X-SD-G-00001
Revision 37

KEYWORDS:
Waste Acceptance Criteria,
WAC, Waste Generators.

RETENTION: Permanent

CLASSIFICATION: U
Does not contain UCNI

WASTE ACCEPTANCE CRITERIA FOR LIQUID WASTE TRANSFERS TO THE TANK FARMS (U)

November 2015

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REVISION HISTORY

Rev. 17 6/04	**Revision bars used** -changed basis for Saltstone limits for Tank 50 from the proposed limits of a new permit to the limits in the currently approved Saltstone WAC -grammatical changes (as needed – not denoted by revision bars)
Rev. 18 7/04	**Revision bars used** -added U-235, Pu-239 limits for transfers into Tank 50 in order to protect the Tank 50 Valve Box NCSE -clarified the need for a deviation request if a generator does not meet the Saltstone limits directly for transferring to Tank 50 -revised Attachment 13.4 to reflect latest Saltstone WAC requirements (deleted U-232, Am-242m, and Cm-245; added Ra-226, and Th-230)
Rev. 19 9/04	**Revision bars used** -added implementation checklist/effective date signatures -deleted Attachment 13.5 -deleted sentence from Section 2 that said non-compliance with the SB related items would constitute a DSA violation – this will be determined after such an event -changed references to PIR to PR/STAR to reflect change in form used for these situations (revision bars not used for this change) -revised Attachment 13.4 to include minimum periodic characterization requirements for influents into Tank 50; revised Attachment 13.1 to reflect this change -changed Concentration, Storage, and Transfer (CST) to Liquid Waste (LW) – revision bars not used for this change -changed SRTC to SRNL in Section 2 -deleted paragraph from Section 2.3 that was an example of wording for generator's DSA -added clarification to Section 6.2 for better understanding of characterization requirements -removed reference to the Process Interface Description document -removed wording requesting analytical uncertainty within 3 months of rev. 15 approval since all generators have already complied with request -minor editorial changes throughout document
Rev. 20, 9/05	**Revision bars used** - Reference was added to each section that contained Safety Basis (Documented Safety Analysis and Technical Safety Requirements) related requirements by placing the specific requirement referenced in brackets and bold text (example *A/C* Admin Control 5.8.2.15, etc....). - Revised sections 6.2 and 11.8 to clarify characterization requirements per the Saltstone WAC. - Revised section references in sections 7, 8, and attachment 13.2 per observations reported in ETP Self-Assessment. - Revised section 11.1 to clarify inhibitor and corrosive species requirements. - Revised section 11.5 to clarify requirements, per Q-ESR-G-00053 (Waste Compliance Plan Review Team Summary Report). - Revised attachment 13.1 and 13.2; updated sampling basis and reduced sampling requirements, to include Tank 50 (Saltstone) requirements. - Removed attachments 13.3 and 13.4 - Updated revision history to include only the most recent revisions.

Rev 21, 8/06	Revision bars used • Specific Admin Control (SAC) flagging added. • Section 11.6, Requirements for Criticality Safety, changed Note 6 to delete reference to F-Canyon transfers • Section 11.6, Requirements for Criticality Safety, changed reference to Attachment 14.1 to Attachment 13.1. • Attachment 13.1 Si and Ce added to complete characterization. Al and CO3 changed to be required for all new stream complete characterization, was required only for streams to Tank 50. The changes for Si, Al, and CO3 are to provide information for streams potentially going to an evaporator system. Ce has been identified to have potential process impacts on DWPF. No changes to acceptance parameters are associated with these additions to complete characterization.
Rev 22, 3/07	• Inhalation Dose Potential for influents to Tank 50 (Section 11.4.2) changed to 2.09E+5 Rem/gal to match JCO WSRC-TR-2003-00083 Revision 6.
Rev 23, 6/07	• Generalized Extended Sludge Processing (ESP) to sludge processing. • Updated References • Grammatical changes (e.g. Rem/gal replaces Rem/gal). • Deleted Toluene requirement from 11.2.1 on DWPF Recycle Transfers. • Added Strip Effluent volume limit per Recycle Collection Tank. • Descriptive changes made throughout to include MCU related acceptance criteria. • Hydrogen Generation Rate, and NO_{eff} acceptance criteria added for Tank 50 influent streams. These limits are applicable at and following the initiation of MCU transfers to either Tank 50 or DWPF. • Inhalation Dose Potential and HC-3 Sum of Fractions acceptance criteria added for MCU receipts. • Fissile Material Management section added for MCU. • Out of date references deleted. • Added Temperature limitation for transfers from 512-S into MCU. This restriction was added to section 11.2.2, the section relating to Hydrogen Generation Rate < 50 °C. Additionally, a process requirement for the same stream to be between 20 and 29 °C added to 11.12 • Liquid Waste Environmental Engineering (LWEE) instances changed to Environmental Compliance Authority (ECA), added third bullet to ECA (was LWEE) responsibilities • '...as requested' removed from instances of ECA co-approval of WAC/WCP's. • Added 'at 100 °C following up to 20% contribution in the 5th paragraph of 11.2.1 for consistency • 11.5 description of responsibility changed to be consistent with the ECA change to section 4.4. ECA review of all WCP/WAC revisions to check for permit impact. • Added 11.12 MCU Process Requirements • Added clarification to Saltstone WAC criteria Limits, section 11.8. • Section 5, timing for submission of a new or revised WCP to be submitted nominally 6 weeks before transfer. This is a change in that the previous revision required a preliminary WCP 6 weeks prior only for new waste streams. • Section 6.2, Timing of characterization submittal prior to transfer changed to match that of the WCP (see change to Section 5) • Section 11.6 Changed the format of Equations 1-4 for clarity. Added Gadolinium as an acceptable neutron poison.

Rev.24; 0508	Revision bars used • Revised Implementation Checklist to address procedure changes and LDD update • Added SAC 5.8.2.42 to Requirements • Added 299-H in Section 2 , Application of Waste Acceptance Criteria • Added new Section 11.13
Rev.25; 10-08	Revision bars used • Grammar and formatting changes made throughout • Section 11.6.1 changed in accordance with the new 2H Evaporator NCSE
Rev 26; 03-09	Revision bars used • Update to clarify Saltstone WAC pass-through requirements. • Update to Ammonia limit specific to ETP transfers. • Deleted the previous Attachment 13.2. • Replaced instances of LWF with CSTF. • Deleted TPB sampling requirement. • Former reference 19, WSRC-TR-2003-00083 the 'organic' JCO, deleted. • Ru-106 moved from Minimum Characterization gamma PHA to Complete Characterization. • 'Case 2' TBP and butanol limits for Tank 50 influent added to 11.8. • Add Reference 52, X-CLC-Z-00067.
Rev 27; 09-09	Revision bars used • Add flush requirement for influent streams of IDP > 3.5E+07 rem/gallon
Rev 28; 11-09	Revision bars used • To allow for an elevation of the Tank 50 High Level Conductivity Probe, the Tank 50 specific Hydrogen Generation limit lowered to 2.9E-08 ft^3H_2/hr-gallon and NO_{eff} minimum of 1.7. • ARP/MCU NCSE, N-NCS-H-00192 revision 3, makes significant changes to the criticality requirements for MCU receipts. • Specific prohibition to Petro AG added to the Downstream Impact section 11.8.
Rev 29, 2-11	Revision bars used • Allowance made for preevaluated transfers that are outside the corrosion specifications of 11.1.2-11.1.4 • Section 11.8, Requirements to Satisfy Downstream Facility Acceptance Criteria, updated to specify ETP WAC limits be considered for transfers into an Evaporator system. • Various non-technical updates. • Implementation Checklist moved to stand-alone documentation. • Reference to Saltstone WAC updated to Revision 10 from Revision 9. • Section 11.2.2 updated to include prohibition on transfers through lines for which diversion boxes or pump pits with hydrogen generation greater than 9.6E-06 ft^3/gal-hr.

Rev 30	Revision bars used • pH minimum limit changed from 9.5 up to 12 to match the Corrosion Control PDD, WSRC-TR-2002-00327. • Section 11.11 updated to align with Annual Update change to DSA section 5.7.1. • Reversed change to Section 11.2.2, the 9.6E-6 ft^3/hr/gal limit was not applicable to H-Canyon transfers.
Rev 31	Revision bars used • Section 11.6.2 changed to show the new limit for soluble plutonium for MCU as 0.3 mg/L • Section 11.8 WAC revision number update
Rev 32	Revision bars used • Section 11.1.3 changed example tank for RCT receipt to reflect actual operations • Section 11.6 corrected Multiple Safe Weight Ratio equations • Section 11.8 updated Revision references due to new Saltstone WAC and mention of the Saltstone FINAL Calculation program • Section 3 Acronym added for Saltstone Disposal Unit (SDU)
Rev 33	Revision bars used • Updated the document title. • Section 8 requirement expanded to explicitly require generators to supply sludge quantities, on the condition the generator sends measurable quantity of sludge. • Section 11.2.1 added the sentence, "This engineering evaluation shall be performed using the methodology outlined in Reference 12.", the Organic PISA, to resolve a SAC assessment comment directing consistency with DSA section 3.4.1.5.3. • Section 11.2.2 changed HGR requirement for Type IV waste tanks to 3.2 ft^3/hr total for the tank. • Section 11.2.2 added compliance requirement that generators sending to Type IV waste tanks provide sludge data for transfers. • Section 11.2.2 added requirement receipt requirement for tanks undergoing salt dissolution • Section 11.4.1 added compliance requirement that generators sending to Type IV waste tanks provide sludge data for transfers. • Section 11.4.1 &11.4.3 deleted '68' when referring to ICRP to resolve a SAC assessment comment directing consistency with DSA section 3.4.1.5.1. DSA values derived only from ICRP 72. • Section 11.6 Reference 21 corrected to the new HCanyon DCA, N-NCS-H-00243, and added discussion added regarding the U-235:Pu-239 equivalency ratio. • Section 11.8 updated Tank Farm WAC revision number to current (33). • Section 1 clarification added to list of transfers to which the WAC does not apply. • Section 5 list of required approvers changed for consistency with ENG.08. • General: made consistent the capitalization of 'Tank Farm'. • Minor grammatical and formatting corrections throughout. • Section 11.6 changed 'inherently safe with respect to criticality' to 'subcritical' in advance of the Tank Farm DSA Annual Update for consistency. • Section 11.6 Note 1 changed to link to new Nuclear criticality safety manual wording for potential exemption from poison requirement • Section 11.7 Reference corrected.

Rev 34	Revision bars used • Section 11.4.2 - Updated parameters that protect MCU as a Haz Cat. 3 facility • Section 11.8 - Incorporated the current SS WAC revision • Section 11.12 - Updated filter size requirement for MCU Salt feed solutions • Section 14 – Updated References
Rev 35	Revision bars used • Section 3: Added new acronyms • Section 4.1: Added responsibility for LWE • Section 4.2: Added responsibility for LWGR • Section 11.6: Revised note 6 • Section 13: Uniformed reference section, updated references, & deleted reference 21. • Removed attachment 13.1 and relevant references and added additional clarification in Sections 6.2 & 11.8 based on the deleted attachment: Deletion of Attachment 13.1 allows for waste generators to be responsible for ensuring their waste streams are appropriately characterized. Their respective WCPs are approved by the TF and can be used as a guideline when characterizing a waste stream.
Rev 36	Revision bars used • Section 11.8: Removed requirement for MST strike, when not needed • Updated corresponding SS WAC revision number
Rev 37	Revision bars used • Updated sections 6.0, 11.1, 11.2, 11.4, and 11.6 to specify when analytical uncertainty is and is not required in accordance with CST DSA annual update.

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Requirement: This document meets the requirement of the following:

- Admin Control 5.8.2.13
- SAC 5.8.2.15
- SAC 5.8.2.21
- SAC 5.8.2.25
- SAC 5.8.2.42
- Admin Control 5.8.2.32
- DSA 5.7.1
- DSA 6.5.2
- DSA 3.4.1.5.2

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1 Introduction to SRS High Level Liquid Waste Management

Liquid high level waste received into the Tank Farm is held in interim storage in 51 underground tanks (where tanks 12 and 16 are undergoing closure sampling and tanks 5, 6, 17, 18, 19 and 20 have been closed) that range in capacity from 0.7 to 1.3 million gallons. Henceforth, the use of the terms "Tank Farm (TF)" and "Liquid Waste Facilities (LWF)" are defined to include the 299-H Tank Farm Maintenance Facility, the Modular Caustic-Side Solvent Extraction Unit (MCU) and Actinide Removal Process (ARP) at 241-96 H with the interim storage tanks and their associated systems, unless specifically noted otherwise. Typically, fresh waste is transferred into a receipt tank where the insoluble solids (sludge) are allowed to settle. The supernatant liquid is decanted and then transferred to an evaporator for volume reduction. Evaporator overheads are collected and processed through the F/H Effluent Treatment Project (ETP) and then are discharged to an outfall. The tank farm evaporator bottoms are transferred to a concentrate receipt tank, where the contents are cooled to crystallize the salts. The remaining solution is recycled as evaporator feed and the cycle repeated until as much water as possible has been removed. In this fashion, the overall volume of the waste is reduced by approximately 60-70%. Saltcake and sludge fractions have, for the most part, been segregated. The major radionuclide in salt waste is ^{137}Cs while the actinides and the rest of the fission products accumulate in the sludge. Major chemical components include the NO_3^-, NO_2^-, OH^- and salts of Na in the saltcake, and oxides and hydroxides of Fe, Mn, and Al in the sludge.

Eventually, the waste will be removed from the waste tanks and processed into feedstock either for the Defense Waste Processing Facility (DWPF) or for the Saltstone Production Facility (Z Area) for the purpose of tank closure. Salt that has crystallized in the concentrate receipt tanks will be dissolved and processed as necessary through the Actinide Removal Process (ARP) and MCU to reduce the concentration of radioactive contaminants before transferring the decontaminated salt solution to Z Area for disposal as saltstone. The ARP and MCU are designed to remove actinides/^{90}Sr and Cs from the salt solutions, respectively. The radioactive contaminants removed by these processes will be sent to DWPF for processing into glass for final disposal. Sludge in the waste tanks will be slurried and transferred into Tank 40 or Tank 51 for sludge processing. The residual sludge solids will then be washed to reduce the concentration of soluble salts in the sludge slurry. Washing consists of several cycles, each including the steps of wash water addition, sludge suspension/mixing, sludge settling, and decanting the spent wash water. Washed sludge will then be transferred to the DWPF for processing into glass for final disposal.

Management of the liquid radioactive waste (i.e., interim storage and processing operations) requires:

- safe disposition of waste in the LW tanks;
- safe operation of Tank Farm facilities (e.g., evaporators, MCU);
- understanding the impact of new wastes on existing inventories prior to their acceptance;
- compliance with feed requirements for downstream and processing facilities (e.g., ARP, MCU, DWPF, Saltstone, and ETP);
- certification of solid low level waste (generated as a result of Tank Farm activities) for disposal in the E-area Solid Waste Disposal Facility;
- compliance with environmental permits and regulations;

- compliance with all associated facility Safety Basis (SB) (e.g., Tank Farm, ARP, MCU, DWPF, etc.).

All waste transferred to the Tank Farms for interim storage must be compatible with existing equipment and facilities, and must remain within the Concentration Storage and Transfer Facility (CSTF) SB safety envelope. As the site mission evolves and generators change their processes, waste characteristics are also expected to change. Because of the potential for waste variability formalized control of waste being transferred into the Tank Farm is needed.

The Waste Acceptance Criteria (WAC) presented in this document provides the controls to satisfy the requirements listed above. To that end, this document includes:

- the criteria and the basis for determining the acceptability of waste to be transferred to the Tank Farms (including MCU) such that (a) interim storage or processing of the waste will be in compliance with applicable safety, environmental, and regulatory requirements and DOE Orders; and (b) the waste composition will meet the downstream facilities' (e.g., ARP, MCU, DWPF, Saltstone and ETP) feed requirements;
- the methods for reviewing and approving the acceptability of new waste streams, and for accepting waste that deviates from the specific criteria (Section 9);
- the identification of WAC sections that are credited in the Tank Farm SB.

This document does not include the requirements for performing inter-tank transfers within CSTF, ARP (Tank 49 to 241-96H) and MCU(MCU to Tank 50). Inter-tank transfer requirements are identified in other Technical Safety Requirements (TSR) Administrative Control Programs such as the Transfer Control Program.

2 Application of the Waste Acceptance Criteria

This document identifies the requirements and specifications that must be satisfied by the waste generators for direct waste transfers to the Tank Farms. These requirements are applicable to all organizations and facilities that directly transfer waste to the Tank Farm. This includes, but is not limited to, waste generated in the following facilities:

- F-Canyon and Outside Facilities
- H-Canyon and Outside Facilities
- Nuclear Materials Management
- DWPF
- ETP
- Other on-site facilities
- SRNL
- Tank Farm Maintenance Facility (299-H)
- 512-S
- Analytical Laboratories
- Off-site facilities

299-H
299-H Tank Farm Maintenance Facility is a part of the Tank Farm Facilities. 299-H is a Hazard Category 3 facility. To preserve that designation, compliance with the 299-H Inventory Control Program, WSRC-TR-97-0342, Reference 49, is required All material processed in the 299-H Facility shall be characterized sufficiently for LWE to demonstrate that the Tank Farm's ability to meet various acceptance criteria imposed by the downstream processing and disposal facilities will not be impaired.

All components from approved site facilities must satisfy the Inventory Control Program. Components from facilities other than FTF/HTF will require Special Waste Compliance Plan to show acceptability for receipt into the 299-H facility.

2.1 Tank Farm WAC

All liquid waste directly transferred into the F/H Tank Farm waste tanks must satisfy the WAC defined in the following sections. This includes chemicals that are added to a waste tank for use as a special cleaning solution. Waste that is transferred through an intermediate facility for subsequent transfer to the Tank Farms must also satisfy these WAC at the time of discharge to the Tank Farms (i.e., the intermediate facility that directly transfers the waste to the Tank Farm is responsible for assuring transfers from other facilities will not prevent them from complying with the WAC).

Waste generators are required to document their Waste Compliance Plan (WCP, refer to Section 5), including the waste characterization and controls that ensure the waste satisfies the WAC. Most importantly, the WCP must clearly identify the controls protecting the Tank Farm SB and the maintenance of these SB controls.

2.2 Tank Farm Technical Safety Requirements

[*A/C* SAC 5.8.2.15]

The Waste Acceptance Criteria Program is credited in the SB with ensuring that the composition of waste streams received into the facility are within analyzed limits. Waste streams not bounded by the analyzed isotopic and chemical inventory assumptions shall not be accepted unless a USQ evaluation has been performed and approved. Ensuring that the composition is within analyzed limits ensures that the assumptions made in calculating the consequences and deriving the limits in the safety analysis are maintained [1].

Safety Basis (Documented Safety Analysis and Technical Safety Requirements) related requirements are identified by placing the specific requirement referenced in brackets and bold text (example *A/C* SAC 5.8.2.15, etc.).

2.3 Generators Safety Basis

Each generator must recognize the Tank Farm WAC Program in their Safety Basis (SB). A section should be added to demonstrate the importance of the Tank Farm WAC Program [1].

3 Acronyms

Regular
Irregular
Special } - the three categories of waste (refer to Section 6.1)

Minimum
Complete } - the two levels of characterization (refer to Section 6.2)

ARP	- Actinide Removal Process
CHAP	- Consolidated Hazards Analysis Process
CLFL	- Composite Lower Flammability Limit
CSTF	- Concentration, Storage, and Transfer Facility
DBP	- Dibutylphosphate
DIRT	- Data Integrity Review Team
DSA	- Documented Safety Analysis
DWPF	- Defense Waste Processing Facility
EEC, ECC	- Environmental Evaluation Checklist, Environmental Compliance Checklist
ECA	- Environmental Compliance Authority
EPA	- Environmental Protection Agency
ERD	- Emergency Response Document
ESP	- Extended Sludge Processing
ETP	- Effluent Treatment Project
FOSC	- Facility Operations Safety Committee
H&V	- Heating and Ventilation
ICRP	- International Commission on Radiological Protection
IDP	- Inhalation Dose Potential
IW	- Irregular Waste (refer to Section 6.1)
LEL, LFL	- Lower Explosive Limit, Lower Flammability Limit

LWE	- Liquid Waste Engineering (may be read as Tank Farm Engineering and/or Liquid Waste Organization Engineering)
LWEE	- Liquid Waste Environmental Engineering (Environmental Services Section)
LWF	- Liquid Waste Facilities
LWGR	- Liquid Waste Generator Representative (refer to Sections 4.2 and 7)
LWM	- Liquid Waste Management (i.e., LWO, LWE, and LWEE)
LWO	- Liquid Waste Operations
MCU	- Modular Caustic-Side Solvent Extraction Unit
PDD	- Program Description Document
PR/STAR	- Problem Report, Site Tracking Analysis and Reporting
RCRA	- Resource Conservation and Recovery Act
RCT	- Recycle Collection Tank
RW	- Regular Waste (refer to Section 6.1)
SB	- Safety Basis
SCDHEC	- South Carolina Department Health and Environmental Control
SDU	- Saltstone Disposal Unit
SIRIM	- Site Incident Reporting and Issue Management (ref: manual 9B)
SRS	- Savannah River Site
SW	- Special Waste (refer to Section 6.1)
SWDF	- Solid Waste Disposal Facility (i.e., the E-Area Vaults)
TBP	- Tributylphosphate
TPB	- Tetraphenylborate
TCLP	- Toxicity Characteristic Leaching Procedure
TSR	- Technical Safety Requirement
USQ	- Unreviewed Safety Question
USQS	- Unreviewed Safety Question Screening (ref: procedure 1.05 in manual 11Q)
WAC	- Waste Acceptance Criteria
WCP	- Waste Compliance Plan (refer to Section 5)
WCS	- Waste Characterization System

4 Responsibilities

4.1 Liquid Waste Engineering (LWE) WAC Cognizant Engineer

is responsible to:

- maintain the WAC, including reviews and revisions as needed
- co-prepare and co-approve the WAC implementation checklist for each WAC revision
- advise all waste generators on the WAC requirements, including the relation to Technical Safety Requirements (TSR), and other technical bases
- co-approve the waste generator's Waste Compliance Plan document (WCP)
- conduct Technical Reviews *(USQS)* of the waste streams only if they deviate from the WAC
- assign a waste stream number to all approved waste streams
- revise the Approved Waste Stream List (i.e., N-ESR-G-00001 – ERD) to include any new waste streams approved for receipt in the Tank Farms
- coordinate with the WCS PDD owner, or DIRT chairperson, monthly on WG08 updates if there have been transfers to the Tank Farms [38]
- document and review the waste generator's self assessment programs for compliance with the WAC and WCP
- evaluate the impact of a WAC non-compliance, assist the investigation (e.g., PR/STAR, SIRIM) and address

the impact to the Tank Farm WAC Criteria Program [1]

4.2 Waste Generator and Liquid Waste Generator Representative (LWGR)

is responsible to:

- develop, document, co-approve, and implement a Waste Compliance Plan (WCP) (refer to Section 5)
- clearly identify items within the WCP that protect CSTF SB requirements and the program for maintaining controls for these items (e.g., procedures, procurement specification)
- designate their "Liquid Waste Generator Representative" (LWGR, refer to Section 7), who serves as the primary contact with LW for all communications regarding these responsibilities
- prepare all waste for transfer to the Tank Farm so that all WAC requirements are met
- verify that any procedure changes associated with a waste stream do not impact any WAC/WCP agreements
- input all characterization and transfer information into the Wisdom Workgroup WG08 as agreed to in the WCP and maintain records demonstrating compliance with the WAC and WCP
- notify the LWE WAC Cognizant Engineer when a special transfer is terminated (e.g., completion of PVV flush)
- include compliance with their WCP as part of a self assessment program
- finance any additional evaluations or other measures required for the Tank Farm to accept special waste
- report a WAC non-compliance to LW and assist the investigation (e.g., PR/STAR, SIRIM)
- finance any required studies to develop technical bases for receipt of the waste
- finance any corrective action resulting from the generator's failure to meet the WAC
- communicate with WCS PDD owner, or DIRT Chairperson, on WG08 updates regarding significant changes to volume of existing waste streams or, any other non-routine WG08 updates.

4.3 Liquid Waste Operations (LWO)

is responsible to:

- co-approve the WAC and each WCP, particularly the operational aspects of all waste transfers
- notify the LWE WAC Cognizant Engineer of any changes to the facility, processes or procedures that could impact the receipt of a waste stream
- advise all waste generators of operational requirements for transfers into the Tank Farm and approve the actual waste transfers.

4.4 Environmental Compliance Authority (ECA)

is responsible to:

- advise LWE and all waste generators on the WAC requirements, assuring compliance with environmental permits, local , state, and Federal laws and regulations
- co-approve the WAC and review WCP deviation requests
- notify the Generator Certification Official (GCO) and the characterization engineer (supporting Tank Farm Solid Waste Disposal) of possible impacts to the Tank Farm Solid Waste streams as a result of WAC changes or changes to the input streams.

5 Waste Generator's Compliance Plan and CST Approval

Each waste generator shall develop, implement and maintain an approved compliance program, as described in a formal Waste Compliance Plan document (WCP). The WAC and WCP combine to bridge the interface between LW and the waste generator, ensuring that waste transferred to the Tank Farms can be safely stored and processed for disposal. At a minimum, the WCP document shall:

- describe the transfer volumes and frequencies to the Tank Farms
- describe the chemicals (and radionuclides if applicable) used in the process generating the waste (i.e., species that could affect the waste composition)
- describe the waste stream in terms of complete characterization (refer to Section 6)
- technically justify any deviations from any WAC requirements
- describe activities that ensure compliance with the WAC, including any required waste processing (e.g., the generator may need to decant and/or evaporate to remove any organic material)
- identification of "SB" controlled requirements (see section 2.2)
- describe the self assessment program that assures compliance with the WCP
- describe waste minimization activities (e.g., acid recovery and volume reduction by evaporation, reduced consumption of chemicals)
- describe any future activities that will validate and/or improve the characterization (e.g., samples)

The originator, Waste Generator and Receiving Facility Technical Reviewer(s), Waste Generator Engineering Manager, Waste Generator Facility Manager, Receiving Facility Chief Engineer, Environmental Support Services, and Receiving Facility Manager(s), at a minimum, must approve the new/revised WCP/SWCP including the Implementation Checklist, if necessary.

The WCP may subdivide the major waste streams (listed in Section 6.1) on any appropriate basis provided each waste stream is characterized separately. As described in Section 6.2, "process knowledge" and sample analysis can be combined to characterize a waste stream.

LWE shall review the WCP, particularly the waste characterization versus the specific acceptance criteria described in Section 11.

Any new waste stream or WCP change requires a reviewed and approved WCP for CST review nominally ***6 weeks*** before the waste is to be transferred to the Tank Farms. Calculations performed to demonstrate compliance with criteria shall meet the requirements of E7 procedure 2.31. Any waste stream generated from a discussed activity in the approved WCP must be characterized (and the characterization included as an attachment, or referenced, in the WCP). The final WCP shall be in place before transfer of a new or modified waste stream is allowed.

An evaluation, by LWE, of the flammability impact (predicted time-to-LFL) to the proposed waste receipt tank shall be completed prior to LWE approval of any WCP for a special waste stream.

Basis

The WCP is an agreement between the waste generator and Liquid Waste (LW) that documents the generator's responsibilities to prepare the waste for interim storage, processing, and eventual disposal.

6 Waste Stream Categories and Characterization

Waste to be sent to the Tank Farm shall be characterized sufficiently for LWE to demonstrate that the receiving process or tank will not exceed the characterization used in the CSTF Safety Basis [2]. All sample analyses used to demonstrate compliance with the requirements for organic flammable species, inhalation dose potential, MCU Hazard Categorization and criticality safety must include the analytical uncertainty of those measurements (2 sigma). [3].

Note: LWE will evaluate the waste stream characterization to ensure that any impacts on the Tank Farm Safety Basis are recognized, evaluated and approved. For example, the DSA uses certain inhalation dose potential compositions and inventories (e.g., Ci/gal or rem_{inh}/gal).

Basis

Waste transferred to the F/H Tank Farms must not cause the receiving pump tank or waste tank to exceed the bounding composition allowed in the Safety Basis. As the SRS missions change and evolve, the waste transferred to the Tank Farm may be more variable than historically observed. Similarly, the Safety Basis must be updated periodically as changes occur. Relative to the Safety Basis, the impact of each waste stream on the existing waste tank inventory must be known.

LWE's evaluation (refer to Section 5) uses data for several of the radionuclides included in the waste stream characterization (refer to Section 6.2). For example, the USQ process (a part of the overall Technical Review process) ensures that the inhalation dose potentials used in the Documented Safety Analysis (DSA) are not exceeded.

6.1 Categories

Three categories of waste streams are defined to determine the characterization and reporting requirements. The three categories are:

- **Regular Waste** (RW) has a consistent composition -- both the species present, and their concentrations, are relatively constant (over time).

  Since a given RW stream has little variation in composition, that characterization is sufficient to evaluate the stream's acceptability. However, a full characterization may be required for new waste streams never received in the Tank Farms. Reporting the volume of each waste stream transferred is sufficient to allow tracking the receipts (and the waste tank inventories) of each species.

  A RW stream will have a consistent composition over time unless the flowsheet is altered by the generator. The volume of such waste streams may be large and transfers to the Tank Farms may be frequent, helping to minimize the variability in composition. For example, "PUREX low heat process waste" was generated continuously by the production process, and varied as a function of irradiation time and the timing of a transfer relative to other operations that generate low heat waste (e.g., decontamination waste).

- **Irregular Waste** (IW) has a variable composition -- the concentrations of various species vary within some bounds, but the same species are present (over time).

  Since a given IW stream contains the same species and their concentrations can be bounded, that bounded composition is sufficient to evaluate the stream's acceptability. However, to permit tracking the receipts (and the waste tank inventory), the volume and the composition of each batch or the concentration of a selected "indicator" species must be reported for each transfer.

  An IW stream may be generated frequently or intermittently, but it has a potential for large composition variations. The species in a particular IW may be the same as those present in the RW of that process, but

the concentrations vary widely (e.g., from batch to batch). No new species/process chemicals are introduced.

- Special Waste (SW) has a highly variable composition -- either different species are present, or their concentrations may vary too widely to be bounded satisfactorily. Special waste may also encompass material that is non-routine (or irregular) and/or not necessarily waste.

  For SW, species present may have significant variation in composition from batch to batch or the waste may contain constituents that are not present in waste normally received in the Tank Farms. As such, characterization of each batch is required to evaluate the stream's acceptability. Also, the composition and volume of each transfer must be reported in more detail to allow tracking the receipts and waste tank inventory. In this context, the term "transfer" may refer to individual waste transfers, or it may apply to all transfers from a special process campaign. The appropriate scope shall be defined by the generator in the WCP.

  These wastes may be generated as part of special activities such as addition of radioactive liquid chemicals to a waste tank or use of a special cleaning solution, or in a process where the presence of species changes from batch to batch, or from one-time activities (e.g., facility decommissioning and closure).

The key to categorizing a given stream as RW, IW, or SW is the variability in species that are present and their concentrations -- neither the volume of waste nor the transfer frequency is important.

The generator's WCP will define their streams and assign the appropriate category to each.

6.2 Characterization

Characterization shall be based on a combination of (1) process knowledge and (2) analysis of process samples. When sufficient analyses are available for a species, then they should be used for the characterization. When process knowledge is used for some species and analyses are used for others, then the validity of the process knowledge may be corroborated by following a similar reasoning for the "analyzed" species, and comparing that process knowledge to the sample analyses. The characterization should be presented in terms of concentrations in the waste stream to be transferred to the Tank Farms.

In the case of MCU, the waste characterization serves as the basis for compliance with the feed control requirement specified in the SB. The control of the feed ensures that the facility does not exceed its Hazard Category rating and inherently ensures the facility complies with the facility's corrosion, flammable species, hydrogen generation, radionuclide content/IDP, and criticality safety basis, etc.

Table 1 provides the characterization requirements for influent waste streams to the F/H Tank Farms.

Table 1 Characterization Requirements

Type of Waste Compliance Plan	Complete Characterization	Periodic Characterization
Regular WCP	Required	Required Quarterly or As Defined in WCP
Irregular WCP	Required	Frequency Defined in WCP
Special WCP	Required	Frequency Defined in WCP

Table 1 shows the characterization requirements for all approved waste streams to the tank farm. A complete characterization is required prior to the approval of any and all waste streams. The periodic characterization, or minimum characterization is required quarterly, or as defined in the generator's WCP for all regular waste streams; the frequency of the periodic characterization for all irregular and special waste streams is defined in the agreement obtained in the generator's WCP for that waste stream. The waste generator will be responsible for ensuring their waste streams are appropriately characterized. Waste generators sending to Tank 50 will characterize their waste streams to comply with the current revision of the Saltstone WAC [6].

As noted in Section 5, the generator's WCP will document the appropriate characterization bases (both complete and

periodic), and will be approved by LWE. As is discussed in Section 9, the WCP may take exception to a characterization requirement and provide a defensible rationale and/or alternative.

Changes in a waste stream's characterization are to be approved by revising the WCP.

The quarterly requirement to characterize RW streams may be relaxed if the generators' procedures analyze for major constituents (e.g., isotopes for criticality and inhalation dose, or constituents near downstream facility or process limits, etc.) in waste streams prior to transfer to CSTF. The generator's WCP will define and justify the sampling frequency if the frequency is not quarterly.

Additional characterization may be required in order to meet the requirements of section 11.8 of the WAC. Characterization needed to satisfy downstream and processing facility requirements will be required prior to the approval of the generator's WCP.

Characterization information should be provided at least six weeks prior to the planned transfer to the Tank Farm. Transfer information should be provided within two weeks of the transfer or as agreed upon in the WCP.

6.3 Basis

A wide variety of liquid waste is received into the CSTF, and based on the definitions in Section 6.1; these wastes are assigned to a category (i.e., RW, IW, or SW).

RW is typically generated by a facility's ongoing/routine operations. IW may be generated in a facility as a result of activities used to improve production (e.g., flushing of process vessels). The use of nitric and oxalic acid solutions for cleaning and decontamination is also considered as generation of IW, even though the salts of these acids are present in normal waste. Another example of IW is dissolution of HEME/HEPA material in the DWPF. Other waste streams may be categorized as SW due to their potential for a wide variety of chemical constituents and concentrations. Examples of SW would include the following:

- Acceptance of outside waste streams for processing at the ETP, or the use of special flushing/cleaning agents in all facilities will likely introduce species that are not present in RW streams.
- Miscellaneous streams from the F/H-Canyons could include product solutions, which would require detailed characterization and evaluation before transfer to the Tank Farm.
- The use of different chemicals for experiments or analytical methods within the site laboratory facilities could generate waste in which the species inventory will vary significantly from batch to batch, depending on programs being performed at the time. Note that a lab waste stream could well be considered RW, depending on the consistency in its operations and waste composition (over time).
- Decontamination, decommissioning, and closure of site facilities could generate waste solutions drastically different than routine high level waste. Each batch of these wastes will require evaluation of impact to the Tank Farm, and are categorized as SW.

Characterization of influent waste streams into the Tank Farms must be tracked throughout the CSTF. The inclusion of specific species in the characterization is based on requirements discussed in Section 11. Species that can cause upsets with respect to these requirements must be identified so that a strategy for handling these species can be developed.

7 Liquid Waste Generator Representative (LWGR)

Each organization that transfers waste to the F/H Tank Farms will designate a LWGR (or a lead LWGR and appropriate alternate(s)). The LWGR will be the LWE's point of contact for communications with the generator. Specific duties of the LWGR are listed in Section 4.2.

To provide accurate information on waste transfers, the LWGR must be knowledgeable of all processes and activities in the generator's facility that can affect the quantity and composition of waste. The LWGR must be aware of day-to-day operations or activities that could affect the status of a waste stream. For example, a chemical addition or non-standard operation that results in waste which exceeds the approved characterization requires the waste stream to be characterized before the waste is transferred to the Tank Farm.

Note: A generator's WCP can define (and characterize) a given waste stream to allow a range of activities if the

composition doesn't vary too widely.

8 Documenting Waste Transfers to the Tank Farms

[*A/C* SAC 5.8.2.15 and Admin Control 5.8.2.32]

The waste generators will input characterization and transfer information into the WG08 folder, HLW-WRT to provide easy tracking. In addition, the generators shall perform an independent verification of data.

When transferring waste to the Tank Farms, generators shall comply with the criteria in Section 5.7.1 of the CSTF DSA (refer to Section 11.11 of this document) [3].

For generators that send measurable sludge quantities, the entries to WG08 shall include data adequate to determine the total sludge amount added. The generator's WCP will include description of the data supplied to meet the determination needs.

Basis

The Tank Farms SB has an administrative requirement to have a WAC Program to safely receive waste [1, 3]. To meet the future processing requirements the characterization and transfer information will be recorded in WG08.

9 Deviations from the WAC Requirements

[*A/C* SAC 5.8.2.15]

Programmatic controls shall ensure that waste streams to be received into the CSTF (or transferred through the CSTF from an outside sender) is within the analyzed isotopic and chemical inventory, and physical condition (e.g., temperature) requirements of the CSTF WAC and is performed in accordance with the applicable CSTF-approved Waste Compliance Plan (or other approved engineering document). If the material does not meet the WAC requirements, an USQ review (or equivalent) shall be performed and approved by CSTF prior to transferring the material [3].

A waste generator may take exception to anything in this WAC (i.e., any deviation can be proposed), and such deviations will be documented in the generator's WCP. In this context, the terms "deviation", "exception", and "exemption" have the same meaning. If the WCP takes exception to a characterization requirement, it shall provide a defensible rationale and/or alternative. As discussed in Section 5, LW's approval of the WCP will thus include any requested deviations. For example, a waste generator might request to deviate from a characterization requirement. For example, an online process density measurement could be substituted for the periodic specific gravity sample analysis, or a facility having highly consistent ratios of NO_3^-, NO_2^-, and OH^- could explain why the periodic sample analysis for these anions is unnecessary.

For transfer of a particular solution that is outside one or more of the specific WAC requirements in Section 11, depending on the circumstance, a deviation may be possible, particularly for a limited volume of the waste. For example, the existing contents of a waste receipt tank may be "credited" for "blending" the composition of a proposed waste. LW and the waste generator will jointly determine if any additional controls are needed to ensure that the waste can be safely received, managed and eventually processed by DWPF, Saltstone, or ETP. For example, additional mitigating measures or studies may be necessary to receive the waste.

When deviating from the WAC, generators must submit a written request, which must be approved by Engineering and Operations Managers after a USQ has been performed against the proposed activity and approved by the FOSC. When generators deviate from their Waste Compliance Plan (WCP), a written evaluation must be performed on the proposed activity which must be approved by Engineering and Operations Managers. FOSC approval is not required for WCP deviations that do not impact the WAC. Generators must provide a basis/justification for why a deviation (regardless of whether it is a WAC or WCP deviation) is acceptable in their WCP. Deviation must be clearly identified and summarized in the "Deviation" section of the WCP.

Note that a WAC deviation may also trigger other administrative systems (e.g., Safety Basis change, procedure changes, and set point changes).

Basis

The activities that result in the generation of a different waste composition, and the act of receiving that waste into the Tank Farms, fall within the scope of a "Proposed Activity" [2,3], thus, "Technical Review" procedures are the most appropriate means of evaluating and approving the transfer of a waste stream with a different composition.

10 Recovery from a Non-Compliance

Immediately, the LWGR is required to inform LWE and Tank Farm Operations verbally and in writing of any requirements which have not been satisfied (e.g., due to a process upset, an inadvertent transfer). In conjunction with LWO and LWEE, LWE will determine the actions to be performed by the Generator before waste can be (or can continue to be) accepted in the CSTF.

Note: the PR/STAR, and/or SIRIM procedures will be invoked as appropriate.

Basis

For waste that does not comply with the specific requirements of the WAC, a strategy must be developed for safe management and future processing. The purpose of the criteria is to ensure that all waste received conforms to requirements for interim storage, processing, and eventual disposal.

11 Specific Criteria for High Level Liquid Waste Receipts

This WAC identifies chemical and radionuclide requirements and other specifications that must be satisfied by the waste generators for waste transfers to the F/H Tank Farms.

Specific requirements detailed below govern the presence and allowable concentrations of several species. They incorporate many safety and regulatory considerations for the safe management and processing of waste within the Tank Farms (e.g. corrosion prevention [4]). Safety Basis (Documented Safety Analysis and Technical Safety Requirements) related requirements are identified by TSR Administrative Control number or relevant DSA section in the section's heading. CSTE's review of a generator's WCP will evaluate the appropriate implementation of SB identified items. Specifications also result from feed requirements of the downstream processes (e.g., ARP at 512-S, MCU, DWPF, Saltstone [5, 6, 42, 43], and ETP [7]). Some of the species and/or properties appear in more than one requirement; however, the most conservative limit is documented below.

11.1 Requirements for Corrosion Prevention

The Tank Farm waste tanks and cooling coils within the tanks are constructed of carbon steel, and are susceptible to nitrate induced stress corrosion cracking, general corrosion and pitting corrosion. To prevent unacceptable rates of corrosion, waste solutions in the Tank Farms must satisfy the specifications in sections 11.1.1-11.1.4. In the case of MCU, the primary product stream is a decontaminated salt solution (DSS) that will be sent to Tank 50, waste accepted by MCU will need to comply with the corrosion prevention requirements for Tank 50.

A waste generator's WCP will ensure that waste solutions transferred into the Tank Farms also satisfy the specifications in sections 11.1.1-11.1.4. A single transfer that does not meet the specifications in sections 11.1.2-11.1.4 is not automatically considered a WAC non-compliance, but will require the LWGR to notify LWE in order to evaluate the impact on the receipt tank's chemistry. In cases where a planned transfer is outside the specifications of sections 11.1.2-11.1.4, transfers may proceed where the impact on receipt tank chemistry has been evaluated and documented prior to receipt. The specification in section 11.1.1 is a Tank Farm SB requirement and waste transfers into the Tank Farm must meet this requirement.

As corrosion is a relatively slow phenomenon and limits are based on general chemistry regimes, analytical uncertainty is not required to be applied when demonstrating compliance with corrosion limits [3].

11.1.1 Minimum pH of Waste

[*A/C* CST Admin Control 5.8.2.13 and DSA 6.5.2]

pH > 12

Basis

This is a TSR Administrative Control which requires limits on pH [1, 4]. A minimum pH of 10.3 for influents into the waste tanks was established in the Corrosion Control Program [4]. A minimum pH of 12 will bound the PDD requirement that transfer lines with 'low' points be flushed with inhibited water unless another waste transfer is planned within the next 5 days. The Tank Farm DSA 6.5.2 requires an alkaline solution (pH>7) to protect criticality. The requirement of a pH>12 also protects this Tank Farm Criticality Safety Basis [28].

Solutions with a pH below 7 cause general corrosion of carbon steel. To prevent general corrosion, solutions transferred to the tanks must have a pH above neutral, and the specification of pH above 12 is judged to provide adequate margin to account for error in sampling and analysis. The waste tank corrosion chemistry sampling program corrects for inhibitor depletion (e.g., hydroxide depletion by CO_2 absorption), and also confirms the generator's pH controls and inhibitor additions.

11.1.2 Minimum Inhibitor Contents for all Waste Generators

Including DWPF Recycle when Stored Below 40°C

[*A/C* CST Admin Control 5.8.2.13]

For 5.5M < $[NO_3^-]$ ≤ 8.5 M:		$[OH^-] \geq 0.6$ M
	and	$[OH^-] + [NO_2^-] \geq 1.1$ M
For 2.75 M < $[NO_3^-]$ ≤ 5.5 M:		$[OH^-] \geq 0.3$ M
	and	$[OH^-] + [NO_2^-] \geq 1.1$ M
For 1.0 M < $[NO_3^-]$ ≤ 2.75 M:		$[OH^-] \geq 0.1 * [NO_3^-]$
	and	$[OH^-] + [NO_2^-] \geq 0.4 * [NO_3^-]$
For 0.02 M < $[NO_3^-]$ ≤ 1.0 M:		$[OH^-] \geq 1.0$ M
	or	$[NO_2^-] \geq 1.66 * [NO_3^-]$
For $[NO_3^-]$ ≤ 0.02 M:		$[OH^-] \geq 1.0$ M
	or	$[NO_2^-] \geq 0.033$ M

Note: all concentrations are in moles/liter, and $[OH^-]$ refers to free hydroxide.

Basis

The Corrosion Control Program requires limits on OH^-, NO_2^-, and NO_3^- to ensure that the tank chemistry is controlled to minimize corrosion of tank walls, cooling coils and transfer lines [1, 4]:

- The specification for free hydroxide concentration through the entire range of nitrate composition ensures that the alkalinity of the waste is sufficiently high to prevent general corrosion.
- The combination of nitrite and hydroxide as inhibitors provides protection against nitrate induced stress corrosion cracking, which can occur for nitrate concentrations above 1M. The nitrate ion is, by far, the predominant aggressive species. The cracking aggressiveness of solutions increases as the nitrate concentration increases, requiring more corrosion inhibitor is present.
- The concentrations of nitrite and hydroxide provide protection against pitting corrosion, which is the main corrosion mechanism for solutions with nitrate concentrations below 1M in carbon steel tanks. The limits are based on either nitrite or hydroxide acting alone to prevent pitting. No pitting has been observed for a free hydroxide concentration above 1M. Because no data have been developed at lower hydroxide concentrations, the value of 1M is used. For nitrite inhibition, the minimum concentration was developed from the amount of nitrite needed at a minimum hydroxide concentration. The nitrite concentration specified in the limit was determined for a waste temperature of 40°C. Waste temperature in uncooled tanks in which dilute waste is stored has been observed to only reach about 30-32°C during the summer months.

The waste tank corrosion chemistry sampling program corrects for inhibitor depletion (e.g., hydroxide depletion by CO_2 absorption), and also confirms the generator's pH controls and inhibitor additions.

DWPF recycle waste may use the limits given above as long as the receipt tank's supernate temperature is not greater than 40°C. These limits may also be used for a receipt tank that will have a resulting nitrate concentration greater than 1 M [37].

11.1.3 Minimum Inhibitor Contents for Waste Generated by DWPF When Stored at Temperatures in Excess of 40°C [*A/C* CST Admin Control 5.8.2.13]

For $[NO_3^-] \geq 1.0$ M:		follow Section 11.1.2
For 0.1 M $\leq [NO_3^-] < 1.0$ M:		$[OH^-] \geq 1.0$ M
For 0.01 M $\leq [NO_3^-] < 0.1$ M:		$[OH^-] \geq 0.5$ M
	and	$[NO_2^-] \geq 3.17 * [NO_3^-] - 0.0192$
For $[NO_3^-] < 0.01$ M:		$[OH^-] \geq 0.5$ M
	and	$[NO_2^-] \geq 0.0013$

Note: all concentrations are in moles/liter, and $[OH^-]$ refers to free hydroxide.

Basis

The Corrosion Control Program requires limits on OH^-, NO_2^-, and NO_3^- to ensure that the tank chemistry is controlled to minimize corrosion of tank walls and transfer lines [1, 4]. This requirement is based on analytical experiments with simulated DWPF recycle waste [8, 9, 27] as well as an evaluation of the temperature dependence of inhibitor limits [37]. Nitrite and hydroxide in the DWPF recycle will provide protection against pitting corrosion. The recycle volume can be as much as 3 Mgal/yr and is collected from various unit operations throughout the DWPF. The waste is collected and transferred to the Tank Farm (e.g., Tank 22) in ~8,000 gal batches. The nitrate concentration is expected to vary widely, up to a concentration of 1M. The specified concentrations of inhibitors will provide adequate protection for the composite recycle stream. The waste tank corrosion chemistry sampling program corrects for inhibitor depletion (e.g., hydroxide depletion by CO_2 absorption), and also confirms the generator's pH controls and inhibitor additions.

11.1.4 Maximum Concentrations of Corrosive Species [*A/C* CST Admin Control 5.8.2.13]

The waste's supernate phase is limited to (these concentrations may occur simultaneously):

- $[Cl^-] \leq 0.11$ M;
- $[F^-] \leq 0.086$ M (the concentration of uncomplexed fluoride);
- $[NO_3^-] \leq 8.5$ M; and
- $[SO_4^{=}] \leq 0.18$ M.

Basis

The Corrosion Control Program requires limits on $SO_4^=$, Cl^-, and NO_3^- to ensure that the tank chemistry is controlled to minimize corrosion of tank walls and transfer lines [4]. The maximum chloride and sulfate concentrations reflect the maximum concentrations found in the Tank Farm [10]. The Tank Farm's satisfactory operating history demonstrates that the inhibitor levels specified in Section 11.1.2 are sufficient to prevent corrosion of the waste tanks at these chloride and sulfate concentrations. The limits refer to the soluble phase composition.

The maximum uncomplexed fluoride concentration is specified to prevent corrosion of the carbon steel waste tanks and cooling coils. Fluoride is used in the Separations processes to promote dissolution. The specification is based on corrosion tests for dilute waste solutions (i.e., nitrate concentration < 1.0 M) inhibited with nitrite. The maximum fluoride concentration tested was 0.086 M, and the inhibitor levels specified in Section 11.1.2 for $[NO_3^-]$ less than 1 M were found to prevent corrosion [11].

The maximum nitrate concentration is a Corrosion Control Program limit [4]. This limit prevents addition of waste outside of the range of nitrate concentration for which corrosion inhibitor requirements have been developed.

11.2 Requirements to Prevent Accumulation of Flammable Species

[*A/C* SAC 5.8.2.15]

11.2.1 Organic Vapor Control

[*A/C* SAC 5.8.2.15]

All sample results reported to demonstrate compliance with the requirements to prevent accumulation of flammable species (organic content) must include the analytical uncertainty, and the uncertainty must be used in any subsequent calculations based on those results [3]. If process operations (e.g. evaporation and decantation) are credited for organic vapor control rather than sample analyses, sample uncertainty is not required for any organic analysis.

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 [3]. This includes volatile organics as well as ammonia. Although the Tank Farm DSA calculates LFL values at 100°C in the pump tank (so reliance on temperature controls is not needed), generators are still required to transfer waste at no greater than 70°C. Meeting the WAC requirement will require WAC restrictions on generators with the nature and extent of the restriction varying by waste stream. 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 [3,12]. Also, no new sources of flammable material may be added to the waste stream after it has been evaporated and decanted. Waste shall only be excluded from these decanting and evaporation requirements if prior process knowledge has shown it to contain only trace organics (< 5 % hydrogen LFL) without evaporation or an evaluation is performed to ensure the 5% limit is not exceeded. A semi-annual sample for volatile/semi-volatile organics will provide analytical assurance that the organic content of the waste stream will contribute less than 5% hydrogen LFL. Other senders (e.g., Defense Waste Processing Facility (DWPF)) may require limits on the waste stream constituents (e.g., strip effluent, ammonia).

Canyon PVV flushes may exceed the 5 % limit and be transferred into the Tank Farm if they are evaluated and shown to have:

- Less than, or equal to, a 20 % organic contribution to the hydrogen LFL in receipt pump tank (at 100°C), and [3]
- Less than, or equal to, a 5 % organic contribution to the hydrogen LFL in locations downstream of the receipt pump tank (at 100°C) [3].

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 the hydrogen LFL to less than or equal to 5 % (at 100°C) [3]. 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 12.

The ammonia concentration in the ETP stream transferred into Tank 50 is limited to 720 mg/L. [44]

Basis

"Organics" as used in the DSA is defined as flammable vapors other than hydrogen contributing to the LFL, including both organic vapors and other flammable vapors. 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.

Volatile species, both organic (e.g., butanol) and inorganic (e.g., ammonia), can be "driven" from solution by the presence of dissolved salts at high pH. Most of the waste already in the Tank Farms contains higher salt concentrations than the fresh waste streams, so mixing the solutions can force the volatile species into the waste tank vapor space. A limit is required to ensure that the pump tank and waste tank vapor space does not exceed 5% of the hydrogen LFL (exemptions, up to 20% contribution at 100 °C, are allowable if documented by WCP, SWCP, or deviation) under liquid-vapor equilibrium conditions. This excludes the hydrogen generation.

Only occasionally, a few grams of methanol are included in a DWPF recycle batch. Even the maximum amount of methanol that is transferred from DWPF does not contribute to increasing the hydrogen LFL in waste tanks [12]. Thus, the impact of methanol in waste tanks is negligible and, therefore, ignored.

The ammonia limit applied to the ETP influent stream to Tank 50, 720 mg/L, is based on X-CLC-H-00581 [44]. This value is greater than the Saltstone WAC and so is an exception to the requirements of 11.8, Requirements to Satisfy Downstream Facility Acceptance Criteria.

Restrictions for DWPF Transfers

The concentration of organics in DWPF's RCT waste stream must be limited to the following in order to restrict the organic contribution to the hydrogen LFL to ≤ 5% at 100°C in the pump tank [12]:

Strip Effluent: ≤ 20 gallons per Recycle Collection Tank batch of DWPF recycle [43]
Ammonia: ≤ 60 mg/L in waste tank
Note: the ammonia limit, in addition to protecting the LFL limitation in a pump tank, factors in protecting the ETP receipt limit. Any change to this ammonia limit shall consider the impact on Evaporator overheads compliance with the ETP limit.

11.2.2 Hydrogen Generation Rate

[*A/C* SAC 5.8.2.15, 5.8.2.25 and DSA 3.4.1.5.2]

The Liquid Waste Generators (LWG) must ensure that the hydrogen generation from radiolysis for influent sludge slurry waste streams is below 1.5E-05 ft^3 of hydrogen/hr/gallon (at 25°C) [3]. In addition, generators must ensure that they meet the hydrogen generation rate limit for transfers into evaporator feed tanks of 9.6E-06 ft^3/hr/gal (at 25°C) [3]. This requirement is to be met if the generator sends directly to an evaporator system. For the MCU, the hydrogen generation rate is directly controlled by complying with the feed composition controls for radionuclide constituents (Section 11.4). The hydrogen generation limit for transfer into Tank 50 is limited to 2.9 E -08 ft^3/hr-gal (with an NO_{eff} of 1.70 minimum at 43°C). This requirement is only applicable at and following the initiation of MCU transfers to either Tank 50 or DWPF [44, 53].

The Waste Compliance Plan for waste streams received by Tanks undergoing salt dissolution (e.g. Tank 41) that are sludge bearing streams (e.g. DWPF recycle) shall address the total addition of sludge. Each salt dissolution has an accompanying gas release mode (GRM) evaluation. The GRM sets the total amount of sludge that tank may receive.

The hydrogen generation rate shall be calculated using the following formulas [3]:

For alpha particles:

$$R_\alpha = 134.7 - 82.3 * \left[NO_{eff}^-\right]^{1/3} - 13.6 * \left[NO_{eff}^-\right]^{2/3} + 11.8 * \left[NO_{eff}^-\right]$$

where $\left[NO_{eff}^-\right] = \left[NO_3^-\right] + 0.5 * \left[NO_2^-\right]$

For beta/gamma:

$$R_{\beta/\gamma} = 48.36 - 52.78 * \left[NO_{eff}^{-}\right]^{1/3} + 14.1 * \left[NO_{eff}^{-}\right]^{2/3} + 0.572 * \left[NO_{eff}^{-}\right]$$

where R is expressed as ft^3 $H_2/10^6$ Btu. The hydrogen generation rate should be expressed as ft^3 H_2/hr/gal. Significant hydrogen generated from any other mechanism (e.g., chemical) shall be accounted for. The hydrogen generation rate calculated or assumed is for Standard Temperature and Pressure (STP) (STP: 0 °C and 1 atmosphere). Many of the accidents are assumed to occur at elevated temperatures. Therefore, the hydrogen generation rate must be corrected for the higher temperatures.

Type IV Waste Tank Requirement

The total bounding hydrogen generation rate Type IV waste tanks shall be less than or equal to 3.2 ft^3/hr (at 25°C) [3]. The hydrogen generation limit for transfers into Type IV waste tanks is imposed on the waste tank, rather than the influent waste stream. Generators sending waste to Type IV waste tanks shall provide data on a by transfer basis that will allow for the determination of the resulting hydrogen generation rate in the Type IV receipt tank (See Section 8). A total allowance of sludge will be determined for any Type IV waste tank designated for receipt from a waste generator. The total allowance of sludge will protect the total bounding hydrogen generation rate of 3.2 ft^3/hr. For a generator to send waste to a Type IV waste tank, they must demonstrate through their waste compliance plan a method for staying within that total sludge allowance and tracking the total sent. Flowsheet changes (e.g., change of sludge batch) will drive changes to the total sludge allowance.

Basis

Hydrogen generated from radiolysis is limited to 1.5E-05 ft^3 hydrogen/hr/gallon (or 3.2 ft^3 hydrogen/hr total for Type IV waste tanks) to ensure adequate time is provided to tank farm operations to re-initiate pump tank ventilation [3]. In addition, generators who transfer waste to an evaporator feed tank are limited to 9.6E-06 ft^3 hydrogen/hr/gallon in order to comply with the DSA limit for evaporator bottoms [3]. This will ensure that limit is met. For the purpose of hydrogen generation in Type IV waste tanks, it is assumed that there is no mixing available and thus sludge transferred into the tank will accumulate. The total sludge amount transferred into Type IV tanks must be accounted for.

In the absence of purge ventilation, leakage, or other mitigating factors, hydrogen and organic vapor may accumulate in the vapor space of F- and H-Area Tank Farm waste tanks and pump tanks. To prevent the composite gas/vapor from reaching 100% hydrogen LFL (which is 4% of the vapor space volume for the case of hydrogen, alone), administrative controls must be used to monitor the potential hydrogen and organic vapor buildup [3].

Using empirical data relating the volumetric rate of hydrogen generated to the nitrate and nitrite concentration and decay heat present, estimates can be made of the time required to reach LFL (TLFL) due to hydrogen accumulation for each waste tank and pump tank in F- and H-Area Tank Farms [3].

The prohibition on steam jet transfers of waste with a radiolytic hydrogen generation rate greater than 9.6E-06 ft^3/hr/gallon of waste through transfer lines for which diversion boxes or pump pits are credited leak detection locations comes from DSA section 3.4.1.5.2, Facility Configuration and Design Inputs.

Restrictions for Transfers Into MCU

Transfers into MCU from 512-S are to be ≤ 50°C.

Basis

A high temperature input of 50°C was the basis for the hydrogen generation rate evaluation for streams within MCU [45].

11.3 Prevent Formation of Shock Sensitive Compounds

No waste containing silver shall be transferred into the Tank Farm.

Note: this specification does not prohibit silver present as a fission product, or a minimal quantity of silver present as a result of laboratory and/or analytical methods, or if the quantity received is evaluated to have no impact on the tank farm.

Basis

This requirement is based on administrative controls resulting from previous transfers of silver-laden flush water from the F/H-Canyons. In 1970, popping noises were heard when dried waste deposits in the Tank 21 feed-jet enclosure and the 242-H Evaporator cell were disturbed by personnel and/or equipment. Investigation of the incident revealed that silver was present in the waste feeding the evaporator, and likely formed silver nitride, a shock sensitive compound [13]. The silver was present due to flushes of the silver coated Berl saddles used in the canyons to remove radioiodine. After an administrative control prohibiting such flushes was implemented in the Canyons, no similar incidents have been observed.

11.4 Requirements for Radionuclide Content for Waste Receipts

All sample results reported to demonstrate compliance with the requirements for inhalation dose potential and MCU Hazard Categorization must include the analytical uncertainty, and the uncertainty must be used in any subsequent calculations based on those results [3]. For MCU, the radionuclide concentrations in wastes (i.e., waste feed characterization) sent to MCU must be used in calculations to verify that the facility's Hazard Category 3 is not exceeded [1]. The control of the waste feed to MCU to maintain its Hazard Category 3 rating ensures inhalation dose potential limits for the facility are not exceeded. The feed control/waste characterization also ensures that the facility operates within its design parameters [1].

11.4.1 Receipt Inhalation Dose Potential Criteria for Slurried Type IV Waste Tanks

[*A/C* SAC 5.8.2.15]

Transfers into slurried Type IV tanks may not cause the tank waste limit for the material at risk of 1.0E+07 rem_{inh}/gallon for any slurried Type IV waste tank to be exceeded [3]. This limit is imposed on the waste tank not on the influent waste stream; however, the generator must still provide the IDP of the influent waste. In addition, generators shall use ICRP Publication 72 for dose conversion factors as was used in developing the Tank Farm DSA.

The total IDP in a Type IV waste tanks shall be less than or equal to 1.0E+07 rem_{inh}/gallon [3]. The IDP limit for transfers into Type IV waste tanks is imposed on the waste tank, rather than the influent waste stream. Generators sending waste to Type IV waste tanks shall provide data on a by transfer basis that will allow for the determination of the resulting IDP in the Type IV receipt tank (See Section 8). A total allowance of sludge will be determined for any Type IV waste tank designated for receipt from a waste generator. The total allowance of sludge will protect the total bounding IDP rate of 1.0E+07 rem_{inh}/gallon (at a controlled minimum volume for the receipt tank). For a generator to send waste to a Type IV waste tank, they must demonstrate through their Waste Compliance Plan a method for staying within that total sludge allowance and tracking the total sent. Flowsheet changes (e.g., change of sludge batch) will drive changes to the total sludge allowance.

Basis

The 1.0E+07 rem_{inh}/gallon requirement is from the CSTF Documented Safety Analysis and Technical Safety Requirements. Type IV waste tanks are assumed to contain material at risk which has a slurry dose potential bounded by 1.0E+07 rem_{inh}/gallon at the normal operating capacity [3].

For the purpose of inhalation dose potential total in Type IV waste tanks, it is assumed that there is no mixing available and thus sludge transferred into the tank will accumulate. The total sludge amount transferred into Type IV tanks must be accounted for.

11.4.2 Receipt Inhalation Dose Potential, Hazard Category 3 Criteria, and Cs-137 for MCU [*A/C* SAC 5.8.2.15]

Material transferred into the MCU facility shall be less than or equal to 1.69E+05 Rem/gallon [3].
Material transferred from 512-S to MCU shall maintain a sum of ratios less than 1 to protect the HC 3 status of MCU.
1.1 Ci/gallon is the maximum allowable Cs-137 concentration for transfer into MCU [47].

Basis
By controlling the inhalation dose potential of the feed stream, the assumptions made for the MCU accident analysis are maintained [3].

ARP R&D program identified key flow sheet parameters for 241-96H processing to ensure DF for Sr and other various actinides are achieved. By controlling the parameters of temperature, MST concentration, ionic strength or sodium concentration, MST strike time, and agitation in 241-96H, MCU is protected as a Hazard Category 3 facility. In addition to the listed parameters, the filtering function performed in 512-S, along with a feed limit for Cs-137 concentration, also protect the Hazard Category 3 classification of the MCU [57].

The sum of ratios is less than 1.0 when compared to HC 2 thresholds [3].

11.4.3 Receipt Inhalation Dose Potential Criteria for non-Type IV Waste Tanks

[*A/C* SAC 5.8.2.15]

[*A/C* SAC 5.8.2.21]

[*A/C* SAC 5.8.2.25]

The waste stream composite (solids and liquids) dose potential concentration must be less than 1.5E+09 rem_{inh}/gallon to be received in the Tank Farm [3]. This limit is imposed on the influent waste stream. Generators shall use ICRP Publication 72 for dose conversion factors as was used in developing the Tank Farm DSA. In addition, waste transfers may be categorized as "High-Rem" or "Low-Rem" transfers. High-Rem waste transfers have an inhalation dose potential of greater than 2.0E+08 Rem/gallon, while Low-Rem transfers have an inhalation dose potential of less than, or equal to, 2.0E+08 Rem/gal [3]. It is assumed in the DSA that all Canyon transfers are Low-Rem, and thus, must remain as such. Low-Rem transfers that exceed 3.5E+07 Rem/gal require, within 30 days, a sufficient flush of the core pipe such that the inhalation dose potential of the residual waste in the core pipe is less than or equal to 3.5E+07 Rem/gal. If an evaluation indicates that the inhalation dose potential of the residual waste in the core pipe is less than or equal to 3.5E+07 rem/gal, flushing is not required. If flushing is required, the necessary flush volume and duration shall be determined. Flushing is not required if the time between transfers is less than 30 days (the 30-day completion time for the flush shall be based on completion of the last transfer) [3]. Any transfer which has an IDP above 9.8E+07 Rem/gallon shall be considered a sludge-slurry transfer and shall be labeled as such in the generators' WCP. Sludge-slurry transfers require special flushing procedures in order to be transferred to the Tank Farm. In addition, all generators must identify in their WCP's whether a given waste stream is considered to be a High-Rem or Low-Rem transfer. In order to make a High-Rem transfer, generators must submit a special WCP.

Material transferred into the 2H and 2F evaporator feed tanks (i.e., Tanks 43H and 26F) shall not cause the evaporator bottom IDP of 3.3E+07 Rem/gallon to be exceeded [3]. **[*A/C* SAC 5.8.2.25]**

Material transferred into Tank 50 (Saltstone feed) shall not have an inhalation dose potential greater than 2.09E+05 Rem/gal [3]. **[*A/C* SAC 5.8.2.15]**

Basis

These requirements are mitigative measures to ensure that the consequences of explosion events are bounded by the current DSA accident analysis and to ensure no additional safety basis controls are necessary [3].

Accident analyses of liquid waste with a dose potential concentration above this concentration (1.5E+09 Rem_{inh}/gallon) have not been performed; therefore, acceptance of a liquid waste above the dose potential concentration limit would require a USQ to be completed and could require an SB change.

11.5 Requirements for Regulatory Compliance (RCRA)

An Environmental Evaluation Checklist shall be generated for each new waste stream received in the facility. Completion of the Environmental Evaluation Checklist is the responsibility of the organization or facility that is the source of the new waste stream received into the facility.

Permit modifications may be necessary for process changes within the scope of this WAC. The ECA is responsible for determining if proposed changes require permit modifications.

No RCRA hazardous "listed" waste will be received in the Tank Farm.

Except for the following, waste received in the Tank Farms must be below the RCRA TCLP toxic "characteristic" concentration limits [14]. The "Mixed Waste Site Treatment Plan" [15] lists the species that are allowed to exceed the TCLP criteria:

Characteristic	TCLP Code [14]
Corrosivity	D002
Ba	D005
Cr	D007
Pb	D008
Hg	D009
Ag	D011 (except refer to Section 11.3 limitation)
Benzene	D018

Basis

The LWF Tank Farms are permitted for operation as an Industrial Wastewater Treatment Facility [16]. Waste stream composition must be controlled to ensure that the applicable Tank Farm permits are met. Similarly, waste composition must be controlled to ensure that permits of downstream processing facilities and site-level permits are not affected, including the generation of secondary waste from activities within the Tank Farm.

A prohibition on RCRA "listed" wastes (ref: 40 CFR 261) is imposed to ensure that any waste received into the Tank Farms can be processed by DWPF, Saltstone and the ETP; and that solid wastes generated from LWF operations can be properly disposed of in the SWDF. All waste will eventually be processed through these facilities, and the respective regulatory permits require final waste forms be non-hazardous (e.g., high-level waste glass, Saltstone, and ETP's treated effluent). The EPA and SCDHEC regulations specify that anything "derived from" (e.g., mixed with) a "listed" hazardous waste are also considered "listed" hazardous wastes (unless the difficult process of "de-listing" is accomplished). Thus "listed" wastes are excluded from the Tank Farms to prevent creating hazardous products in DWPF, Saltstone, and ETP. There are some exemptions whereby the use of chemicals on the RCRA lists does not cause the waste to be "listed". If the waste generator uses such chemicals, then the WCP must include the Environmental Services Section's written concurrence that the specific use does not cause the waste to be "listed". For example, if particular chemical were used in the production process, then that waste would be "listed". However, if that same chemical is used in a laboratory analysis and the lab waste meets certain other requirements, then the lab waste stream would not be "listed".

The "Mixed Waste Site Treatment Plan" [15] lists the RCRA constituents that are currently found in the Tank Farms at concentrations greater than the TCLP limits. New constituents could be added to the plan (and then to the "acceptable" list in this WAC) if the new constituents are shown to be compatible with the treatment plan and applicable industrial wastewater permits.

11.6 Requirements for Criticality Safety

[*A/C* SAC 5.8.2.15 and DSA 6.5.2]

All sample results reported to demonstrate compliance with the requirements for criticality safety must include the analytical uncertainty, and the uncertainty must be used in any subsequent calculations based on those results [3].

Waste received in the Tank Farm shall be subcritical for any concentration and mass in the uncontrolled geometry of the waste tanks. Table 2 provides the required weight ratio of a single neutron poison to equivalent U-235 and Pu-239 to ensure the waste is inherently safe. To determine the equivalent U-235 for sludge slurries (applicable for all poisons), use the appropriate equivalency factor (EF) from Table 2 (i.e. Equivalent U-235 = U-235 + appropriate equivalency factor (Pu-239+Pu-241)) **[17, 18]** . Waste transfers that contain U-233 should be considered Pu-239.

If multiple neutron poisons are present in the waste stream, additional safe weight ratios for multiple neutron poisons can be evaluated for use. Alternatively, equations 1- 4 show the single and multiple weight ratios for neutron poisons to U-235 and Pu-239 for mixed fissile waste streams. Equations 1-4 do not use equivalency factors of any kind (i.e., single fissile isotopes are used). Equations 1-4 only apply to Canyon transfers and shall not be applied to poisoned DWPF waste streams.

Table 2: Safe Weight Ratios for Neutron Poisons to Equivalent U-235 and Pu-239

Single Neutron Poison	Required Weight Ratio to Equivalent U-235	Required Weight Ratio to Equivalent Pu-239	Equivalency Factor Pu-239 to U-235	Reference
Fe	72	160	2.25	[17]
Mn	14	29	2.07	[17]
U-238	103	-	1.6 [18]	[19]

Single and Multiple Safe Weight Ratios for Neutron Poisons to Equivalent U-235

For Fe Addition:
Equation 1: [Fe: U-235] = (-5.8* [Mn: U-235]) + 70 - [known Fe: U-235] [17]

For Mn Addition:
Equation 2: [Mn: U-235] = (-0.17* [Fe: U-235]) + 12 - [known Mn: U-235] [17]

Single and Multiple Safe Weight Ratios for Neutron Poisons to Equivalent Pu-239

For Fe Addition:
Equation 3: [Fe: Pu-239] = (-5.7* [Mn: Pu-239]) + 160 - [known Fe: Pu-239] [17]

For Mn Addition:
Equation 4: [Mn: Pu-239] = (-0.17* [Fe: Pu-239]) + 28 - [known Mn: Pu-239] [17]

Notes

1. Under certain circumstances when a waste stream can be demonstrated per Reference **20**, a deviation to adding neutron poisons may be possible **[20]**.
2. An equivalency factor of 2.25, 2.07, or 1.6 should be applied to (Pu-239 + Pu-241) to determine the equivalent U-235 mass when poisoning with Fe, Mn, and U-238, respectively **[17,18]**. Equivalency factors shall not be used in Equations 1-4. (The 1.6 equivalency factor for Pu-239 to U-235 is taken from Reference **18** which states 0.65 grams of Pu-239 is equivalent to 1 gram of U-235, by inverting that ratio one arrives at 1.53. Using a 1.6 ratio is therefore conservative.)
3. The generator's WCP document shall demonstrate that criticality is not a concern. If the fresh waste is a slurry, then the settled sludge phase (i.e., the concentrated insoluble phase) must also be demonstrated to be safe.
4. LWE will evaluate the waste stream characterization for downstream processing impacts (e.g., aluminum dissolution in ESP, concentrated supernate and salt cake produced by evaporation).
5. The solubility of fissile material and neutron poisons is low in supernate due to the alkaline chemistry maintained in the waste tanks. The fissionable material along with the chemical compounds tends to settle to the bottom of the waste tank to form a sludge layer. Therefore, supernate is critically safe in the uncontrolled geometry of the waste tanks. Therefore for supernate, there is no requirement to report the weight ratios of neutron poisons to equivalent U-235.
6. H-Canyon limits the routine waste transfers to contain less than a fissile mass unit (U-235 eq. $\leq$ 624 grams. Pu-239 eq. $\leq$ 390 grams) per batch or less **[18]**. A special, or regular, WCP must be submitted and approved to transfer more than a fissile mass unit per batch.

In addition, transfers into Tank 50 must contain no more than 16.5 mg/L U-235 (25 mg/L of total Uranium at an enrichment of 66%) and 1.68 mg/L Pu-239 **[40]**. These restrictions on Tank 50 are to protect the Tank 50 Valve Box NCSE **[40]**.

Gadolinium is acceptable as a neutron poison **[3]** at a mass ratio for Gd: Pu-239 equivalent that is 1:1 or greater with H/Pu ratios greater than 30:1 **[48]**. Use of Gd as a poison must be evaluated prior to acceptance of the waste stream to confirm the multiple safe weight ratios of neutron poisons to fissile is maintained in the receipt tank.

Basis [3].

The waste tank sludge inventory at SRS has a low fissile material concentration, low areal density of fissile material, and an abundance of neutron absorbing diluents in the sludge matrix. Each of these three properties contributes to demonstrating that sludge is be subcritical for any concentration and mass in the uncontrolled geometry of the waste tanks. The fissile material is distributed in a large volume, over a large surface and co-exists with other waste materials that are effective neutron absorbers. To describe the criticality safety margin associated with the SRS sludge inventory, the use of safety parameters is required. Because sludge is a variable mixture of insoluble solids with varying elemental compositions, calculating safe fissile material concentrations for specific sludges is tedious. Because of the low fissile material concentrations, the neutron absorber to fissile material ratios are high resulting in sludge being an inherently safe mixture. The criticality safety margin demonstrated in the waste tank's low areal densities is supplemented by an abundance of neutron absorbers. Three consistently abundant neutron-absorbing elements, for which safe weight ratios to (Pu-239 + Pu-241) and U-235 have been calculated, are iron, chromium, and manganese. In addition to the iron, chromium, and manganese, safe ratios of (Pu-239 + Pu-241) and U-238 have been determined if the U-235 content of the uranium is at or below that found in 0.96 wt. % uranium. This latter safety parameter is very useful in describing criticality safety in waste tanks that received large amounts of depleted uranium, like that found in PUREX waste. Demonstrating criticality safety based solely on the presence of one or two sludge diluents, while neglecting the presence of other neutron absorbing diluents indicates a large margin of safety. This margin of safety is demonstrated independently of the physical distribution of the fissile material in the waste tanks.

LWE's evaluation (refer to Section 5) will utilize data for several of the species included in the waste stream characterization (refer to Section 6.2).

11.6.1 Uranium Enrichment in 2H Evaporator System (includes Tanks 38 and 43)

External transfers that may proceed directly into Tanks 43, 38, or 22 must meet the following conditions:

- ≤ 5.5 wt % U-235 (eq) enrichment (DWPF must re-evaluate enrichment upon changing sludge batches) **[34, 50]**
- U-235 eq is to be calculated per the formula:
  U-235 (eq) = U-235 +1.4 X U-233 + 2.25 X (Pu-239 + Pu-241)
  U (eq) = U + 2.25 X (Pu-239 + Pu-241)
- The plutonium content of the fissionable elements in the waste transfers into the 2H Evaporator System shall not exceed 2 wt % **[50]**.

Basis

Prior to acceptance of a new sludge batch, DWPF must confirm to LWE that a U-235 (eq) enrichment of 5.5 wt% is not exceeded. DWPF will satisfy this requirement by requiring that the sludge fed from the Tank Farm to DWPF have an enrichment of ≤5.5 wt% U-235 (eq). The limit on plutonium content in the supernate in the 2H evaporator system is an administrative control required by the 2H NCSE. Prior to acceptance of a new sludge batch, DWPF must confirm to LWE that the plutonium content of the fissionable elements in the waste transfers into the 2H Evaporator System shall not exceed 2 wt %.

11.6.2 Fissile Material Management in MCU

Criticality safety is controlled in ARP and MCU by ensuring that each ARP/MCU feed macro batch will be shown via Nuclear Criticality Safety Assessment (NCSA), Salt Batch Qualification document, or engineering evaluation to have a soluble uranium and plutonium concentration and the wt % U-235 (eq_sol) enrichment in Tank 49 solution less than or equal to 50 mg/L, 0.3 mg/L, and 3 wt % respectively **[41]**.
Wt% U-235 (eq_sol) is defined as 100% * (U-235 + 1.4 * U-233) / U.

Basis

The basis for the wt % U-235 (eq_sol), uranium, and plutonium concentration limits are found in N-NCS-H-00192 **[41]**.

11.7 Requirements to Protect Heat Generation Rate

[*A/C* SAC 5.8.2.15]

The Tank Farm DSA requires that the waste tanks in the facility contain waste with a heat generation rate less than 8.0E+05 BTU/hr, and the pump tanks in the facility contain waste with less than 2.1E+04 BTU/hr. This requirement has been determined to be bounding for all incoming waste streams, so no additional controls are necessary.

Basis

The basis for the heat generation rates listed in the DSA and historical information shows that these limits are bounding and need no further controls **[35]**.

11.8 Requirements to Satisfy Downstream Facility Acceptance Criteria

[*A/C* SAC 5.8.2.15]

Waste received in the Tank Farm shall be characterized sufficiently for LWE to demonstrate that the Tank Farm's ability to meet various acceptance criteria imposed by the downstream processing and disposal facilities will not be impaired.

For waste being transferred to Tank 50, the Saltstone WAC [6] describes the Waste Acceptance Criteria required for the transfer of low-level aqueous waste from Tank 50H to the Saltstone Facility. Sample results or process knowledge may be used to determine the concentration of these constituents contained in a waste stream, but a value for all of the constituents must be given. This information is used to demonstrate continual compliance with the Saltstone requirements. Additional sample analyses may be required by the Tank Farm if such samples are deemed necessary to ensure the accuracy of the Tank 50 characterization. In addition, the waste generator must ensure that no waste that is hazardous or that will produce solid saltstone classified as TRU or HLW waste is transferred to Tank 50.

Prior to transferring waste into Tank 50, a waste generator must demonstrate compliance with the Saltstone WAC Limits. If a waste generator is unable to meet a Saltstone WAC Limit, on any single constituent, a deviation request will be made. The approval/disapproval of the deviation request by the Tank Farm will determine whether the waste stream will be approved to be transferred to Tank 50.

The following processing requirements associated with ARP/MCU processing requirements are to protect the critical inputs and assumptions that are used to demonstrate compliance to the 2009 PA and the Waste Determination (WD) and are applicable to the clarified salt solution transferred to MCU from 512-S:

For the MST-Strike option at ARP:
1. All material passed through the ARP passes through a cross-flow filter (at 512-S) to remove and concentrate the insoluble solids.
2. The concentrated solids heel in the filter feed tank (at 512-S) is washed and filtered to remove soluble sodium salts.
3. If a salt solution is processed through ARP, MST strikes shall be conducted.
4. MST strike tank contents are to be agitated between 4 and 24 hours. (Procedurally, the minimum strike time will be 4 hours.)

For the Filter-only option at ARP:
1. All material bypasses 241-96H (ARP) and passes through a cross-flow filter (at 512-S) to remove and concentrate the insoluble solids.
2. The concentrated solids heel in the filter feed tank (at 512-S) is washed and filtered to remove soluble sodium salts.

The Saltstone WAC, X-SD-Z-00001, allows for limits alternative to those set for 'other' organics on the condition of analysis consistent with the methodology of S-CLC-Z-00067 [52] and S-CLC-Z-00080 [54] for SDU 2 and those of similar design showing the influent stream volatiles contribute less than 10% to the CLFL at the time the SDU is at its peak percent of CLFL. Additionally, calculation X-CLC-Z-00065 [55] varies the concentrations of the butanol, methanol, Norpar, isopropanol, and TBP in various combinations to ensure that they contribute less than 10% to CLFL for SDUs 2, 3/5 and similar designs in the future.

Due to an undesirable effect on MCU processing, the anti-caking agent, Petro AG shall be excluded from DWPF recycle.

For waste streams that will be received into one of the Tank Farm evaporator systems, the following constituents must be analyzed and compared to the ETP WAC [7] to avoid any detrimental downstream impacts on ETP: Tritium, ammonia, mercury and beta-gamma. Stream composition can be compared against historical feed compositions to show compliance. Impacts will be documented in the WCP.

Note: The Saltstone WAC, X-SD-Z-00001, Revision 15 approved December 2015 [6] is the approved version at the time of implementation of this Tank Farm WAC, Revision 37.

Note: LWE will evaluate the waste stream characterization to ensure that any impacts on downstream facilities are recognized, evaluated and approved.

Note: Filtrate generated from solids wash and filter wash at 512-S may by-pass the MCU facility to be sent directly to Tank 50. This stream may be outside the Saltstone WAC Limits. Prior to the transfer, the impact on Tank 50 must be evaluated.

Basis

All waste sent to the Tank Farms eventually goes to "downstream" treatment and disposal facilities. Waste, which is sent to the Tank Farms, must be compatible with various acceptance criteria imposed by those facilities. Each individual transfer or waste stream sent to the Tank Farm does not need to meet each of the downstream acceptance criteria (except for influents to Tank 50 – see paragraph below), but a given stream must not prevent the Tank Farm from meeting those criteria:

- DWPF, Saltstone **[5, 6]**, and ETP's requirements (e.g., H-3) [7],
- SWDF's Waste Acceptance Criteria (e.g., solid low level waste characterization, B-25 tornado accident) **[23]**.
- Tank Farm Evaporators (e.g., evaporator IDP 3.3E+07 Rem/gallon for 2H and 2F),
- Tank Farm Waste Tanks and pump tanks heat generation,
- Single Contained transfer lines (< 0.05 Ci/gal), and
- Tank Farm Vamp detection during "High-Rem" transfers (e.g., IDP limits, area radiation monitors spill detection (i.e., 1 Ci/gal Cs-137))

A material balance is being kept for constituents going into Tank 50 (i.e. Waste Characterization System 1.5). The constituents needed to maintain this material balance are given in the Saltstone WAC **[6]**. All influent streams into Tank 50 must either meet the Saltstone LIMITS **[6]** directly, or a deviation request must be made. The approval of the deviation request from the Saltstone LIMITS shall be required prior to the approval of the waste generator's WCP to Tank 50. Saltstone WAC TARGETS may be exceeded by an influent to Tank 50 given the downstream impact analysis evaluates the stream as ultimately acceptable.

11.9 Industrial Hygiene Safety

Personnel protection issues shall be discussed in the WCP. Additional Health and Safety Information shall be provided for all new chemicals contained in radioactive solutions which are introduced into the facility. In the DSA, the Chemical Inventory Program provides control over NEW chemicals entering the facility. MSDSs are governed at a site level program.

Basis

Liquid waste received into the tank farm could expose Tank Farm personnel to chemical hazards at concentrations above the Occupation Safety and Health Administration (OSHA) limits. Chemical constituents that present a hazard should be identified, and the OSHA permissible exposure limits stated.

Consideration on the chemical constituent behavior under the Tank Farm conditions should be addressed. For example, ammonium has a low vapor pressure in acidic solutions; however, under the alkaline tank farm conditions the ammonium is converted to ammonia and is evolved into the vapor space of waste tanks and pump tanks. Venting ammonia could expose personnel to concentrations above OSHA limits, depending on the individual facilities ventilation system and atmospheric conditions.

11.10 Tanker Trailer Waste Receipt Criteria

The following requirements must be met for tanker trailer waste receipts into the Tank Farm.

1. identification number of each tanker
2. volume of material in each tanker
3. any material heel shall be evaluated for potential impacts to subsequent deliveries
4. comply with requirements of 5Q 1.1 for radiation and contamination control
5. completion of Transfer Report Form (if needed) as agreed to in the WCP
6. inhalation dose potential must be provided to CSTF (in WCP) for review

11.11 Transfer Requirements of Radioactive Waste into the Tank Farm [*A/C* SAC 5.8.2.15 & DSA 5.7.1]

The following interface control requirements require TSR controls within the appropriate waste sender's Safety Basis to protect the CSTF safety analysis assumptions [3]. The following requirements are not part of the 5.8.2.15 SAC unless specifically noted.

1. Notification shall be provided to the CSTF Shift Manager/FLM/Control Room Manager prior to intended transfers to the CSTF.
2. The equipment needed to stop transfers, siphons, and liquid additions to the CSTF shall be available to respond to indications of a primary containment waste release. This requirement is a SAC.
3. When transferring material to the CSTF with an inhalation dose potential greater than 2.0E+08 rem/gal (High-Rem Waste Transfer), the following shall be required:
   a. For facilities that own the leak detection capability of a CSTF owned transfer line (e.g., H-Canyon transfers to the CSTF), leak detection with control room alarm shall be operable within the LDBs associated with the Transfer Path. This requirement is a SAC.
   b. Two physically separated functional transfer isolation devices shall be identified. The transfer isolation devices shall be sufficiently separated (by distance) such that the availability of one isolation device is maintained.
4. Transfers into the CSTF shall be secured as a result of a tornado warning, tornado watch, or high wind warning for the CSTF as issued by the SRS Operations Center. This requirement is a SAC.
5. Transfers into the CSTF shall be secured following a seismic event. This requirement is a SAC.
6. Transfers into the CSTF shall be secured following notification of a CSTF wildland fire event. This requirement is a SAC.
7. Transfers into the CSTF shall be secured following notification of a CSTF control room abandonment event. This requirement is a SAC.
8. For evolutions not intended for the CSTF, sound isolation (single leak-tested valve, double valve isolation, blank, or jumper removal) shall be required. Where sound isolation is not possible, notification shall be given to the CSTF Shift Manager/FLM/Control Room Manager of the potential for an unintended Waste Transfer prior to the intended transfer.
9. Notification shall be given to the CSTF Shift Manager/FLM/Control Room Manager prior to performing excavations potentially affecting CSTF transfer lines.

11.12 MCU Process Requirements:

Direct feed to MCU shall meet the following process requirements:

Potassium molarity shall be less than or equal to 0.05 M [47].

Salt feed solutions shall be filtered through a 0.1 or 0.5 micron filter to remove solids [56]

Analysis is required for the content of lipophilic anions, specifically tributylphosphate (TBP), dibutylphosphate (DBP), trimethylamine (TMA), formate, and 1-butanol. For concentrations above 30 mM TBP, 2mM DBP, 10mM TMA, 100 mM formate, or 10 mM 1-butanol evaluation of the impact on MCU process will be required prior to transfer [47].

The sending facility (512-S) shall be in compliance with the Foreign Material Exclusion Program [46].

The temperature of feed shall be between 20 and 29 °C. Basis: Experience earned from simulant testing at MCU has shown feed temperatures above 29 °C may cause sodium alumino-silicate formation/precipitation in MCU.

Specific Gravity shall be between 1.16 and 1.3. Basis: this corresponds to a sodium range of 3 to 7 molar sodium [51].

11.13 Transfer Requirements to 299-H

[*A/C *SAC 5.8.2.42]

In order to preserve the HC-3 designation of 299-H, component transfers to 299-H shall comply with the 299-H Inventory Control Program [49].

12 Records

Records and documentation generated as a result of the WAC and WCP will be maintained by LWE and by the individual Waste Generators (per their Division's Record Retention Schedule "RIDS").

13 References

1 S-TSR-G-00001, Concentration, Storage, and Transfer Facilities Technical Safety Requirements

2 WSRC-IM-94-10, LWD/WS Project Safety Basis Manual

3 WSRC-SA-2002-00007, Concentration, Storage, and Transfer Facilities Documented Safety Analysis

4 WSRC-TR-2002-00327, CSTF Corrosion Control Program

5 WSRC-SA-6, S-Area DWPF Final Safety Analysis Report

6 X-SD-Z-00001, Rev. 15, Waste Acceptance Criteria for Aqueous Waste Sent to the Z-Area Saltstone Production Facility (U), December 2015

7 X-SD-H-00009, F/H Effluent Treatment Project Waste Acceptance Criteria

8 WSRC-TR-94-072, P. E. Zapp, Inhibitor Levels for the DWPF Recycle Stream (U), February 8, 1994

9 SRT-MTS-94-2007, G. T. Chandler/et.al., DWPF Materials of Construction Process Requirement Formal Review (U), March 14, 1994

10 DP-1347, R. S. Ondrejcin, Chemical Compositions of Supernates Stored in SRP High Level Waste Tanks, August 1974

11 WSRC-TR-92-175, P.E. Zapp, Applicability of the Sludge Processing Technical Standard to Type IV Waste Tanks with High Fluoride Concentration (U), March 31, 1992

12 WSRC-TR-2002-00094, Resolution of the Organic PISA, T. E. Britt

13 WSRC-TR-91-444, Revision 3, Possible Explosive Compounds in the Savannah River Site Waste Tank Farm Facilities (U), D. T. Hobbs, February 15, 2000

14 South Carolina Hazardous Waste Management Regulations (SCHWMR) R61-79.261, and Title 40 Code of Federal Regulations, Part 261, Identification and Listing of Hazardous Waste

15 WSRC-TR-94-0608, SRS – Mixed Waste – Proposed Site Treatment Plan, November 2007

16 J. W. Chapman (for SCDHEC), Project: F and H Area High Level Radioactive Waste Tank Farms Construction Permit No.: 17,424-IW, County Aiken and Barnwell, March 3, 1993

17 N-NCS-H-00152 Rev. 0, Nuclear Criticality Safety Evaluation: H-Canyon Waste Stream Poisoning with Fe and Mn, M. D. Murray

18 N-NCS-H-00243, H-Canyon Double Contingency Analysis, J. R. Lint, B. M. Williamson, June 2012

19 WSRC-TR-93-0872, Canyon Transfer Neutron Absorber to Fissile Material Ratio Analysis (U), Revision 1, J. S. Clemmons, March 4, 1994

20 SCD-3, Nuclear Criticality Safety Manual

21 Reference Deleted (Superseded See Ref. 18)

22 Reference Deleted

23 1S Manual, SRS Radioactive Waste Requirements Manual

24 Reference Deleted

25 Reference Deleted

26 Reference Deleted

27 WSRC-TR-92-0375, P. E. Zapp, Corrosion Tests of DWPF Recycle Solution (U), July 27, 1992

28 WSRC-TR-93-056, Solubility of Plutonium and Uranium in Alkaline Solutions, D.T. Hobbs, February 12, 1993

29 Reference Deleted

30 Reference Deleted

31 Reference Deleted

32 Reference Deleted

33 Reference Deleted

34 WSRC-TR-2003-00055, CSTF Evaporator Feed Qualification Program

35 WSRC-TR-2003-00515, Position Paper: Heat Generation Rate and Its Implications on the Tank Farm WAC, P. B. Rogerson, December 2003.

36 Reference Deleted.

37 WSRC-TR-2003-00336, Inhibitor Limits for Recycle Waste Generated by the DWPF (U), P. E. Zapp, February 2004

38 WSRC-TR-2003-00048, Rev. 3, Waste Characterization System Program Description Document

39 Reference Deleted

40 N-NCS-H-00132, Rev. 3, Nuclear Criticality Safety Evaluation: Tank 50 Valve Box Transfers, M. H. Barnett

41 N-NCS-H-00192, Rev. 13, Nuclear Criticality Safety Evaluation: Actinide Removal Process and Modular CSSX Unit (U)

42 X-SD-G-00008, Waste Acceptance Criteria for Sludge, ARP, and MCU Process Transfers to 512-S and DWPF

43 X-CLC-H-00641, Rev. 2, Impact of a Chronic Strip Effluent Leak at DWPF on Tank Farm Flammability, T. E. Britt

44 X-CLC-H-00581, Rev. 3, Impact of CSSX Organic Carry-Over on Tank Farm Operation, T. E. Britt

45 X-CLC-H-00583, Rev. 1, Hydrogen Generation Rates for Modular Caustic Side Solvent Extraction Unit (MCU)

46 S4 ENG.31, Liquid Waste Operations Foreign Material Exclusion Measures for Protection of MCU

47 CBU-SPT-2005-00262, Feed Specification for the Modular Caustic-Side Solvent Extraction Unit (MCU)

48 N-NCS-H-00134, Rev. 1, Nuclear Criticality Safety Evaluation: Minimum Safe Gadolinium to Plutonium Ratio in an Infinite System

49 WSRC-TR-97-00342, Rev. 2, Inventory Control Program for the 299-H Facility, T. E. Britt

50 N-NCS-H-00180, Rev. 0, Nuclear Criticality Safety Evaluation: Operation of the 2H Evaporator, D. A. Eghbali

51 WSRC-TR-2002-00330, Thermodynamic Modeling of the SRS Evaporators: Part IV. Incorporation of the High Caustic Aluminosilicate Solubility Data. C. M. Jantzen, J. M. Pareize and T. B. Edwards

52 S-CLC-Z-00067, Rev. 5, Maximum Amount of Isopar-L to Remain Below the Lower Flammability Limit (U).

53 X-CLC-H-00785, Rev. 1, Determination of the Maximum Elevation of the HLLCP in Tank 50H During ARP/MCU Operations, T. E. Britt August 2009

54 S-CLC-Z-00080, Rev. 1, Saltstone Facility SDU 2 and SDU 3/5 Flammability Analysis (U).

55 X-CLC-Z-00065, Rev. 0, SDU 2, 3 and 5 Flammability – Expanded Case (U).

56 X-CLC-H-00575, Rev. 4, MCU Waste Streams Radiological Makeup, C. I. Aponte

57 X-ESR-H-00121, Rev. 1, Actinide Removal Process Technical Basis for Protecting MCU Hazard Category, Celia Aponte.