g/L
MaxCalix	143 g/L
TOA	3.18 g/L
TiDG	4.65 g/L
Strip Feed Tank Maximum Concentration	≤ 0.006 M (0.038 wt. %) nitric acid or ≤ 0.0125 M (0.077 wt. %) boric acid
Chemical Cleaning Agent Tote Maximum Concentration	≤ 2.58 M (15 wt. %) nitric acid or ≤ 10.5 M (31.5 wt. %) sodium hydroxide
Maximum Ci Concentration for Unloading Solvent	≤ 0.03 Ci/gal (Cs-137)

Notes:
(a) By controlling the inhalation dose potential of the feed stream, the inhalation dose potentials of Strip Effluent Hold Tank and Contactor Drain Tank (≤ 4.62E+05 rem/gal) and the inhalation dose potentials for Strip Effluent Decanters and Centrifugal Contactors (≤ 1.54E+06 rem/gal) will inherently be controlled.
(b) Sum of ratios is less than 1.0 when compared to HC 2 thresholds (Ref. 236).
(c) The solvent component concentrations are based on 440 gallons in the solvent concentrate drums.

Table 3.3-19 ARP and MCU Tank Data

Vessel	Vessel Volume (gal)
MCU Facility	
Salt Solution Receipt Tank 1	7,755
Salt Solution Receipt Tank 2	7,755
Salt Solution Feed Tank	7,751
Contactors and Piping	1,000
DSS Decanter	1,206
Strip Effluent Decanter	391
DSS Hold Tank	7,757
Strip Effluent Hold Tank	1,079
Solvent Hold Tank	415
ARP Facility	
241-96H MST Strike Tank 1	6,204
241-96H MST Strike Tank 2	6,204

Table 3.3-20 Radiological and Chemical Hazard Related Controls Selection Criteria Matrix: Public, Co-Located, and Facility Worker (Ref. 242)

Frequency → / Consequence ↓	Beyond Extremely Unlikely ($f < 10^{-6}$/yr)	Extremely Unlikely ($10^{-6} \le f < 10^{-4}$/yr)	Unlikely ($10^{-4} \le f < 10^{-2}$/yr)	Anticipated ($f \ge 10^{-2}$/yr)
**High	*C/A3	A2	A1	A1
Moderate	C	B	B	B
Low	C	B	B	B
Negligible	C	C	C	C

Key:

A1 — **Region A1**

Region A1. Unmitigated events falling in Region "A1" due to radiological release require controls (SC for the public and SS for workers), and are highly recommended for additional Levels of Control for all receptors. Unmitigated events falling in Region "A1," due to chemical release require SS controls and are highly recommended for additional Levels of Control. The desired result is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.**

A2 — **Region A2**

Region A2. Unmitigated events falling in Region "A2" due to radiological release require controls (SC for the public and SS for workers), and are recommended for additional Levels of Control for all receptors. Unmitigated events falling in Region "A2," due to chemical release require SS controls and are recommended for additional Levels of Control. The desired result is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.**.

A3 — **Region A3**

Region A3. Unmitigated events falling in Region "A3" due to radiological release require controls (SC for the public and SS for workers), and are considered for additional Levels of Control for CW or public. Unmitigated events falling in Region "A3," due to chemical release require SS controls and consideration for additional Levels of Control. The desired result is that the mitigated consequence is moved from "high" to "low" or "negligible."**

B — **Region B**

Events having moderate "B" consequences that challenge "A" region consequences require SC (public) or SS (worker) controls. Otherwise, events falling in Region "B" require Facility Controls. The desired result is that the mitigated combination of consequence and frequency is moved toward, and possibly into, the "C" region.

C — **Region C**

Events falling in Region "C" are not considered for controls. However, there may be events in this region that require the addition of Facility Controls because the frequency is higher than desired, the occurrence of the uncontrolled event is unacceptable to management in any event, or the uncontrolled event is unacceptable for programmatic or political reasons.

* Process related internal events that are not covered by NPH or External Events are assumed to be credible events, regardless of frequency, and fall into the Region A's; however, also see related criteria in E7, 2.25 (Rev. 14), Att. 8.8 (Ref. 16). Credible external man-made events with a frequency of $< 10^{-6}$/yr as conservatively estimated, or $< 10^{-7}$/yr as realistically estimated fall into Region C. NPH events are evaluated at the frequency specified by DOE-STD-1020 (Ref. 19).

** When a preventive control strategy is selected for unmitigated events falling in Region A1 or A2, there is not an absolute requirement to make the mitigated event BEU. If the control strategy meets all the engineering requirements for its classification [SC for public (radiological) and SS for public (chemical) or workers], it is acceptable even if the event frequency is not BEU. The mitigated event is considered to be in Region B. The desired result is that the mitigated consequence is moved well into the B region, and possibly the "C" region by the addition of Facility Controls.

Table 3.3-21 Radiological, Chemical Hazard, and Physical Injury Related Controls Selection Criteria Matrix Public, Co-located, and Facility Worker (Ref. 242)

Frequency → / Consequence ↓	Beyond Extremely Unlikely ($f < 10^{-6}$/yr)	Extremely Unlikely ($10^{-6} \le f < 10^{-4}$/yr)	Unlikely ($10^{-4} \le f < 10^{-2}$/yr)	Anticipated ($f \ge 10^{-2}$/yr)
High	C/A3*	A2	A1	A1
Moderate	C/B1**	B1	B1	B1
Low	C	B	B	B
Negligible	C	C	C	C

Key:

A1 — **Region A1**

Unmitigated events falling in Region "A1" due to radiological release require controls (SC for the public and SS for workers), and are highly recommended for additional Levels of Control (LOC) for all receptors per Ref. 16. Unmitigated events falling in Region "A1," due to chemical release or prompt fatality (etc.), require SS controls and highly recommended for additional LOC per Ref. 16. The goal is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.***

A2 — **Region A2**

Unmitigated events falling in Region "A2" due to radiological release require controls (SC for the public and SS for workers), and are recommended for additional Levels of Control for all receptors per Ref. 16. Unmitigated events falling in Region "A2," due to chemical release or prompt fatality (etc.), require SS controls and recommended for additional Levels of Control per Ref. 16. The goal is that the mitigated consequence is moved well into the B region, and possibly the "C" region or the event is prevented.***

A3 — **Region A3**

Unmitigated events considered credible per E7, 2.25 falling in Region "A3" due to radiological release require controls (SC for the public and SS for workers), and are considered for additional LOC for CW or public per Ref. 16. Unmitigated events falling in Region "A3," due to chemical release or prompt fatality (etc.), require SS controls and consideration for additional LOC per Ref. 16. The desired result is that the mitigated consequence is moved into the "B" or "C" region, or the event is prevented.***

B1 — **Region B1**

(a) Radiological events that have been evaluated using 50% meteorology and 100 cm surface roughness (for onsite receptors) or 95% meteorology and 100 cm surface roughness (for offsite receptor) and have moderate "B1" consequences that challenge the high consequence criteria require SC controls for the public or SS controls for the workers.

(b) For offsite receptor (public), radiological events that have been evaluated using 95% meteorology and 3 cm surface roughness and have moderate "B1" consequences that challenge the high consequence criteria require SC controls.

(c) For onsite receptors (worker), radiological events that have been evaluated using 95% meteorology and 3 cm surface roughness and fall into Region "B1" (i.e., not exceed EG) require Facility Controls.

(d) Unmitigated events that have moderate "B1" consequences to all receptors due to chemical release require SS controls; serious injury (etc.) to the worker requires Facility Controls.

(e) For unmitigated events having moderate consequences that do not challenge the high consequence range, Facility Controls and/or safety programs should be selected. Documentation must be provided when facility controls or safety programs are not implemented.

B — **Region B**

Unmitigated events having low "B" consequences may require facility controls or safety programs. Justification must be provided when facility controls or safety programs are not implemented.

C — **Region C**

Events falling in Region "C" are not considered for controls. However, there may be events in this region that require the addition of Facility Controls because the frequency is higher than desired, the occurrence of the uncontrolled event is unacceptable to management in any event, or the uncontrolled event is unacceptable for programmatic or political reasons.

* NPH , external events, and internal events in this frequency bin shall be addressed as required by E7, 2.25, Att. 8.8, Section 8.8.1.

** Moderate consequence "B1" events considered credible in this frequency bin that challenge high consequence criteria shall be treated the same as A3 events (i.e., consistent with E7, 2.25, Att. 8.8, Section 8.8.1). Moderate consequence events considered credible per E7, 2 25 in this frequency range that do not challenge high consequences should consider facility controls or safety programs.

*** When a preventive control strategy is used, there is no requirement to make the event BEU. See E7, 2.25.

Table 3.3-22 CSTF Defense-in-Depth / Important-to-Safety Hazard Controls

DID Item	SSC	Safety Function
1	MCU Process Vessel Ventilation System	1. Reduce flammable vapors from the Solvent Hold Tank (SHT) to maintain combustible gas concentrations less than the CLFL during normal operation 2. Provide an active filtered release path for Decontaminated Salt Solution Hold Tank, Contactor Drain Tank (CDT), Strip Effluent Hold Tank (SEHT), SHT, Shielded Sampler Containment Boxes, and Sample Station Enclosure
2	MCU Process Area Cell and Sump	Contain spill from MCU process
3	MCU Enclosure Ventilation System	Provide an active filtered release path for the main Process Enclosure and the Strip Effluent Decanter Cell
4	MCU Sampler Shroud	Minimize the potential for a puncture wound to worker from sample needles
5	MCU Shielded Sampler Containment Boxes	Contain spill from SEHT, CDT, or SHT sample line
6	ARP Process Vessel Ventilation System	Reduce flammable vapors from the Strike Tank to maintain combustible gas concentrations less than the LFL during normal operation
7	ARP Process Cell Ventilation System with HEPA	1. Reduce flammable vapors from the Process Cell to maintain combustible gas concentrations less than the LFL during normal operation 2. Provide a filtered release path from the cell
8	ARP Process Cell	Contain spill from ARP process
9	PP, DB, Waste Tank, and H-Area Catch Tank Gang Valve ARM	Provide control room alarm, upon the detection of higher than normal radiation levels, to minimize exposure to personnel
10	Pump Tank High Level Alarm	Provide control room alarm, upon high level, to minimize the potential for overflowing the pump tank

Table 3.3-22 CSTF Defense-in-Depth / Important-to-Safety Hazard Controls (continued)

DID Item	SSC	Safety Function
11	H-Area Catch Tank High Level Alarm	Provide control room alarm, upon high level, to minimize the potential for overflowing the Catch Tank
12	H-Area Catch Tank Passive Vent with HEPA	Provide a filtered release path for the Catch Tank
13	H-Area Catch Tank Encasement Sump Leak Detection	Provide control room alarm, upon detection of liquid waste, to minimize the potential for release of radioactive material to the environment
14	Tank 50 to Z-Area IAL Leak Detection	Provide control room alarm, upon detection of liquid waste, to minimize the potential for release of radioactive material to the environment
15	Waste Tank Hydrolance Foot Valve (Notes a, b)	Design prevents valve from being positioned to serve as an eductor to pull waste out of the tank
16	Type IV Tank Leak Detection Sump Dip Tube	Provide air flow to minimize the potential for developing a flammable atmosphere in the sump
17	CRW Pump House ARM	Provide control room alarm, upon the detection of higher than normal radiation levels, to minimize potential release to environment and exposure to personnel
18	242-16H Evaporator Well Water Addition Line	Design provides an air gap to prevent siphoning waste from the pot during evaporator chemical cleaning
19	242-16H/242-25H Evaporator Dip Tubes and Alarms	1. Provide air flow to minimize the potential for developing a flammable atmosphere in the pot 2. Provide control room alarm, upon high pot level, to minimize the potential for pot overfill/carryover (high foam/specific gravity)
20	242-16H/242-25H Evaporator Cell Ventilation with HEPA	Provide a filtered release path following a release to the cell
21	242-16H Evaporator Overheads Piping, including Demister	Provide open flow path to cell to minimize the potential for pot overpressurization

Table 3.3-22 CSTF Defense-in-Depth / Important-to-Safety Hazard Controls (continued)

DID Item	SSC	Safety Function
22	242-16H/242-25H Evaporator Pot High Pressure Alarm/Interlock	Provide indication of high pot pressure and ensure steam to the tube bundle is secured via interlock
23	242-16H/242-25H Evaporator Cell Conductivity Probe/Alarm	Provide control room alarm, upon detection of liquid waste, to minimize the potential for release of radioactive material to the environment
24	242-25H Heat Detectors	Provide for indication of fires to minimize the potential releases from a fire in the cell
25	299-H Truckwell Ventilation System with HEPA	Provide a filtered release path following a release to the truckwell
26	299-H Process Vessel Ventilation System with filtration	Provide a filtered release path following a release to the process cell
27	299-H Waste Collection Pit	Provide passive containment following a WCT release
28	299-H Waste Collection Pit Leak Detection and Alarm	Provide control room alarm, upon detection of liquid waste, to minimize the potential for release of radioactive material to the environment
29	F-Area Diversion Box/ Valve Box Conductivity Probe/Alarm	Indicates a leak into secondary containment
30	LWPT High Level Interlock (Note c)	Interlock transfer pump (Tank 49 or 241-96H) upon high level reading in the LWPT

DID/ITS hazard controls are not required for inactive locations identified in Section 3.4.1.5.2 or Closure Waste Tanks unless noted as follows:

Notes:
(a) Applies to inactive locations identified in Section 3.4.1.5.2
(b) Applies to Closure Waste Tanks
(c) Supports DWPF Safety Basis

Table 3.4-1 Transfer Facility Inputs

	ID	Sump Volume (ft^3)	Nominal wall area (ft^2)	Nominal Footprint (ft^2)	Nominal Volume including sump (ft^3)	Initial Waste (Residual) Volume (gal) (b)	Equilibrium H_2 %LFL (b)
Valve Box	1-4	0.0	67.6	5.4	44.4	4.28 (a)	25%
Valve Box	5	0.0	78.0	5.4	51.2	4.94 (a)	25%
Valve Box	LDB-17	0.0	22.3	9.1	18.9	5.67 (a)	< 70%
Valve Box	15/16	0.161	14.8	6.2	7.8	N/A (g)	N/A
Tank 21 Valve Box		0.157	61.7	10.9	54.3	7.97 (a)	< 40%
Tank 22 Valve Box		0.157	61.7	10.9	54.3	7.97 (a)	< 40%
Valve Box	28a	0.122	57.2	20.8	59.9	13.88 (a)	< 55%
Valve Box	28b	0.0	74.1	5.5	48.8	4.71 (a)	25%
Pump Pit	FPP-1	8.000	1,437.6	225.0	4,436.5	428.09 (a)	25%
Pump Pit	FPP-2	9.100	1,470.3	265.9	5,015.2	483.93 (a)	25%
Pump Pit	FPP-3	9.100	1,470.3	265.9	5,015.2	483.93 (a)	25%

Table 3.4-1 Transfer Facility Inputs (continued)

	ID	Sump Volume (ft^3)	Nominal wall area (ft^2)	Nominal Footprint (ft^2)	Nominal Volume including sump (ft^3)	Initial Waste (Residual) Volume (gal) (b)	Equilibrium H_2 %LFL (b)
Pump Pit	HPP-1	7.880	1,572.0	225.0	5,902.9	N/A (g)	N/A
Pump Pit	HPP-2	7.880	1,572.0	225.0	4,940.4	476.71 (a)	25%
Pump Pit	HPP-3	7.880	1,572.0	225.0	4,940.4	476.71 (a)	25%
Pump Pit	HPP-4	7.880	1,572.0	225.0	4,940.4	476.71 (a)	25%
Pump Pit	HPP-5	9.760	1,710.1	270.0	6,043.0	583.10 (a)	25%
Pump Pit	HPP-6	9.760	1,710.1	270.0	6,043.0	583.10 (a)	25%
Pump Pit	HPP-7	25.890	2,412.0	324.0	9,917.4	956.95 (a)	25%
Pump Pit	HPP-8	25.890	2,412.0	324.0	9,917.4	956.95 (a)	25%
Pump Pit	HPP-9	25.890	2,412.0	324.0	9,917.4	956.95 (a)	25%
Pump Pit	HPP-10	25.890	2,412.0	324.0	9,917.4	956.95 (a)	25%
High Point Flush Pit	HPFP	1.042	55.3	30.0	76.4	7.37 (a)	25%
Diversion Box	FDB-1	0.0	3,505.4	546.0	11,258.5	N/A (g)	N/A
Diversion Box	FDB-2	3.480	295.8	225.0	1,112.7	107.37 (a)	25%
Diversion Box	FDB-3	1.060	125.7	50.3	252.4	24.35 (a)	25%
Diversion Box	FDB-4	5.744	679.7	295.6	2,897.1	279.55 (a)	25%
Diversion Box	FDB-5	9.300	823.0	146.3	2,491.2	N/A (g)	N/A

Table 3.4-1 Transfer Facility Inputs (continued)

	ID	Sump Volume (ft^3)	Nominal wall area (ft^2)	Nominal Footprint (ft^2)	Nominal Volume including sump (ft^3)	Initial Waste (Residual) Volume (gal) (b)	Equilibrium H_2 %LFL (b)
Diversion Box	FDB-6	7.100	925.6	165.0	2,944.1	N/A (g)	N/A
Diversion Box	HDB-1	0.0	3417.0	546.0	10,974.6	N/A (g)	N/A
Diversion Box	HDB-2	0.0	839.2	390.0	3,762.5	363.05 (a)	25%
Diversion Box	HDB-3	1.000	250.0	25.0	313.5	N/A (g)	N/A
Diversion Box	HDB-4	1.060	84.3	38.5	148.6	14.34 (a)	25%
Diversion Box	HDB-5	0.980	87.3	41.3	159.2	15.36 (a)	25%
Diversion Box	HDB-6	2.440	500.2	144.0	1,502.9	145.02 (a)	25%
Diversion Box	HDB-7	6.610	1,224.0	280.0	5,046.6	147.22 (f)	25%
Diversion Box	HDB-8	25.170	883.0	396.0	4,395.8	424.16 (a)	25%
Tank 40 Valve Box		0.0	119.5	36.0	132.1	5.59 (f)	< 35%
Tank 40 Drain Valve Box		0.0	69.4	5.6	46.4	4.48 (a)	25%
Tank 42 Valve Box		0.0	184.1	22.3	196.4	18.95 (a)	25%
Tank 49 Valve Box		0.0	161.0	23.8	174.2	16.81 (a)	25%
Tank 50 Valve Box		0.0	180.8	39.9	202.9	N/A (d)	(d)
Tank 51 Valve Box		0.0	119.6	36.0	132.1	5.59 (f)	< 35%
Tank 51 Drain Valve Box		0.0	94.4	11.2	84.0	6.98 (f)	< 65%

Table 3.4-1 Transfer Facility Inputs (continued)

ID	Sump Volume (ft^3)	Nominal wall area (ft^2)	Nominal Footprint (ft^2)	Nominal Volume including sump (ft^3)	Initial Waste (Residual) Volume (gal) (b)	Equilibrium H_2 %LFL (b)
241-96H Valve Box	1.5	164.33	45	256	39.27 (a)	25%
LDB Drain Cell	6.250	416.6	35.8	629.1	60.70 (a)	25%
F-Area Catch Tank Encasement	1.000	1,272.0	546.0	4,989.0	N/A (g)	N/A
FTF Jet Encasement	0.0	1,044.0	47.5	1,710.0	N/A (g)	N/A
H-Area Catch Tank Encasement	1.000	1,272.0	546.0	4,989.0	N/A	N/A
HTF-West Jet Encasement	0.0	1,102.0	47.5	1,805.0	N/A	N/A
LPDT Cell				14,200	N/A (d)	(d)

Notes:
(a) Based on 1.29% of the total cell volume at a bounding hydrogen generation rate of 1.5E-05 ft^3/gal waste-hr per Reference 98.
(b) Based on Reference 98, excluding Tank 50 Valve Box and LPDT Cell (see Note d).
(c) Deleted.
(d) For analyses associated with the Tank 50 Valve Box, flammable vapor concentration is assumed to reach stoichiometric conditions (for Isopar® L) and no maximum Initial Waste (Residual) Volume is assumed. For LPDT Cell, the vapor space does not reach 100% of the CLFL (based on discussion in Section 3.4.2.7.1.4) and no maximum Initial Waste (Residual) Volume is assumed.
(e) Deleted
(f) Based on a bounding hydrogen generation rate of 5.0E-05 ft^3/gal waste-hr per Reference 98. For HDB-7, based on 0.39% of the total cell volume at a bounding hydrogen generation rate of 5.0E-05 ft^3/gal waste-hr per Reference 98.
(g) Inactive location.

Table 3.4-2 Waste Tank Data

Waste Tank Data							
Waste Tank Type	**Tank Internal Volume (gal) (3.4.2.11, 3.4.2.12)**	**Height (inches)**	**Maximum Fill Limit (inches) [a] (3.4.2.9, 3.4.2.10, 3.4.2.11 [b], 3.4.2.12, 3.4.2.13)**	**Maximum Ventilation Flow Rate (cfm) (3.4.2.10, 3.4.2.13)**	**Nominal Fill Factor (gal/in) [c]**	**Exposed Area (ft^2) (3.4.2.10, 3.4.2.13)**	**Roof Surface Area (ft^2) (3.4.2.10, 3.4.2.13)**
Type I	791,100	294	274	1,000	2,710	4,273 at Level of 278 Inches	3,223
Type II	1,118,500	324	304	1,000	3,500	5,079 at Level of 312 Inches	4,259
Type III/IIIA	1,373,238	396	372	1,000	3,510	5,492 at Level of 372 Inches	4,244
Type IV	1,685,000	411	386	1,000	3,540	6,317 at Level of 396 Inches	N/A

Notes:

(a) Maximum fill limit is based on Reference 292 and may be further restricted based on the limiting criteria of the Tank Fill Limits Program.
(b) 15,000 gallons maximum missing waste was included in the determination of the maximum fill limits.
(c) Waste tank fill factors stated in this column reflect nominal values; however, these values may be used for Facility and Engineering programs that support implementation of DSA Administrative Controls (e.g., Flammability Control Program). Refer to Reference 292 for more detailed values of waste tank volume as a function of fill height.

Table 3.4-3 Waste Tank Annulus Data

Waste Tank Annulus Data (a)					
Tank Type	**Annulus Volume (gal)**	**Liquid Waste Footprint Area (ft^2)**	**Nominal Wall Area (ft^2)**	**Minimum Wall Area (ft^2)**	**Initial Waste (Residual) Height (inches)**
Type I	120,800	610	12,717	11,000	≤ 21 (b) ≤ 7 (f)
Type II	152,200	690	15,646	14,000	≤ 23 (b) ≤ 7 (f)
Type III	176,100	690	19,199	18,000	≤ 5.5 (c)
Type IIIA (e)	177,800	690	19,428	18,000	≤ 5.8 (c) ≤ 2.0 (d)

Notes:
(a) Used in Sections 3.4.2.9 and 3.4.2.12
(b) Reference 95 (excluding Type I/II Acidic Chemical Cleaning Waste Tanks)
(c) Reference 92
(d) For the case of ESP Sludge Slurry, this applies to Tank 40 only due to the transfer path from Tank 51 to 40 (Ref. 92).
(e) For Waste Tank 50, flammable vapor concentration is assumed to reach stoichiometric conditions (for Isopar® L) and no maximum initial waste (residual) volume is assumed.
(f) Reference 248 (Type I/II Acidic Chemical Cleaning Waste Tanks)

Table 3.4-4 Evaporator System Data

Evaporator Parameter	242-16H	242-25H	Applicable Accident
Total Pot volume	4442 gallons	18607 gallons	3.4.2.1
Pot maximum waste volume (normal operation)	2595 gallons @ 73 inches measured	11250 gallons @ 110 inches	3.4.2.1
Pot maximum waste volume (chemical cleaning)	3424 gallons @ 100 inches measured	N/A	3.4.2.2, 3.4.2.3
Pot minimum waste volume	1570 gallons @ 39 inches measured (a)	9660 gallons @ 92.5 inches (a)	3.4.2.1
Pot volume-to-level conversion	30.7 gallon/inch (range 52-73 inches)	92.5 gallon/inch (range 89-110 inches)	3.4.2.1
Pot height (top plate to cone apex)	230.25 inches	320.625 inches	3.4.2.1
Inside diameter of pot de-entrainment demister	36 inches, nominal	42 inches, nominal	3.4.2.1, 3.4.2.4
Length of Pot de-entrainment demister column from top plate	58 inches	70 inches	3.4.2.1
Inside Pot diameter	95 inches	167 inches	3.4.2.1, 3.4.2.4
Non-condensable vent line inside diameter	1.6824 inches	6.3576 inches	3.4.2.1
Maximum operating temperature	160°C	186°C	3.4.2.1, 3.4.2.2
Maximum SpG	1.6 @ 160°C	1.8 @ 186°C	3.4.2.1
Maximum feed flow rate	42 gpm	55 gpm	3.4.2.1, 3.4.2.2, 3.4.2.3
Maximum evaporator lift flow rate	20 gpm	35 gpm	3.4.2.2, 3.4.2.3, 3.4.2.21
Total cell volume	6,880 ft^3	14,903 ft^3	3.4.2.2
Liquid waste "footprint" area - evaporator cell	256 ft^2	550 ft^2	3.4.2.2

Evaporator Parameter	242-16H	242-25H	Applicable Accident
Minimum total wall area - evaporator cell	1,896 ft^2	3,088 ft^2	3.4.2.2
Maximum tube bundle steam pressure	370 psig	370 psig	3.4.2.4
Maximum tube bundle air pressure	200 psig	200 psig	3.4.2.4
Maximum lance gang valve steam pressure	370 psig	370 psig	3.4.2.4
Maximum lance gang valve air pressure	200 psig	200 psig	3.4.2.4
Maximum dip tube air pressure	N/A	200 psig	3.4.2.4
Maximum diameter of steam source orifice to lance gang valve	0.43 inch	N/A	3.4.2.4
Maximum diameter of air source orifice to lance gang valve (normal operation)	0.09 inch	0.15 inch	3.4.2.4
Maximum diameter of air source orifice to lance gang valve (chemical cleaning)	0.3 inch	N/A	3.4.2.4
Maximum diameter of orifice on discharge of lance gang valve	N/A	1.086 inch	3.4.2.4
Maximum evaporator overheads flow rate (non-seismic)	12 gpm	35 gpm	3.4.2.4
Maximum evaporator overheads flow rate (seismic – 370 psig)	35 gpm	35 gpm	3.4.2.4
Cell sump volume	75 gallons	N/A	3.4.2.2
Initial waste (residual) volume (Reference 98)	663.86 gallons	N/A	3.4.2.2
Equilibrium H_2 % LFL	25%	N/A	3.4.2.2

Notes:
(a) Only applicable when the evaporator is in operation (i.e., steam supplied to the tube bundle).

Table 3.4-5 Rated Pressures for Evaporator Vessel Components

Component	Pressure (a) 242-16H (psig)	Pressure (a) 242-25H (psig)
De-entrainment Column Flat Head	46	32
De-Entrainment Column Shell	257	221
Vessel Top Head (242-16H)	44	N/A
Vessel Torispherical Head (242-25H)	N/A	75.7
Vessel Shell	139	127
Vessel Cone Section	85	75.7
Vessel Bottom Cone Head	322	1177
Interconnecting Piping	N/A	235

Notes:

(a) Reference 58

Table 3.4-6 Aerosolization Inputs

Input	Value [a]
Steam/Air Line Length for Steam Jet Accidents	4 feet
Steam/Air Line Inner Diameter for Steam Jet Accidents	1.049 inches
Steam Pressure for Steam Jet Accidents (non-seismic)	171 psig
Air Pressure for Air Jet Accidents (non-seismic and seismic)	200 psig
Steam Pressure for Steam Jet Accidents (seismic)	370 psig
Steam Transfer Jet Nozzle Throat Diameter	0.5 inches
Sump Steam Transfer Jet Nozzle Throat Diameter	0.183 inches
Pulse Tube Agitator Discharge Nozzle Line Length	2.694 inches
Pulse Tube Agitator Discharge Nozzle Inner Diameter	0.456 inches
Pulse Tube Agitator Air Pressure	150 psig
Diameter of Pulse tube Agitator Suction Nozzle Throat	0.13 inches
Quad-Volute Slurry Pump - Number of Nozzles	2
Quad-Volute Slurry Pump - Nozzle Internal Diameter	3.625 inches
Quad-Volute Slurry Pump - Total Flow Rate	8550 gpm
Number of Slurry Pumps operating in a Single Waste Tank	4

Table 3.4-6 Aerosolization Inputs (continued)

Input	Value [a]
SMP - Number of Flow Discharge Nozzles	2
SMP - Flow Discharge Nozzle Diameter	4.4 inches (180º apart)
SMP - Number of Motor Cooling Discharge Nozzles	2
SMP - Motor Cooling Discharge Nozzle Diameter	0.625 inches (180º apart)
SMP - Maximum Flow Rate through each pump	11,400 gpm
SMP - Maximum Cooling Flow Rate through each pump	120 gpm
SMP - Maximum Number of pumps operating in a Single Waste Tank	4
Diaphragm Pump - Total Liquid Flow Rate	150 gpm
Diaphragm Pump - Air Exhaust Nozzle Inner Diameter	0.75 inches
Diaphragm Pump - Air Supply Nozzle Inner Diameter	0.75 inches
Diaphragm Pump - Air Consumption	150 scfm
Diaphragm Pump - Air Supply Pressure	125 psig
Diaphragm Pump - Compressed Air Temperature	110°F
CSMP – Number of Flow Discharge Nozzles (b)	2
CSMP – Flow Discharge Nozzle Diameter (b)	1.8 inches
CSMP – Maximum Flow Rate through each pump (b)	2,925 gpm
CSMP – Maximum Number of pumps operating in a Single Waste tank (b)	4

Notes:

(a) Reference 157
(b) Reference 296

Table 3.4-7 Airborne Radiological (rem) and Chemical (mg/m^3) Consequences for the Design Basis Accidents

Section	Design Basis Accident		Unmitigated Offsite [a]	Mitigated Offsite [a]	Unmitigated Onsite [a] (100-meter)	Mitigated Onsite [a] (100-meter)
3.4.2.1	Evaporator Pot Explosion		≤ 0.1	≤ 0.1	≤ 41	≤ 41
3.4.2.2	Evaporator Cell Explosion		≤ 0.1	≤ 0.1	> 100	≤ 7
3.4.2.3	Evaporator Overflow, Leaks, and Spills		≤ 0.1	≤ 0.1	> 100	≤ 35
3.4.2.4	Evaporator Overpressure		≤ 0.2	≤ 0.2	> 100	≤ 93
3.4.2.5	Transfer Facility Fire		≤ 1	≤ 1	> 100	≤ 72
3.4.2.6	Transfer Line and Transfer Line Jacket/ Encasement Explosions	Sludge Slurry Encasement Explosion	≤ 9.7	≤ 9.7	> 100	0.0
		Core Pipe Explosion	≤ 0.70	≤ 0.70	> 100	≤ 95
3.4.2.7	Transfer Facility Explosions	Transfer Facility Explosions	≤ 0.54	≤ 0.54	> 100	0.0
		Transfer Facility Explosions (Tank 50/MCU only)	≤ 0.1	≤ 0.1	≤ 22	≤ 22
3.4.2.8	Pump Pit and Pump Tank Explosion		≤ 0.66	≤ 0.66	> 100	0.0
3.4.2.9	Transfer Error/SMP Waste Release	SMP Riser Overflow	≤ 0.7	≤ 0.7	> 100	0.0
		Tank 50 to Z-Area Above-Ground Core Pipe Release	≤ 0.1	≤ 0.1	≤ 23	≤ 23
3.4.2.10	Aerosolization Events		> 25	≤ 8.3	> 100	≤ 70
3.4.2.11	Waste Tank Explosion	Type I/II/III/IIIA Tank (except Tank 50) – Non-Seismic	> 25	≤ 2.1 [c]	> 100	0.0
		Type I/II/III/IIIA Tank (except Tank 50) – Seismic	> 25	≤ 2.1	> 100	> 100
		Type IV Tank	≤ 1.5	≤ 1.5	> 100	0.0
		Tank 50	≤ 0.1	≤ 0.1	> 100	0.0
		Pump Column Explosion	≤ 0.15	≤ 0.15	> 100	≤ 36

Table 3.4-7 Airborne Radiological (rem) and Chemical (mg/m^3) Consequences for the Design Basis Accidents (continued)

Section	Design Basis Accident		Unmitigated Offsite [a]	Mitigated Offsite [a]	Unmitigated Onsite [a] (100-meter)	Mitigated Onsite [a] (100-meter)
3.4.2.12	Waste Tank Annulus Explosion	Tank 50 Annulus Explosion	≤ 0.1	≤ 0.1	≤ 50	0.0
		Chemical Cleaning Waste Tank Annulus Explosion	≤ 4	≤ 4	> 100	0.0
		Underliner / Leak Detection Sump Explosion	≤ 0.1	≤ 0.1	≤ 8	≤ 8
3.4.2.13	Waste Tank/Pump Tank Overheating		≤ 0.2	≤ 0.2	> 100	≤ 76
3.4.2.14	Waste Tank Wall Failure	Waste Tank Top Collapse	≤ 0.1	≤ 0.1	0	0
		Waste Tank Wall Leak	≤ 0.1	≤ 0.1	≤ 96	≤ 33
3.4.2.15	Waste Tank Siphon/Pump-Out		≤ 12.1	≤ 5.1	> 100	0.0
3.4.2.16	299-H Events [b]		0	0	0	0
3.4.2.17	Tornado and High Winds Event		> 25	≤ 0.7	> 100	≤ 21.3
3.4.2.18	Seismic Event		> 25	≤ 15.5	> 100	> 100
3.4.2.19	Wildland Fire		> 25	≤ 0.1	> 100	≤ 15.5
3.4.2.20	Loss of Offsite Power		> 25	0.0	> 100	0.0
3.4.2.21	Chemical Release		0.0012 mg/m^3	0.0012 mg/m^3	0.404 mg/m^3	0.404 mg/m^3
3.4.2.22	Transportation Accident		≤ 0.1	≤ 0.1	≤ 50	≤ 50

Notes:

(a) Chemical consequences applicable only for the Chemical Release DBA (Section 3.4.2.21). For all other DBAs, the consequences from chemical releases, when coincident with a radiological release, are not quantified since they are either bounded by the consequences of the radiological release or the quantity and nature of the released material does not exceed the chemical EGs (Ref. 73, 239, 314).

(b) Events associated with Building 299-H were deemed not credible (see Section 3.4.2.16); therefore, Offsite and Onsite consequences are reported as zero.

(c) The mitigated Offsite consequences are associated with Waste Tank Explosions due to flammable transients, and these consequences are bounded by the mitigated Offsite consequences from seismically-induced Waste Tank Explosions.

Table 3.4-8 Radiological Constituent Concentrations in CST Waste Streams

	Maximum High-Activity Sludge [a]	Maximum Low-Activity Sludge [a]	Maximum High-Activity Supernate [a]	Maximum Low-Activity Supernate [a]	Tank 32 High-Activity Sludge [a]	Tank 50 Low-Activity Supernate [a]	Type I/II Tank High-Activity Sludge [a]
Isotope	(Ci/g sludge solids)	(Ci/g sludge solids)	(Ci/gal)	(Ci/gal)	(Ci/g sludge solids)	(Ci/gal)	(Ci/g sludge solids)
Sr-90	1.2E-01	9.6E-03	0.0E+00	0.00E+00	1.2E-01	8.51E-02	4.4E-02
Y-90	1.2E-01	9.6E-03	0.0E+00	0.00E+00	1.2E-01	0.0E+00	4.4E-02
Cs-137	7.5E-03	8.9E-04	4.2E+01	3.80E-02	7.5E-03	4.51E-01	3.2E-03
Ba-137m	7.1E-03	8.4E-04	4.0E+01	3.60E-02	7.1E-03	0.0E+00	3.0E-03
Pu-238	6.7E-03	1.5E-04	1.4E-02	4.00E-04	1.9E-03	0.0E+00	1.2E-03
Pu-239	5.7E-05	6.3E-06	1.7E-03	4.90E-05	5.7E-05	0.0E+00	3.2E-05
Pu-240	4.0E-05	1.6E-06	3.8E-04	1.30E-05	4.0E-05	0.0E+00	4.6E-05
Pu-241	5.1E-03	2.3E-05	1.0E-02	1.20E-03	5.1E-03	3.17E-03	3.3E-04
Am-241	4.4E-04	9.5E-06	1.3E-02	1.30E-04	4.4E-04	0.0E+00	4.5E-04
Cm-244	2.6E-03	8.8E-08	4.0E-03	2.80E-07	4.2E-06	0.0E+00	3.2E-04
Eu-154	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.51E-03	0.0E+00
Total α	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.49E-04	0.0E+00

Notes:

(a) Based on information provided in References 58, 167, 168, 169, 171, 172, 233, 262

Table 3.4-9 Waste Tank Explosion Controls Summary

Waste Tank Explosion Controls (Non-NPH, excluding Type I/II Acidic Chemical Cleaning Waste Tanks) (a, b)															
Control	**Routine Flammability**									**Activities Exceeding Gas Release Criteria**					
	Rapid Generation Tanks			**Slow Generation Tanks**			**Very Slow Generation Tanks**			**Sludge Agitation**		**Bulk Saltcake Dissolution**		**Interstitial Liquid Removal**	
	I/II/ III/IIIA	**IV**	**50**	**I/II/ III/IIIA**	**IV**	**50**	**I/II/ III/IIIA**	**IV**	**50**	**I/II/ III/IIIA**	**IV**	**I/II/ III/IIIA**	**IV**	**I/II/ III/IIIA**	**IV**
Waste Tank Ventilation System	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1 (d)	SS-1 (d)		SC-1	SS-1	SC-1	SS-1	SC-1	SS-1
Ventilation Local Flow Indication	SC-1	SS-1	SS-1							SC-1	SS-1	SC-1	SS-1	SC-1	SS-1
Ventilation Low Flow Interlock										SC-1	SS-1	SC-1	SS-1	SC-1	SS-1
Periodic Hydrogen Monitoring	SS-2	SS-2		SS-2	SS-2										
Continuous Hydrogen Monitor with High Hydrogen Concentration Interlock										SS-2	SS-2	SS-2	SS-2	SS-2	SS-2
Periodic Waste Temperature Monitoring with Local Indication			SS-1			SS-1			SS-1						
Gas Release Program (c)	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1	SS-1	SC-1	SS-1	SC-1	SS-1
Waste Tank Quiescent Time Program (Spontaneous Liberation Protection)	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1	SS-1				
Waste Tank Structure (e)	SS-3	SS-3	SS-2	SS-3	SS-3	SS-2	SS-2	SS-2	SS-2	SS-3	SS-3	SS-3	SS-3	SS-3	SS-3
Emergency Response Program (e)			SS-3			SS-3	SS-3	SS-3	SS-3						

Table 3.4-9 Waste Tank Explosion Controls Summary (continued)

Notes (for Waste Tank Explosion Controls [Non-NPH, excluding Type I/II Acidic Chemical Cleaning Waste Tanks]):

(a) These are a summary of the non-NPH Waste Tank Explosion controls detailed in Section 3.4.2.11. The controls do not apply to Closure Waste Tanks or Type I/II Acidic Chemical Cleaning Waste Tanks. Controls for Type I/II Acidic Chemical Cleaning Waste Tanks are in a subsequent table. The controls above do not contain prohibited operations associated with the waste tanks (see Section 3.4.2.11). Additionally, the following controls are not included in the table as they apply to all waste tanks:
- Flammability Control Program (SC-1 except as noted: SS-1 for Type IV Waste Tanks and Tank 50)
- HLLCP with Control Room Alarm (SC-1 except as noted: SS-1 for flammable transients [all waste tanks]; SS-1 for Type IV Waste Tanks and Tank 50)
- Tank Fill Limits Program (SC-1 except as noted: SS-1 for flammable transients [all waste tanks]; SS-1 for Type IV Waste Tanks and Tank 50)
- Inadvertent Acid Addition Controls (SC IC for all waste tanks)
- Waste Tank Chemical Cleaning Program (SC IC for all waste tanks)

(b) Key: SC-1 = SC 1st Level of Control; SS-1 = SS 1st Level of Control; SS-2 = SS 2nd Level of Control; SS-3 = SS 3rd Level of Control

(c) Required during waste tank mixing device operation, bulk saltcake dissolution, saltcake interstitial liquid removal, or free supernate removal activities. For flammable transients, the controls are required to be SS only for all waste tanks.

(d) Required when receiving a steam jetted transfer.

(e) For flammable transients, the Waste Tank Structure is required to be SS-2 for all waste tanks and the Emergency Response Program is required to be SS-3 for all waste tanks.

Table 3.4-9 Waste Tank Explosion Controls Summary (continued)

Waste Tank Explosion Controls (NPH, excluding Type I/II Acidic Chemical Cleaning Waste Tanks) (a, b)									
Control	**Tornado/High Winds Event**			**Seismic Event**			**Wildland Fire / Loss of Offsite Power**		
	I/II/ III/IIIA	**IV**	**50**	**I/II/ III/IIIA**	**IV**	**50**	**I/II/ III/IIIA**	**IV**	**50**
Flammability Control Program	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1	SC-1	SS-1	SS-1
Severe Weather Response	SC-1	SS-1	SS-1						
Ventilation Low Flow Interlock				SC-1	SS-1				
High LFL Interlock				SS-2	SS-2				
Periodic Waste Temperature Monitoring with Local Indication			SS (IC)			SS (IC)			SS (IC)
Gas Release Program (c)				SC-1	SS-1				
Waste Tank Quiescent Time Program (Seismic Release Protection)				SC-1	SS-1	SS-1			
Event Response Program				SC-1	SS-1	SS-1	SC-1	SS-1	SS-1
Waste Tank Structure	SS-2	SS-2	SS-2	SS-2	SS-2	SS-2	SS-2	SS-2	SS-2
Emergency Response Program	SS-3	SS-3	SS-3	SS-3	SS-3	SS-3	SS-3	SS-3	SS-3

Notes (for Waste Tank Explosion Controls [NPH, excluding Type I/II Acidic Chemical Cleaning Waste Tanks]):

(a) These are a summary of the NPH Waste Tank Explosion controls detailed in Sections 3.4.2.11, 3.4.2.17, 3.4.2.18, 3.4.2.19, and 3.4.2.20. The controls do not apply to Closure Waste Tanks or Type I/II Acidic Chemical Cleaning Waste Tanks. Controls for Type I/II Acidic Chemical Cleaning Waste Tanks are in a subsequent table. The controls above do not contain prohibited operations associated with the waste tanks (see Sections 3.4.2.11, 3.4.2.17, 3.4.2.18, 3.4.2.19, and 3.4.2.20). Additionally, the following controls are not included in the table as they apply to all waste tanks:

- HLLCP with Control Room Alarm (SC IC except as noted: SS IC for Type IV Waste Tanks and Tank 50)
- Tank Fill Limits Program (SC IC except as noted: SS IC for Type IV Waste Tanks and Tank 50)
- Inadvertent Acid Addition Controls (SC IC for all waste tanks)

(b) Key: SC-1 = SC 1st Level of Control; SS-1 = SS 1st Level of Control; SS-2 = SS 2nd Level of Control; SS-3 = SS 3rd Level of Control

(c) Required during sludge agitation (using waste tank mixing devices), bulk saltcake dissolution, or saltcake interstitial liquid removal activities.

Table 3.4-9 Waste Tank Explosion Controls Summary (continued)

Waste Tank Explosion Controls (Type I/II Acidic Chemical Cleaning Waste Tanks) (a, b)			
Control	**Non-NPH**	**Tornado/High Winds Event**	**Seismic Event / Wildland Fire / Loss of Offsite Power**
Waste Tank Ventilation System	SC-1		
Ventilation Local Flow Indication	SC-1		
HLLCP with Control Room Alarm	SC-1 (d)		
Periodic Hydrogen Monitoring	SS-2		
Periodic Waste Temperature Monitoring (c)	SC-1		
Flammability Control Program	SC-1	SC-1	SC-1
Waste Tank Chemical Cleaning Program	SC-1		
Acidic Spray Wash Controls	SC-1 (d)		
Event Response Program		SC-1	SC-1
Severe Weather Response Program		SC-1	
Waste Tank Structure	SS-3	SS-2	SS-2
Emergency Response Program		SS-3	SS-3

Notes (for Waste Tank Explosion Controls [Type I/II Acidic Chemical Cleaning Waste Tanks]):

(a) These are a summary of the Non-NPH and NPH Waste Tank Explosion controls for Type I/II Acidic Chemical Cleaning Waste Tanks detailed in Sections 3.4.2.11, 3.4.2.17, 3.4.2.18, 3.4.2.19, and 3.4.2.20. The controls above do not contain prohibited operations associated with the waste tanks (see Sections 3.4.2.11, 3.4.2.17, 3.4.2.18, 3.4.2.19, and 3.4.2.20).

(b) Key: SC-1 = SC 1st Level of Control; SS-1 = SS 1st Level of Control; SS-2 = SS 2nd Level of Control; SS-3 = SS 3rd Level of Control

(c) Required during waste tank mixing device operation.

(d) During Acidic Spray Wash operations, the HLLCP is not functional and the safety function is replaced by Acidic Spray Wash Controls.

Table 3.4-10 Waste Tank Siphon/Pump-Out Controls Summary

Control [(a)]	Tanks 13, 14, & 15 [h]	Tanks 25, 26, 27, & 28	Tanks 29, 31 & 32 [b, e]	Tank 30 [b]	Tanks 33 & 34 [c]	Tank 35 [e]	Tanks 36-51 [f, g]
Siphon Breaker (SC)	1st LOC (S/NS)		1st LOC (S/NS)	1st LOC (S/NS)		1st LOC (S/NS)	
Siphon Breaker (SS)					1st LOC (S/NS)		
Cooling Coils (SS)		1st LOC (S/NS)	2nd LOC (NS)		2nd LOC (NS)	2nd LOC (NS)	1st LOC (S/NS)
Event Response Program (SS)	2nd LOC (S/NS)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S)	2nd LOC (S/NS)
CRW Isolation Valves [d] (SS)	2nd LOC (S/NS)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S)	2nd LOC (S/NS)
242-16H Evaporator Chemical Cleaning Program (SC)							1st LOC (S/NS)
242-16H Evaporator Isolation Valves (SC)							1st LOC (S/NS)

Notes:

(a) Key: LOC = Level of Control, NS = Non-seismic, S = Seismic, SC = Safety Class, SS = Safety Significant
(b) The siphon breakers on the Tank 30 cooling water headers provide siphon protection for Tanks 29, 30, 31, and 32.
(c) The siphon breakers on the Tank 34 cooling water headers provide siphon protection for Tanks 33 and 34.
(d) For Tank 30 these are the tank coil isolation valves, for all other tanks these are the tank header isolation valves.
(e) Sludge slurry transfers from Tanks 32 and 35 are prohibited (SC).
(f) Operation of mixing devices in Tank 39 is prohibited (SC).
(g) The 242-16H Evaporator Chemical Cleaning Program and Evaporator Isolation Valves apply to the 242-16H Evaporator drop and/or feed tank during chemical cleaning operations.
(h) For Tanks 14 and 15, the controls are only required when the applicable tank is connected to the CRW System. The siphon breakers on the Tank 13 cooling water headers provide siphon protection for Tanks 13, 14, and 15.

3.7 FIGURES

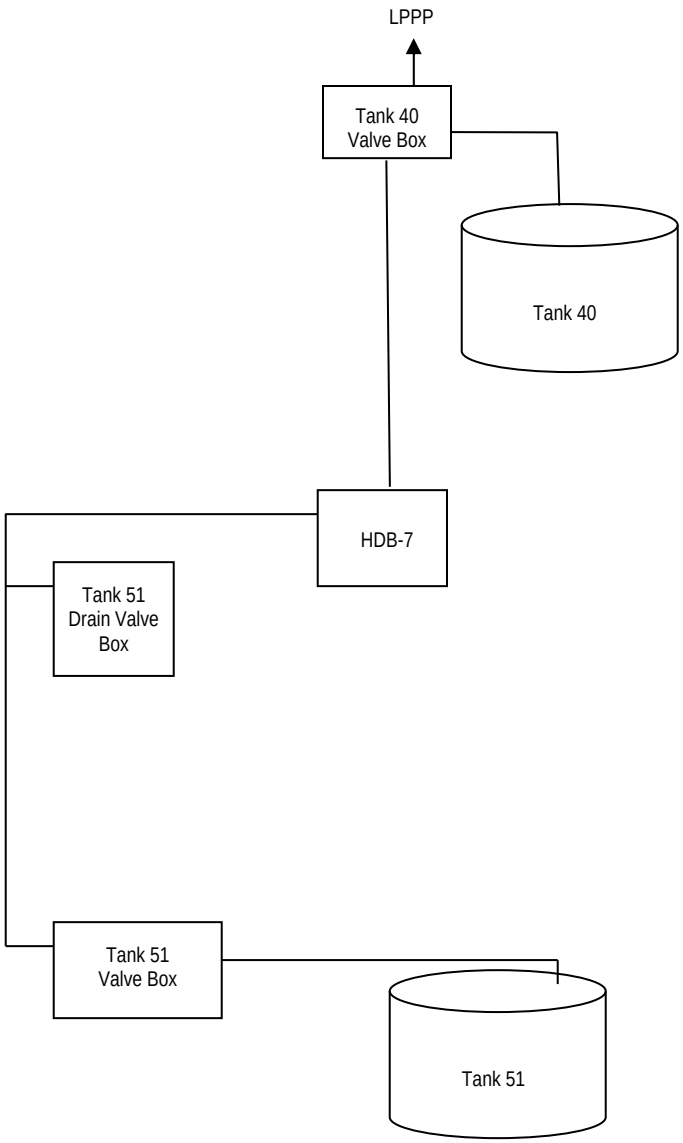
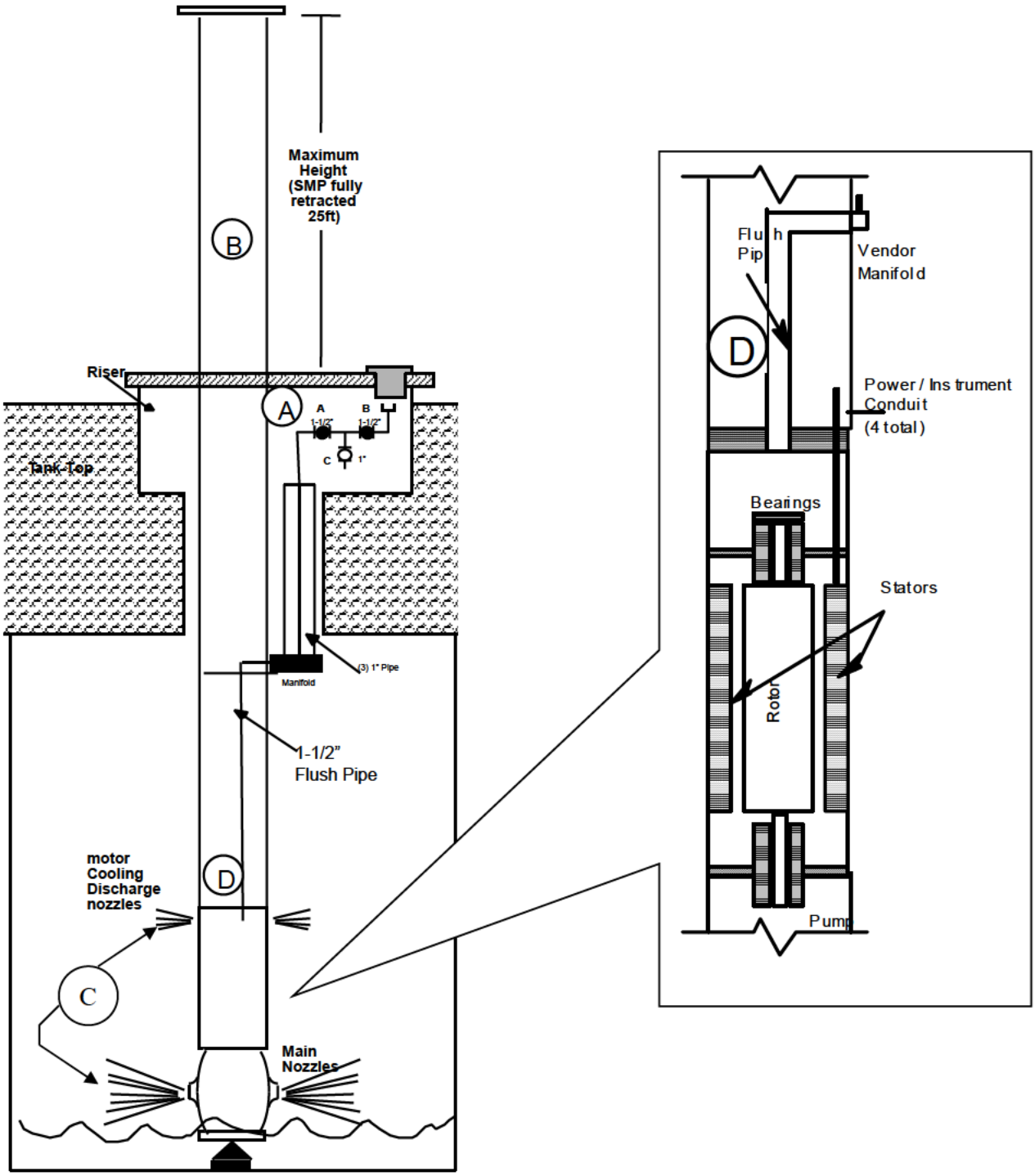


Figure 3.7-1 ESP Sludge Slurry Transfer Path



A. SMP Riser Overflow
B. SMP Column (Top) Spill and Column Spray (crack) – at any place along the column
C. SMP Aerosolization – at motor cooling nozzles and main discharge nozzles
D. SMP Column Explosion – inside the waste tank or above the riser

Figure 3.7-2 SMP Accident Scenarios