X-WCP-H-00008

Revision 19

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Waste Compliance Program for Liquid Waste Transfers from H-Canyon to 241-H Tank Farm

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Summary of Revisions

X-WCP-H-00008, Revision 14:

- New requirements of X-SD-G-00001, "Waste Acceptance Criteria for Liquid Waste Transfers to the 241-F/H Tank Farms," revision 29 which reflects the changes to the Saltstone WAC (Ref. 10) were incorporated.
- Section 2.1 was revised to include processing of Uranium solutions directly through the 2nd Uranium Cycle process, bypassing the First Cycle process. Solutions will be sent through the 2nd Uranium Cycle a second time if HEU blend down specifications are not met on a single pass through 2nd Uranium Cycle. The waste generated from the 2nd Uranium Cycle-only operation will be processed via the Low Activity Waste system with the option to process a portion of this waste through the High Activity Waste system.
- Section 4.0 and 7.0 were revised removing the reference to the deviation(s) for transferring the GPE solution to Tank 50 with TBP concentrations greater than the Saltstone limits.
- Section 8.5 was revised to require self-assessments once per year instead of semi-annually.
- Section 9.2.2, Table 10 was revised to include the new hydrogen generation rate limit of 9.6E-06 ft^3/hr/gal for steam jet transfers through transfer lines for which diversion boxes or pump pits are credited leak detection locations (Section 11.2.2 of the Tank Farm WAC, X-SD-G-00001 rev. 29) and the hydrogen generation rates corrected to 90°C for the steam jet transfers.
- Section 9.8 was revised to add a justification that the streams being transferred to Tank 50 meet the new $Ni(OH)_2$, PO_4^{3-}, and K limits.
- Reference 37 (S-CLC-Z-00067) was updated with the new revision number and date.
- Attachment 12.4 added to show hydrogen generation rates corrected to 90°C.

X-WCP-H-00008, rev. 15:

- Revised Section 4.0 to describe flush streams and the flush stream designator.
- Revised Section 4.0, Removed discussion of the termination of the GPE deviation
- Revised Section 9.1 to increase the minimum pH requirement for waste streams sent to the Tank Farm from 9.5 to 12 per the new requirement of X-SD-G-00001, "Waste Acceptance Criteria for Liquid Waste Transfers to the 241-F/H Tank Farms," rev 30.
- Added new Section 9.7, Requirements to Protect Heat Generation Rate
- Revised Section 9.8 (previously Section 9.7) to update the transfer controls per X-SD-G-00001, "Waste Acceptance Criteria for Liquid Waste Transfers to the 241-F/H Tank Farms," rev 30, reflecting changes to the CSTF DSA Section 5.7.1, "Transfer of Radioactive Waste into the Concentration, Storage, and Transfer Facilities".
- The LAW (HCAN-RW-05), HAW (HCAN-RW-06), and GPE (HCAN-RW-03) streams are being routed to Tank 39 instead of Tank 50, based on the availability of the Tank 50 transfer route via Waste Header #2. The GPE stream is approved to transfer to either LLW Tank 50 or HLW Tank 39. The LAW and HAW streams will be concentrated while routed to Tank 39 such that the Tank 50 [alpha] concentration limits will be exceed. Material that has not been defined as LLW can be processed as a part of the HAW and LAW stream (e.g. sump solutions with recoverable fissile material). Therefore, the Hydrogen Generation Rates and Inhalation Dose Potential for Waste Streams HCAN-RW-05 and HCAN-RW-06 are revised to reflect higher concentrations of actinides. IF Tank 50 becomes available, and IF either the HAW and/or LAW stream is to be authorized to transfer to LLW Tank 50, the stream(s) will need to be sampled and characterized to demonstrate compliance with Tank 50 limits.
- Added several references including:
  - Ref. 45: Savannah River Site Z-Area Saltstone Disposal Facility Waste Streams Permit # 025500-1603, Aiken County, Letter from Kent M. Coleman (SCDHEC) to P. M. Allen (SRR), added
  - Ref. 46: X-WCP-H-00008, Rev. 2 Waste Compliance Program for Liquid Waste Transfers from H-Canyon to 241-H Tank Farm, M. R. Price, 2/8/2005
  - Ref. 47: X-WCP-H-00008, Rev. 0, Waste Compliance Program for Liquid Waste Transfers from H-Canyon to 241-H Tank Farm, L. R. Canas, 5/7/2004
  - Ref. 48: SW 1.9 Waste Management Tank Calibrations, F/H Area Tank Farms April 5, 2002 (Rev. 8), Section D.4
  - Ref. 49: BPF213112, Sheet 7, General Notes [for Basic Pump Tank], 10-30-1980
  - Ref. 50: N-NCS-H-00152, Nuclear Criticality Safety Evaluation: H-Canyon Waste Stream Poisoning with Fe and Mn, M. D. Murray
- Added Attachment 12.5 – List of H-Canyon and OF-H Procedures that Implement and Protect the HFT WAC.

X-WCP-H-00008, rev. 16:

- Section 1.0 - Added requirement to communicate with WCS PDD owner and DIRT chairperson on updates to WG08.
- Section 2.2 – Included H-Canyon Evaporator Overheads as a feed stream to the GPE when the ARU is down, modified description regarding GPE being LLW and permitted for Tank 50, and added reference
- Section 2.4 – Added description of acidic digestion for resin
- Section 4.0 – Corrected table reference, changed Table 8 to Table 7
- Section 8.6 – modified description for complete waste characterization using definitions from the WAC.
- Section 8.6 – deleted reference to the CSTF WAC defining the minimum characterization
- Section 8.6 – Added referenced in describing where the limits for U-235 and Pu-239 are found.
- Table 6 - changed the procedure numbers for the PVV flush
- Table 7 and Attachment 12.4 -changed the procedure numbers and titles for the PVV flush and added note for resin digestion procedures
- Table 8 – Added Volatile/Semi-Volatile organics to the minimum characterization for Tank 50, moved Isopropanol and Isopar-L analysis to complete characterization because the facility does not use Isopar-L, and added n-paraffin (Norpar 13) to the list for complete characterization.
- Table 12 - updated the Tank 50 IDP limits
- Section 9.4 - updated the Tank 50 IDP and alpha limits and added reference
- Section 9.5 – spelled out mercury and chromium
- Section 9.6 – Corrected table reference, changed Table 8 to Attachment 12.5
- Section 9.6 – improved description regarding where the iron in the waste stream originates
- Section 9.6 – updated stream discard description and added DCA reference for Gd poisoning
- Section 9.6 – added description for derivation of 16.5 mg/L U-235 limit to protect Valve Box
- Section 9.6.1 – added references
- Section 9.9 – added references for TBP concentration for transfers to Tank 50 and n-paraffin analysis.
- Reference 25 (N-NCS-H-00132) - updated with the new revision number, date, and author.
- Reference 37 (S-CLC-Z-00067) - updated with the new revision number and date.
- Reference 38 – corrected document number.
- Section 10 - Added several references including:
  - Ref. 51: M&O-MDO-2007-00288, "Categorization of General Purpose Evaporator Waste," W. G. Dyer, June 28, 2007
  - Ref. 52: N-NCS-H-00172, Rev. 1, Nuclear Criticality Safety Evaluation (NCSE): Minimum Safe Gadolinium to Fissile Mass Ratio in an Infinite System, S. T. Gough, 11/11/2004
  - Ref. 53: WSRC-TR-2003-00055, CSTF Evaporator Feed Qualification Program
  - Ref. 54: N-NCS-H-00180, Rev. 0, Nuclear Criticality Safety Evaluation: Operation of the 2H Evaporator, D. A. Eghbali
  - Ref. 55: S-CLC-Z-00080, Rev. 1, Saltstone Facility SDU 2 and SDU 3/5 Flammability Analysis (U)
  - Ref. 56: X-CLC-Z-00065, Rev. 0, SDU 2, 3 and 5 Flammability – Expanded Case (U)
- Section 11 Acronyms – updated list of acronyms
- Attachment 12.1 – updated process diagram
- Attachment 12.5 – added waste header flush procedures, updated the PVV flush procedures, and updated the LSR procedures

X-WCP-H-00008, rev. 17:

- Updated processing description for processing [irradiated] spent nuclear fuels (SNF)
- Updated SS WAC Limits for Nickel Hydroxide and Phosphate (Table 16) and Neptunium (Table 17)
- Section 2.2 - Updated references.
- Remove most of the discussion for HAW and LAW discard to Tank 50
- Updated Section 4.0 to add WAC requirement for including sample uncertainty (2 sigma) for flammable species, inhalation dose potential, and criticality
- Section 4.0 - Deleted streams discussion about and references to waste streams HCAN-RW-04 and HCAN-RW-07
- Table 6 – Added Aluminum and Silicon to the required minimum characterization for HCAN-RW-06 (HAW), HCAN-RW-08 (SSSR), and HCAN-IW-02 (Lab Sample Returns)
- Table 8 - added requirement to sample for mercury for transfers to Tank 50
- Section 9.6 – Added WAC requirement for including sample uncertainty (2 sigma) for criticality
- Deleted references 22, 26, 32, 35, 38, 39, and 41
- Added references:
  - Ref. 57: SRNS-E1120-2016-00002, H-Canyon to H-Tank Farm: WAC Compliance with Analytical Uncertainty Requirements for IDP, Criticality and Organic Flammable Vapor Criteria, R. A. L. Eubanks, January 2016
  - Ref. 58: SRR-ESH-2009-0010, H-Canyon General Purpose Evaporator Waste Stream (U), P. M. Allen, August 2009
  - Ref. 59: N-ESR-G-00001, “High Level Waste Emergency Response Data and Waste Tank Data,” also referred to as the ERD or Emergency Response Document

X-WCP-H-00008 R18

- Removed evaporation from description of head end process.
- Updated Table 10 to reflect the revised hydrogen generation limits in X-SD-G-00001 R40.
- Revised wording of 9.8.1, 9.8.8, and 9.8.9 to match wording from X-SD-G-00001 R41
- Revised Table 18 to reflect current Saltstone requirements.
- Added U-ESS-G-00007 to list of references.
- Revised Reference 4 to the correct document number for the H-Canyon DSA.

X-WCP-H-00008 R19

- Minor editorial changes throughout.
- Removed U-238 as an acceptable neutron poison
- Change Reference 1 to X-SD-G-00009.
- Changed Reference 47 to X-CLC-H-01315, and deleted Reference 46.
- Deleted Attachment 12.4 and Reference 33. Temperature corrections are now performed in the appropriate calculation.
- Updated Tables 10, 12, and 14 with new calculation results.
- Deleted References 10, 25, 34, 36, 37, 42, 55, 56, 61 which dealt with transferring to Tank 50.

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Requirement: **This document meets the Condensate Storage and Transfer Facilities (CSTF) requirements of the following** [22, 30, 60]**:**

- **DSA 3.4.1.5.2**
- **DSA 5.7.1**
- **DSA 6.5.2**
- **SAC 5.8.2.15**
- **SAC 5.8.2.21**
- **SAC 5.8.2.25**
- **SAC 5.8.2.42**
- **AC 5.8.2.13**
- **AC 5.8.2.32**
- **U-ESS-G-00007**

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1.0 Background and Waste Generator Responsibilities

Liquid Waste (LW) has established the Waste Acceptance Criteria (WAC) [1] to control receipts of liquid waste into the Concentration Storage and Transfer Facilities (CSTF). The WAC requires that the waste generators develop a Waste Compliance Program (WCP) document which describes the waste generating process and the controls that ensure the stream(s) comply with the WAC requirements. The WCP is developed and revised in accordance with Reference 23. The WCP characterizes each waste stream's composition, providing the basis for Liquid Waste Engineering (LWE) to evaluate the stream's acceptability. The WAC and WCP combine to bridge the interface between LW and the waste generator and ensure that waste transferred to CSTF can be safely stored and processed for disposal.

The WAC designates the waste generator as being responsible to:

- develop, document, co-approve, and implement a WCP;
- 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), who serves as the primary contact with LW for all communications regarding these responsibilities;
- prepare all waste for transfer to 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 Waste Characterization System (WCS) Program Description Document (PDD) owner, or Data Integrity Review Team (DIRT) Chairperson, on WG08 updates regarding significant changes to volume of existing waste streams or, any other non-routine WG08 updates

Note: All items denoted above are included in this document.

2.0 H-Canyon and Outside Facilities Process Description

The H-Canyon and Outside Facilities have recovered uranium, plutonium, neptunium, thorium, and americium at various times since startup in 1953. H-Canyon has processed and stored uranium, plutonium, and neptunium solutions for future processing and/or discard; these campaigns are addressed with Special Waste Compliance Plans (SWCP).

The current mission of these facilities is two-fold. The first mission is to process irradiated uranium fuels or Spent Nuclear Fuels (SNF) (also known as Used Nuclear Fuel (UNF)) containing U-235 at varying enrichments, to separate uranium from fission products, chemical and elemental contaminants, neptunium, and plutonium isotopes, then blend-down the purified uranium with natural uranium to create a low enriched uranium (LEU) product. The SNF materials are primarily aluminum-uranium alloys from Material Test Reactors (MTR), which includes both Domestic Research Reactors (DRR) and Foreign Research Reactors (FRR). Irradiated uranium-aluminum solutions may also be received from offsite sources. The second mission, referred to as Alternate Feed Stock (AFS-2), is to receive, neutralize and discard the waste streams from HB-Line from plutonium processing. The waste streams received from HB-Line are addressed in a separate Waste Compliance Plan (X-WCP-H-00034).

Each cell in the canyon is equipped with a sump. The sump provides a collection point for material that leaks into a cell; leaked material is predominately from process piping connections, and to a lesser extent overflow, and even more rarely, directly from one of the storage vessels. H-Canyon receives Laboratory Sample Returns (LSR) from F/H Area Laboratory and SRNL which is blended with canyon solutions prior to processing. LSR material is considered an irregular waste stream. Rainwater, ground water, process solutions, and process flush solutions collected at other facilities that meet the WAC and WCP plan requirements implemented by H-Area are also processed in H-Area.

H-Canyon may also process and store uranium and/or plutonium solutions for future processing and/or discard. These campaigns will be addressed in Special Waste Compliance Plans.

2.1 Modified HM-Process (HCAN-RW-05 and HCAN-RW-06)

The HM-Process (HM) consists of multiple primary unit operations with a number of support operations. The SNF is composed primarily of uranium and aluminum but can contain other metals or non-metal in matrix such as silicon or molybdenum. The HM process initially dissolves uranium and uranium/aluminum materials in nitric acid, using a mercuric nitrate catalyst and if needed, a fluoride catalyst. The dissolver solution can also contain a neutron poison, typically gadolinium. The SNF may be blended with natural uranium to reduce the uranium-235 isotopic, then processed through the Head End, First Cycle, and Second Uranium Cycles as described below. The current mission is for the canyon to dissolve and process irradiated SNF materials from various locations around the complex. SNF, similar in composition to the U-Al material dissolved in H-Canyon, may be received directly from offsite sources in a liquid form, transferred into the canyon to be blended with H-Canyon dissolver solution and/or natural uranium, and subsequently processed through solvent extraction for uranium recovery and LEU blend down. The waste generated from these materials is considered High Level Waste.

In the Head End process, a strike occurs in which gelatin is added to coagulate with silica to cause a precipitate to form. The resulting slurry is then centrifuged. The clarified solution is sent to First Cycle while the precipitated cake is rinsed to recover uranium prior to transfer to the High Activity Waste (HAW) neutralization feed tank and eventually to the CSTF.

In the First Cycle process, the uranium, plutonium, and neptunium are separated from the aluminum, molybdenum, iron, neutron poisons (boron or gadolinium), mercuric nitrate and potassium fluoride (KF) catalysts used in dissolving, corrosion products, and fission products in the feed through a series of three mixer-settler banks with various stages. A mixture of 7.5 % tri-butyl phosphate in n-paraffin is used as the extractant in the 1A Bank and the scrub in the 1B Bank. Various concentrations of nitric acid and ferrous sulfamate (FS), $Fe(NH_2SO_3)_2$, are used to affect separation. The 1AW waste stream from First Cycle consists nominally of approximately 1.5 M HNO_3 and 1 M $Al(NO_3)_3$, and may contain other chemical species (nominal concentrations) including 0.01-0.04 M, mercury, 0.5 g/L $Gd(NO_3)_3$, 0.01 M KF, fission products, a neutron poison (gadolinium, if required), and trace quantities of decay products such as ^{241}Am. The waste stream is processed through a decanter to remove entrained solvent and then fed to the HAW system (source of HCAN-RW-06 stream). The product stream 1CU from First Cycle is fed to the Second Uranium Cycle while product stream 1BP is routed via Tank 13.3 to the Low Activity Waste (LAW) (source of HCAN-RW-05 stream).

Historically, the HM-process rejected plutonium to the 1AW stream by adding ferrous sulfamate (FS) to the 1A-Bank in the 1AS-FS stream. By exercising the option to exclude FS from the 1AS input stream to the 1A Bank, H-Canyon's First Cycle process extracts most of the Pu into the 1AU stream and precludes Pu from exiting in the 1AW stream. The Pu is reduced with ferrous sulfamate in the 1B-Bank, exits in the 1BP stream and is routed to the LAW system. The total amount of Pu sent to the CSTF does not increase but is merely redistributed from the HAW stream to the LAW stream. The Pu-bearing 1BP-stream can be sent to the Sumps, Spent Solvent Wash, Sample Returns (SSSR) HCAN-RW-08 stream (canyon waste minimization flowsheet) or Pu storage. Precluding Pu from the 1AW stream substantially reduces the total alpha radiation in the neutralized waste in the HAW system. If needed, the 1BP stream can be redirected to the HAW system for processing and discard to H-Tank Farm to expedite processing the waste.

In the Second Uranium Cycle process, the uranium product stream is processed through a decanter to remove entrained solvent and is then concentrated and chemically adjusted from roughly 0.4 M HNO_3 to 4.5 M HNO_3. The stream is then fed to a series of two mixer-settler banks to further separate out Np, Pu, and fission product impurities. Inlet streams to these mixer-settler banks include various concentrations of dilute nitric acid, a mixture of 7.5 % tri-butyl phosphate in n-paraffin, and a 0.05 M $Fe(NH_2SO_3)_2$ stream. The 1DW from Second Uranium consists nominally of 3.4 M HNO_3, 0.006 M $Fe(NH_2SO_3)_2$, fission products, and trace quantities of Pu and Np. This material stream is decanted and processed through the LAW system (source of HCAN-RW-05 stream). If LEU product specifications are not met on a single pass, the solutions are sent through the 2nd Uranium Cycle a second time. Occasionally, a portion of the 1DW may need to be redirected to the HAW system for processing and discard to H-Tank Farm to expedite processing the waste.

In the Solvent Recovery process degradation products and radioactive and chemical contaminants are removed from the solvent used in the solvent extraction process. Because the quantity of solvent utilized in the banks is extensive and the quality of the solvent degrades upon exposure to radiation and nitric acid, the solvent must also be processed to remove radioactive impurities and mono- and di-butyl phosphates before it is recycled back to the mixer-settler banks. Solvent recovery utilizes a 2.5 % Na_2CO_3 wash to remove uranium, plutonium, neptunium, fission product contaminants, and byproducts of TBP. The solvent is then washed with 0.75 % nitric acid. Each of the two sets of mixer-settler banks has a separate wash system. The solution generated from the spent sodium carbonate wash is processed through the SSSR system whereas the solution generated in the acid wash phase is processed through the General Purpose Evaporator (source of HCAN-RW-03 stream).

In the current HAW process, solutions are received from 1st Cycle (1AW). Tank 8.1 is used as a feed tank for the operation of evaporators 9.1E and 9.2E. Historically, when ferrous sulfamate was used in the 1A-Bank for Pu rejection to the 1AW, sodium nitrite was added to the 1AW stream to destroy the FS and ammonium precursors formed by the degradation of FS in nitric acid solutions. Sodium Nitrite may also be introduced in the evaporators to destroy ammonium that is present in the waste stream. The evaporators are operated to the desired endpoint, while overheads are collected in Tank 9.3 and then transferred to the Acid Recovery Unit (ARU). A neutron poison is added, and the concentrated aluminum salts and radionuclides are then neutralized with excess NaOH and transferred to CSTF as high level waste. Head End cakes from 10.3C are also neutralized in HAW and sent to CSTF.

The current LAW system processes the Second Uranium Cycle 1D Bank raffinate (1DW) and the First Cycle 1B Bank raffinate (1BP). After the material is collected in a hold tank, the specific gravity is reduced to roughly 1.035 and sodium nitrite ($NaNO_2$) is added to the waste to destroy any residual sulfamate (nitrite is used in ferrous sulfamate bearing wastes). The solution is then fed to an evaporator (6.8E or 7.6E or 7.7E) where the waste volume is reduced, and a large fraction of the acid is recovered and recycled through the ARU in Outside Facilities. Sodium Nitrite may also be introduced in the evaporators to destroy ammonium that is present in the waste stream. Currently a neutron poison is added, and the concentrate is neutralized with excess NaOH and transferred to CSTF as high level waste.

H-Canyon handles process solution leaks and spills, as well as canyon floor flushes through the Sump Processing operations. The leaked material, as well as floor flush solutions, is jetted from the sump to the Hot-Canyon Sump Receipt Tank or the Warm-Canyon Sump Receipt Tank where it is normally directed to the SSSR system. However, if large quantities of recoverable product are collected from a spill, the resulting sump solution may be redirected to Head End and subsequently processed through First Cycle to recover the product.

H-Canyon receives Lab Sample Returns (LSR) from F/H Area Laboratory and SRNL in Tank 10.5; these materials are the inputs to stream HCAN-IW-02. LSR can be blended with other solutions in Tank 10.5 prior to decantation and evaporation. The evaporator pot bottoms are concentrated until the acid and salt solution reach a specific gravity of roughly 1.32. These bottoms containing salts and concentrated radionuclides are then stripped of recoverable nitric acid. A neutron poison is added, and the material is neutralized with excess NaOH and sent to CSTF.

2.2 General Purpose Evaporator (HCAN-RW-03)

The General Purpose (GP) evaporator reduces the volume of miscellaneous low-level aqueous solutions collected from various sources in the H-Canyon, HB-Line, and Outside Facilities. Potential sources for the GP evaporator include the Solvent Recovery process, the hot and warm gang valve catch tanks, the railroad tunnel airlock sump, and various sumps that collect rainwater from berms. In addition, rainwater, ground water, process and process flush solutions collected at other facilities that meet the WAC and WCP plan requirements implemented by H-Area are also processed through the GP Evaporator. Overheads from the H-Canyon evaporators are also processed through the GPE when the ARU is not operational. The feed to the evaporator is sampled and then neutralized with 50 wt % sodium hydroxide. The overheads generated are sent to the Effluent Treatment Project (ETP) for further processing while the evaporator's bottoms are sent to waste tanks in CSTF. The GPE waste stream has been determined to be Low Level Waste during processing of both irradiated and unirradiated material [24, 51, 58] and is permitted by South Carolina DHEC for disposal as LLW [45].

A schematic depicting the GP evaporator is presented in Attachment 12.2.

2.3 Process Vessel Vent Filter Flush for Hot and Warm Canyon (HCAN-IW-01)

The primary function of the process vessel vent (PVV) system is to provide a small negative pressure between the vessels within the canyons and the canyons themselves. This negative pressure provides a sweep across the surface of the contents of the canyon vessels and dilutes flammable vapors such as radiolytically generated hydrogen below safety limits. The PVV system has two filters to remove entrained materials: the warm canyon filter (5.7F) and the hot canyon filter (7.2F). Each filter is flushed periodically with approximately 40,000 lbs. of 5.5 wt % nitric acid solution to remove collected material (ammonium nitrate, uranium, and smaller amounts of other compounds). A schematic depicting the PVV Filter flush for the hot and the warm canyon filters is presented in Attachment 12.3.

The spent solution is transferred to one or more holding vessels and sampled for U, Pu, Np, Fe, Mn, Pu isotopics, U isotopics, ammonium, and acidity. Based on the fissile material content, Mn (as manganous nitrate) and/or Fe (as ferrous sulfamate) is/are added as required to poison the solution in compliance with CSTF WAC requirements for nuclear criticality safety (Section 9.6). Prior to transfer, the acidic waste is neutralized with sodium hydroxide.

The ammonium nitrate (AN) in the neutralized solution is calculated from the ammonium concentration measured in the acidic solution. To protect the flammability criterion (maximum 20 % of the Composite Lower Flammability Limit [CLFL]) on the vapor space in the receiving pump tank at overflow capacity, CSTF limits the volume of PVV filter flush waste in the tank to 5950.5 gal with a maximum content of the equivalent of 138.72 kg of AN [Ref. 19]. At these limits the ammonia levels in the neutralized waste are below the maximum 20% of the CLFL, however, increased pump tank ventilation is required since the ammonia concentration exceeds 5% of the CLFL. In turn, a transfer of a full pump tank volume to the receipt waste tank downstream is limited to 131.03 kg AN. However, the storage tank can accept up to 600 kg AN altogether in multiple transfers spaced at minimum intervals of 8 hours. The PVV flush solutions are sampled, evaluated, diluted as necessary to ensure the neutralized waste batch/transfer is in compliance with the WAC.

The ammonium in solution also provides a basis to calculate the actual buildup of AN in a PVV filter just prior to a flush [18]. A single flush normally removes a minimum 80 % of accumulated AN. The result is contrasted against the estimated value prior to the flush and provides a baseline for the next estimate. H-Canyon normally plans a flush when AN in a filter approaches the operating limit (419 kg).

The nuclear composition of waste from a filter flush is variable, depending on the interval between flushes and the materials processed in H-Canyon during this period. For a conservative calculation of radiological hydrogen generation and inhalation dose potential, the bounding isotopic distribution derived from irradiated Mark 16 and unirradiated Mark 22 fuel tubes (Table 1) is assumed.

Table 1 – Isotopic Composition of PVV Flush Waste
(All values in weight %)

U-234	1.3
U-235	59.7
U-236	22.8
U-238	16.1
Total U	99.9

Pu-238	16.7
Pu-239	69.2
Pu-240	9.2
Pu-241	4.4
Pu-242	0.5
Total Pu	100.0

2.4 Digested HB-Line Phase II Spent Resin Waste (HCAN-RW-09)

HB-Line Phase II uses Reillex HPQ resin to recover plutonium/neptunium from canyon solutions. Spent resin is periodically replaced as exposure to plutonium/neptunium and acid reduces efficiency. Before the resin is removed from the HB-Line resin columns, the residual Pu/Np is removed with weak acid. The resin is then slurried and transferred to H-Canyon Tank 5.2. Generally, the spent resin will consist of 20-40 liters of resin slurried in about 650 liters of ~8M nitric acid from one or two of four columns. The resin can be digested either in a caustic solution or in an acidic solution. For the caustic digestion, about 300 liters of 50 % NaOH will be added to reach 0.1 M alkalinity. About 1500 lb of 5.7 wt % $KMnO_4$ will be added and tank contents heated to 71-76°C for 15 hours to digest the resin. In the acidic digestion, about 680 liters of 8M nitric acid and 2800 liters of 5.7 wt % $KMnO_4$ will be added and tank contents heated to digest the resin. The manganese from $KMnO_4$ will be credited as the neutron poison for the small amount of Pu-239 in the resin. In case of a malfunction, up to 70 g of Pu/Np may be present with the resin from the columns. The manganese will precipitate as MnO_2 [2]. The digested resin will be further treated with 50 % NaOH to bring the excess hydroxide to 1.2 M for corrosion inhibition in CSTF. About 3,000-4,500 liters of waste (depending on the digestion flowsheet) will be produced and transferred to CSTF for each spent resin change-out. An operating procedure will cover receipt of the resin from HB-Line, digestion, neutralization and the transfer of this stream to CSTF. HB-Line is currently processing plutonium.

2.5 Laboratory Sample Returns (HCAN-IW-02)

Laboratory Sample Returns (LSR) originate as samples collected and analyzed at Savannah River National Laboratory (SRNL) and F/H Laboratory (F/H Lab). The LSR stream includes process samples and any analytical reagents added during the sample analysis. The SRNL samples are transferred into a High Activity Transport Trailer (HATT) trailer which holds approximately 2,500 gallons and the F/H Lab samples are transferred into an LR-56 trailer which holds approximately 1,000 gallons. The trailers are delivered to the H-Canyon truck well on the west side of H-Canyon. A truck unloading station is utilized to transfer the solutions to canyon Tank 10.5. The LSR material received in Tank 10.5, is incorporated with the SSSR, concentrated through an evaporator, neutralized and chemically adjusted and transferred to CSTF. Cl^- and SO_4^{-2} analyses have been added to the minimum characterization required for each transfer of these solutions. When these streams are combined with other waste streams, the stream designation becomes that of the irregular waste stream.

2.6 Sumps, Spent Solvent Wash, Sample Returns (HCAN-RW-08)

This stream processes solutions from Solvent Recovery alkaline washes, canyon sumps, various contaminated OF-H sumps such as the canyon air tunnel and sand filter sump via Tank 805, fuel bundle storage cells, swimming pool, and decontamination “decon” cell. While process equipment is rarely decontaminated, the decon cell stream is mainly water contaminated with radionuclides. Also processed are solutions from other facilities delivered to the canyon in HM trailers that meet the WAC and WCP plan requirements implemented by H-Area. After the solution is collected in a hold tank, the specific gravity is reduced to roughly 1.035 and sodium nitrite ($NaNO_2$) is added to the waste to destroy any residual sulfamate (nitrite is only used in ferrous sulfamate bearing solutions). The waste is then fed to batch evaporator 17.8E where the waste volume is reduced, and a large fraction of the acid is recovered and recycled through the ARU in Outside Facilities. Nitrite may also be introduced in the evaporators to destroy ammonium that is present in the process stream.

The evaporator pot bottoms are concentrated until the acid and salt solution reach a specific gravity of roughly 1.32 or fissile mass limits are approached. These bottoms containing salts and concentrated radionuclides are then stripped of recoverable nitric acid. The waste has a neutron poison (manganous nitrate) added, is neutralized with excess NaOH and sent to CSTF.

3.0 Chemical Inventory

Chemical usage shown in Table 2 is historic data based on dissolving and processing approximately four (4) dissolver batches of the uranium-aluminum alloy plant fuel per month (e.g. Mk-22).

The typical quantities of chemicals stored for use in H-Canyon, OF-H, and HA-Line processing have been documented [4] and compiled in Table 3. This list does not include maintenance and janitorial supplies (e.g., paint, greases, oils, cutting lubricants, dye check fluids, soaps, floor wax, etc.), some of which include RCRA constituents. RCRA hazardous wastes from maintenance and janitorial activities are controlled by the facility's Hazardous Waste program. No listed hazardous waste from maintenance activities enters the waste streams sent to CSTF.

The process solutions sent to CSTF are hazardous wastes which exceed some of the Resource Conservation Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) threshold values. See Section 9.5 for further discussion.

Table 2 – Monthly Chemical Usage / Only HM-Process Operating

Process Chemicals	Typical Usage (lb/month)
Gelatin	8
40 wt % Ferrous Sulfamate	2,700
Mercury	317
50 wt % Nitric Acid	195,000
n-Paraffin	1,386
Sodium Carbonate	1,660
50 wt % Sodium Hydroxide	87,500
100 wt % Sodium Nitrite (various concentrations)	800
Tri-butyl Phosphate (TBP)	554

Table 3 – Typical Inventory of Chemicals in Storage

HM Process Chemicals In Storage	Typical Inventory (lb)
Aluminum Nitrate	46,000
Boric Acid	4,000
Ferrous Sulfamate	60,000
Manganous Nitrate	20,000
Mercuric Nitrate	0 *
Mercury	7,000
Nitric Acid	300,000
n-Paraffin	61,000
Oxalic Acid	100
Potassium Permanganate	2,000
Sodium Carbonate	10,000
Sodium Hydroxide	220,000
Sodium Nitrite	7,000
Tributyl Phosphate	70,000
Gadolinium Nitrate	1,000

*Generated as needed for dissolving operations.

4.0 Waste Stream Categories and Characterization

The WAC defines three Waste Stream Categories that determine the characterization and reporting requirements. The key to categorizing a given stream is the variability in what species are present and the variability in their concentrations.

- 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. Reporting the volume of each waste stream transferred is sufficient to allow tracking of the receipts (and the waste tank inventories). The volume of such waste streams may be large and transfers to the CSTF may be frequent, helping to minimize the variability in composition. For example, "HM low heat process waste" is generated continuously by the production process.
- Irregular Waste (IW) has 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 of the receipts (and the waste tank inventory), the composition of each batch must be reported (or perhaps just selected "indicator" species). 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 not necessarily waste. For SW the species may have significant variation in composition from batch to batch or may contain constituents that are not present in waste normally received by CSTF. As such, characterization of each batch must be reported in more detail (to allow tracking of the receipts and waste tank inventory). In this context, the term "batch" may refer to individual waste transfers, or it may apply to a certain campaign, etc. – the appropriate scope is to be defined by the generator in the WCP. These wastes may be generated as part of special activities (e.g., use of special cleaning solutions), 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).

Furthermore, the WAC specifies that:

- The WCP will characterize the waste streams based on a combination of (1) process knowledge (e.g., material balances) and (2) analysis of process samples. Where sufficient analyses are available for a species, then they should be the basis for the characterization. When process knowledge is used for some species and analyses are used for others, then the validity of the process knowledge can be corroborated by following a similar reasoning for the "analyzed" species and comparing that process knowledge to the sample analyses.

- Initially, all waste generators will provide a "Complete" characterization of each routine waste stream. Periodically, all waste generators will also provide a "Minimum" analysis of each waste stream. For RW, the minimum characterization will be done semi-annually (2x/year), and for IW/SW the appropriate frequency will be defined in the Generator's WCP.
- A waste generator may take exception to anything in the 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. Approval of the WCP by LW will thus include any requested deviations [1].
- All sample analyses used to demonstrate compliance with the requirements for flammable species, inhalation dose potential, and criticality must include the analytical uncertainty of those measurements (2 sigma).

The WAC specifies that the generator's WCP is to define the waste streams and assign them to appropriate categories. Characterization information should be provided at least six (6) weeks prior to the planned transfer. H-Canyon regular and irregular waste streams are listed in Table 4.

Table 4 – Summary of H-Canyon's Waste Streams

Waste Stream Name	Designation	Status
GP Evaporator Bottoms	HCAN-RW-03	Approved WCP (X-WCP-H-00008)
LAW from HM-processing	HCAN-RW-05	Approved WCP (X-WCP-H-00008)
HAW from HM-processing	HCAN-RW-06	Approved WCP (X-WCP-H-00008)
Sumps, Spent Solvent Wash, Sample Returns	HCAN-RW-08	Approved WCP (X-WCP-H-00008)
HBL Digested Resin	HCAN-RW-09	Approved WCP (X-WCP-H-00008)
PVV Filter Flush	HCAN-IW-01	Approved WCP (X-WCP-H-00008)
Laboratory Sample Returns	HCAN-IW-02	Approved WCP (X-WCP-H-00008)

Streams HCAN-RW-03, HCAN-RW-05, HCAN-RW-06, HCAN-RW-08, HCAN-RW-09, HCAN-IW-01, and HCAN-IW-02 are described in this WCP. Other streams are either no longer generated or are covered in other waste compliance plans. A list of the procedures utilized to transfer the waste streams to the CSTF is provided in

Table 7. Each waste stream may have a flush stream associated with it. The flush stream consists of water with NaOH added to make up > 1.2M NaOH solution and is used to flush the tanks and waste header. No additional fissile material (e.g. U-235 or Pu-239) is added or ammonia generated, therefore a value of "0" may be reported to the HTF. The flush streams are named using the appropriate waste stream designator followed by "-Flush" (e.g. H-CAN-RW-08-Flush).

The GP Evaporator Bottoms Waste (HCAN-RW-03) stream is categorized as Regular Waste because water collected from the sources of feed to the GP Evaporator should not vary significantly. Sources of feed for the GP Evaporator include the hot and warm gang valve catch tanks, the railroad tunnel airlock sump, various drain tanks in old cold feed prep, and various sumps that collect rainwater from berms around tanks including similar sources from other facilities that meet the WAC and WCP requirements implemented by H-Area. This stream is transferred to CSTF.

On average, this waste stream produces 1,500-3,000 gallons of waste per month. The waste is transferred in batches of approximately 700 gallons.

A deviation to WAC requirements exists because the free hydroxide level does not meet the requirements 100 % of the time. Based on pH results, the free hydroxide has, at times, dropped to 0.15 M. Caustic is added prior to feeding the solution to the evaporator. The free hydroxide concentration of 1.2 M (pH 14) is not likely to be met on each transfer. However, the pH of each transfer is between 13 and 14.

This stream underwent a complete characterization in 2004 via analysis of process samples. The results of the isotopic and chemical characterization and historical sampling results are included in Reference 28.

The H-Canyon Low Activity Waste from HM-Processing (HCAN-RW-05) stream is categorized as Regular Waste since it originates primarily from relatively consistent sources; the Second Uranium Cycle Waste, 1DW, from Tank 16.7 and First Cycle's 1BP stream, which is processed as a waste stream. The 1BP and 1DW streams each primarily consist of nitric acid with low concentrations of ferrous sulfamate. They also contain small quantities of uranium, plutonium, and neptunium. After treatment with sodium nitrite to destroy the FS and eliminate the ammonium, the 1BP and 1DW are concentrated and acid stripped in the LAW evaporators. The resulting neutralized solution makes up Waste Stream HCAN-RW-05.

Previous analysis recorded on sample cards and in the WG08 indicates that the gross (total) alpha results were consistently within one order of magnitude, and additionally, the Np and U results varied by a factor of 2 (see WG08 database). The nitrate ion concentration is relatively uniform. The pH requirement determination will be achieved procedurally. The free OH^- requirement determination is achieved through the use of a calculation in the operating procedure. The past stream characterization and historical sampling results are included in Reference 28.

H-Canyon has opted to exclude ferrous sulfamate from the 1AS-FS input stream to the 1A Bank in the First Cycle extraction process, thereby extracting most of the Pu into the 1AU stream and precluding Pu from exiting in the 1AW stream. In this operational mode, the shifted Pu inventory exits the 1B Bank in the 1BP output stream routed to the LAW system. The total amount of Pu sent to CSTF does not increase but is merely redistributed from waste stream HCAN-RW-06 to waste stream HCAN-RW-05.

On average, this waste stream produces 4,000-8,500 gallons of waste per month. The waste is transferred in batches of approximately 1,300-1,700 gallons.

The H-Canyon High Activity Waste from HM-Processing (HCAN-RW-06) stream is categorized as Regular Waste since the feed streams from the centrifuge in the Head End process and the 1AW stream from First Cycle are relatively consistent/uniform. Previous analysis of HAW samples recorded on sample cards and entered into the WG08 database also indicates that results vary by a factor of roughly 5,000 [28]. Some of this variance is attributable to problems being experienced with the centrifuge wash cycle. The WCP pH requirement determination will be achieved procedurally. The WCP free OH^- requirement determination will be achieved through the use of a calculation in the operating procedure. The results of the isotopic and chemical characterization and historical sampling results are included in Reference 28.

On average, this waste stream produces 8,000-12,000 gallons of waste per month. The waste is transferred in batches of approximately 1,800-2,000 gallons.

The Sumps, Spent Solvent Wash, Sample Returns Waste (HCAN-RW-08) stream is categorized as Regular Waste since the waste generated from the canyon sumps, contaminated OF-H sumps (e.g. canyon air tunnel, sandfilter) via Tank 805 , HM Trailers, and solvent wash solutions are relatively consistent and uniform. These solutions that comprise waste stream HCAN-RW-08 were previously processed as a part of the LAW system along with the 1DW and 1BP streams. In an effort to minimize the waste discarded to HLW and subsequently processes as part of a sludge batch, the canyon process flowsheet was reconfigured, and these solutions were segregated from the LAW system. They are being processed in the stream designated as SSSR using the Rerun tanks and evaporator. The Sample Returns are conservatively considered High Level Waste, [Ref. 24]. As stated earlier, the 1BP stream could be processed through this waste system, though it is expected to be processed as part of the LAW stream; therefore, this waste stream is very similar to the LAW stream, minus the relatively innocuous 1DW stream, prior to the waste segregation effort. The waste characterization for LAW (HCAN-RW-05) prior to waste segregation [44] is a reasonable representation of the SSSR (HCAN-RW-08) and will be used in lieu of a new full characterization.

On average, this waste stream produces 1,500-2,500 gallons of waste per month. The waste is transferred in batches of approximately 600-800 gallons.

Hot and Warm Canyon PVV Filter Flush Waste (HCAN-IW-01) stream is categorized as an Irregular Waste since this waste is generated during a PVV filter flush only. This waste is fairly constant in constituents, but the concentration of individual species is variable from one flush to the next. Constituents include nitric acid (used to flush the filter) plus ammonium nitrate, uranium, and lesser amounts of other materials including Pu and Np (washed out of the filter). This waste stream is authorized for transfer on an as-needed basis. Its transfer will require submittal of approved procedures to LW. The PVV flush solutions are sampled, evaluated, diluted as necessary to ensure the neutralized waste batch/transfer is in compliance with the WAC.

This waste stream produces 10,000-15,000 gallons of waste per flush. The waste is transferred in batches of approximately 1,500-3,000 gallons.

This waste stream is generated as needed and will be analyzed following the flush.

The Laboratory Sample Return (LSR) (HCAN-IW-02) stream is categorized as an Irregular Waste. This stream is generated from the receipt of LSR trailers from Savannah River National Laboratory (HATT) and F/H Laboratory (LR-56). This stream is fairly constant in constituents, but the concentration of individual species is variable from one shipment to the next. The solutions are received into H-Canyon through a truck unloading station, transferred to a canyon vessel and combined with routine SSSR solutions. Waste stream HCAN-IW-02 is processed through the SSSR system.

The sulfate and chloride concentration in LSR can potentially peak at concentrations that exceed the WAC limits of ≤ 0.18 M and ≤ 0.11 M, respectively, but, on average, these streams will be below the respective WAC limits.

The HATT delivers ~2,500 gal/transfer and the LR-56 delivers ~1,000 gallons/transfer. Each trailer makes ~6 deliveries/year for a total waste stream of ~21,000 gallons/year.

Digested HB-Line Phase II Spent Resin Waste (HCAN-RW-09) stream is categorized as Regular Waste because the characterization of the waste is not expected to vary from one batch to the other. The chemical composition of the resin and all of the processing steps including the elution step, the digestion step and the neutralization step that the resin will undergo will be controlled either through the procurement process or procedural process to allow for minimum variation. The Reillex resin digestion studies done by SRNL [2, 3] indicate the absence of volatile organic compounds. A trace of formic acid was discovered in one sample and no other volatile organic species (including volatile alcohols, aldehydes, ketones, acids, benzene, acetone, pyridine, and styrene) were identified. The presence of chloride, fluoride, and sulfate is expected to be in trace amounts. The nitrate ion concentration is about 1.0 M. Digested resin contains solids that can plug the canyon samplers, so no sample is drawn.

Resin digestions occur infrequently, (the last one in CY 2019, and the one before that in CY 2010), so to ensure the equipment is working properly, there are no leaks and, the operators are familiar with the procedures, cold runs (includes cold chemical such as nitric acid, domestic/recycle/process water, and 50% NaOH, but no resin or fissile material) may be performed under this waste stream designation. This mixture of cold chemicals does not generate flammable gases (including ammonia). In addition, the Tank 5.2 does not have a sampler, therefore, no samples are required or will be pulled.

This stream produces approximately 500 gallons (2,000 liters) of waste per resin digestion.

5.0 Liquid Waste Generator Representative (LWGR)

The WAC specifies that each organization that transfers waste to F/H Tank Farms will designate a LWGR. The LWGR will be the generator's point of contact for communications with LWE. The LWGR will be knowledgeable of all processes in the generator's facilities, especially in relation to the quantity and composition of waste, to provide accurate information on waste transfers.

The H-Canyon LWGR is the H-Canyon Liquid Waste Compliance Engineer. H-Canyon's designated alternate is the H-Canyon Technical Support Manager.

6.0 Documenting Waste Volumes Transferred to HLW [*A/C* SAC 5.8.2.15 and CST Admin Control 5.8.2.32]

The WAC specifies that the waste generator will enter characterization and transfer information into Wisdom Work Group (i.e., WG08, HLW-WRT) to provide easy tracking, and an independent verification of the data will be performed, which is a safety basis requirement.

In accordance with the WAC, the generators will perform independent verification of data and the transfer and sample data will be entered into the Wisdom Work Group WG08 database within two weeks of the waste transfers. Copies of the completed procedures will be made available for LWE inspection upon request.

CSTF Operations also requires that the waste sending facility notify CSTF of the intent to make the transfer and comply with the transfer protocol documented in Section 9. This notification is essential for meeting the CSTF Safety Basis before the start of the transfer of the waste stream. This implementation will be included in the neutralization and transfer procedures.

In addition to the above WAC requirements, H-Canyon's waste transfer reports will be issued by the LWGR and will be sent to LWE as per Table 5.

Table 5 – Frequency of Waste Transfer Report

Base Volume	Report Frequency
< 3,000 gal/month	Quarterly
≥ 3,000 gal/month	Monthly

7.0 Deviations from the WAC Requirements [*A/C* SAC 5.8.2.15]

When deviating from the WAC, generators must submit a written request, which must be approved by the [Liquid Waste] Engineering and Operations Managers after a USQ has been performed against the proposed activity and approved by the [LW] FOSC. When generators deviate from their WCP, a written evaluation must be performed on the proposed activity which must be approved by [Liquid Waste] Engineering and Operations Managers. The [Liquid Waste] FOSC approval is not required for WCP deviations that do not impact the WAC. A basis/justification for why a deviation (regardless of whether it is a WAC or WCP deviation) is acceptable must be provided in the WCP. Deviations must be clearly identified and summarized in the “Deviation” Section of the WCP [1]. Additionally, when this WCP contains a deviation, it will be identified and summarized in the discussion section of the affected stream.

A deviation to WAC requirements exists for the GPE bottoms stream (HCAN-RW-03) because the free hydroxide level does not meet the requirements 100 % of the time. Based on pH results, the free hydroxide is as low as 0.15 M on occasion. Though caustic is added prior to feeding the solution to the evaporator, the free hydroxide concentration of 1.2 M (pH 14) is not likely to be met on each Tank 710 transfer. However, the pH of each transfer is between 13 and 14.

8.0 Related Programs, Self-Assessment, and Future Enhancements

8.1 Recovery from a Non-Compliance

The WAC specifies that the LWGR is to inform LWE and Tank Farm Operations verbally and in writing of any requirements which have not been satisfied (e.g., due to inadvertent transfers, process upsets, etc.) immediately. In conjunction with LWO, LWE will determine what actions are to be performed by the Generator before the waste can be (or continue to be) accepted into CSTF. Note: the PR/STAR and/or SIRIM procedures are to be invoked as appropriate.

Volume and characterization data will be provided to LWE as soon as available to determine the impact on CSTF. Potential corrective actions will be evaluated with LWE (e.g., chasing un-neutralized waste with NaOH) and performed as soon as practical. The waste being generated is expected to be consistent with

MK 16/22 fuel tubes (for aluminum based fuels) and similar materials (with or without aluminum) that are processed through the facility. When molybdenum based materials are processed the waste streams will contain molybdenum versus aluminum. Information and characterization data will be provided, as it becomes available, and will assist in determining the impact to CSTF. The H-Canyon facility will notify the LWM of any non-compliance and will participate in the appropriate investigations.

8.2 Related Programs

Decontamination chemicals in Outside Facilities and H-Canyon are utilized both throughout the facility and in a designated area termed the Decon Cell. The chemicals utilized in the Decon Cell to decontaminate process equipment prior to repair consist of potassium permanganate and sodium carbonate. Decontamination of process equipment in the Decon Cell is only performed sporadically now and results in essentially no waste. Decontamination of personnel areas results in wastes disposed of with absorbent and mop heads as solid wastes. Decontamination chemicals will not be a significant component of any of the waste streams sent to CSTF.

8.3 Waste Minimization

The quantity of waste generated by H-Canyon is dependent largely upon the following: the number and type of fuel elements processed, the quantity and type of material processed, the neutron flux experienced by the fuel elements in the reactor, the quantity of uranium processed, the quantity and type of chemicals utilized to process the uranium and the degree to which the stream was concentrated. Concentrating the stream minimizes its volume. H-Canyon's use of gadolinium and manganese instead of iron for neutron poisoning minimizes the formation of sludge in CSTF. With the segregation of the LAW system into two separate streams the resulting solutions sent to Tank 39 was greatly reduced with a majority of the solutions going to Tank 50 when unirradiated materials were being processed in H-Canyon. The historic LAW stream remains separated into two streams, as that is the way the canyon piping is configured, and procedures are written. Segregating the solutions may continue to permit more extended acid stripping resulting in a greater volume reduction in the processed wastes.

In addition, the nitrite destruction flowsheet being utilized to reduce ammonium in the waste systems will result in additional reductions in the volume of waste sent to the tank farm primarily due to more dependence on ammonium destruction and the reduction in waste stream dilution to satisfy ammonium requirements.

8.4 Records

All operations performed by H-Canyon are per approved procedures. Procedures require Operations to record the quantity of material transferred to, from, and within the facility. H-Canyon tanks and transfer lines are monitored sufficiently to ensure an accurate record of transfer quantities is maintained.

8.5 Self-Assessment

Once a year, H-Canyon Engineering performs a self-assessment of the Waste Compliance Program. The assessment involves the check or completion of monthly waste transfer reports, H-Canyon waste forecasts, periodic sampling performance, and required completeness of WG08 database.

Semi-annual analysis of the following four streams will be performed to validate/improve the characterization: Low Activity Waste from HM-processing (HCAN-RW-05), High Activity Waste from HM-processing (HCAN-RW-06), SSSR (HCAN-RW-08), and the GP evaporator bottoms streams (HCAN-RW-03). The LWGR will compare all analysis results to the waste characterizations described in the WAC (or alternatively, any other written communication from the LWGR that updates the characterization while the WAC revision is pending). The results of the analysis will typically be provided to LW within eight weeks of the sample being delivered to the laboratory performing the analysis, pending the laboratory's ability to support such a schedule.

Upon confirmation of any laboratory result that is outside of the characterization described in this WCP, the LWGR will contact the receiver's representative to jointly evaluate the need to modify the characterization and/or initiate additional investigative or corrective actions.

H-Canyon will notify LW of any non-compliance to this WCP.

8.6 Characterization

A complete characterization is required prior to the approval of any and all waste streams. As described in the CSTF WAC [1], characterization shall be based on a combination of (1) process knowledge and (2) analysis of process samples. Table 8 lists the species required for a complete characterization for the currently approved waste streams. A comprehensive initial analysis on the streams designated HCAN-RW-05 and HCAN-RW-06 was performed in December 1998. The results from these analyses and the periodic minimum characterization sample analysis taken since the initial analysis are contained in Reference 28. HCAN-RW-03 (GPE Bottoms) underwent a complete characterization via analysis of process samples to ensure the stream comply with Saltstone WAC limits. The results of the characterization for GPE can also be found in Reference 28. A "minimum" characterization as defined and listed in Table 8 will be performed semi-annually for all streams going to the CST. Characterization data will be reviewed and approved by appropriate HMD technical support and process engineering organizations to validate process assumptions. While HCAN-RW-03 (GPE Bottoms) was going to Tank 50, the minimum characterization was performed quarterly for several years. The results of the quarterly characterizations indicate that the waste stream compositions are consistent with initial, complete characterizations of those waste streams. Per section 6.2 of X-SD-G-00009, the quarterly requirement to characterize regular waste streams may be relaxed if generators' procedures analyzed for major constituents, which is currently done and documented in WG-08.

Monthly sampling requirement for HCAN-RW-03 (GPE Bottoms) for TBP, butanol, SVOCs and VOC was terminated in January 2011 [43]. The sampling requirement is now at a semi-annual frequency.

Every transfer to CSTF will be analyzed for a much smaller number of constituents. Currently, the analysis listed in Table 6 is performed on the Regular Waste streams either prior to neutralization, except the digested resin waste from HB-Line Phase II. Neutralized solutions contain solids that would plug the samplers; therefore, no post-neutralization sample can be drawn. For HAW, LAW, and SSSR free OH will be determined by a calculation in the operating procedure. Excess caustic will be added to reach 1.2 M free hydroxide according to procedure before transfer of the waste to CSTF. Thus, the pH and excess OH criteria will be attained procedurally. The temperature of each waste stream will be verified to be < 50°C and excess caustic > 1.2 M caustic. In the evaporators, the more volatile components are the organics. Consequently, the overheads become concentrated in organics and the bottoms become concentrated in aqueous. Evaporation effectively reduces organics down to trace levels in the concentrate. The HAW, LAW, and SSSR streams are in contact with process solvent which is less than 8.5 vol% TBP. The HAW, LAW, and SSSR wastes are decanted to remove entrained organic before feeding the material to the evaporators.

Any constituent that is in close proximity to WAC limits will be closely monitored. If monitoring indicates the running average of any constituent is trending close to or exceeds WAC limits, CSTF will be notified per section 8.1 of this document.

Table 6 – Summary of Minimum Characterization for Each Transfer

Analysis	HCAN-RW-03 NOP 221-H-1160	HCAN-RW-05 NOP 221-H-4725 NOP 221-H-4743	HCAN-RW-06 NOP 221-H-4907 NOP 221-H-4710	HCAN-RW-08 HCAN-IW-02 NOP 221-H-4783 NOP 221-H-4784	HCAN-IW-01 NOP 221-H-4751 NOP 221-H-4752
Specific Gravity	Basic	Acidic	Acidic	Acidic	Acidic
Uranium Concentration	NA	Acidic	Acidic	Acidic	Acidic
Total Acid Molarity	NA	Acidic	Acidic	Acidic	Acidic
Pu, Alpha or TEVA	NA	Acidic	Acidic	Acidic	Acidic
Gross/Total alpha	NA	Acidic	Acidic	Acidic	Acidic
Fe/Mn	NA	Acidic	Acidic	Acidic	Acidic
Aluminum	NA	NA	Acidic	Acidic	Acidic
Silicon	NA	NA	Acidic	Acidic	Acidic
Np alpha	NA	Acidic	Acidic	Acidic	Acidic
*pH	Basic	*Basic	*Basic	*Basic	*Basic

**NH_4^+	N/A	Acidic	Acidic	Acidic	Acidic
***Cl^-	N/A	N/A	N/A	Acidic	N/A
***SO_4^{-2}	N/A	N/A	N/A	Acidic	N/A

* pH determined by calculation and ensured by chemical addition
** This sampling requirement will continue until the LFL requirement is determined to be consistently implemented.
***HCAN-IW-02 only

A maximum temperature limit of 50°C (prior to steam jetting) will be maintained for waste streams from H-Canyon to ensure WAC limit is protected. The temperature limit is incorporated in the transfer procedures to CSTF listed in Table 7.

Table 7 – Transfer Procedures

Stream #	Stream Description	Procedure #	Procedure Title
HCAN-RW-03	General Purpose Evaporator	NOP 211-H-1160	Transferring From Tank 710 to H CST
HCAN-RW-05	LAW	NOP 221-H-4743	Neutralizing Low Activity Waste in Tank 9.8
HCAN-RW-06	HAW	NOP 221-H-4710	Neutralizing High Activity Waste in Tank 8.4
HCAN-RW-08	SSSR	NOP 221-H-4784	Neutralizing SSSR in Tank 16.1
HCAN-RW-09	Digested Resin	NOP 221-H-4939* NOP 221-H-4905*	Resin Digestion in Tank 5.2 – Neptunium Resin Digestion in Tank 5.2 - Plutonium
HCAN-IW-01	PVV Flush	NOP 221-H-4752*	Neutralizing PVV Filter Flush Solution in Tank 8.4.
HCAN-IW-02	LSR	NOP 221-H-4784	Neutralizing SSSR in Tank 16.1

* These procedures are normally inactive and are activated when needed.

Table 8 – Species to be Included in Characterization

Minimum Characterization consists of:

Anion	Cation	Miscellaneous	Radionuclide
NO_3^-		pH	total-α
NO_2^-		Specific Gravity	total-β/γ
free OH^-		TBP (tributylphosphate)	**gamma PHA for:**
			^{60}Co
			^{125}Sb
			^{137}Cs
			^{154}Eu
			^{134}Cs

Complete Characterization consists of the Minimum Characterization plus:

Anion	Cation	Organic & Miscellaneous	Radionuclide
$CO_3^=$	Ag	Total Organic Carbon	^{3}H
Cl^-	Al	Total Insoluble Solids	^{90}Sr
F^-	As	Total Dissolved Solids	^{106}Ru
$SO_4^=$	Ba	Volatile/Semi-Volatile organics	U isotopics & total
	Cd	Phenol	Pu isotopics & total
	Cr		^{237}Np
	Fe		Am isotopics & total
	Hg		Cm isotopics & total
	K		
	Mn		any known isotope >1 Ci%
	Na^+		
	NH_4^+		
	Pb		
	Se		
	Si		

Note: If the waste contains insoluble solids, then the sludge and supernate phases are to be characterized individually.

9.0 Compliance with Specific Criteria for High Level Liquid Waste Receipts

9.1 Requirements for Corrosion Prevention [*A/C* CST Admin Control 5.8.2.13 and DSA 6.5.2]

The minimum pH of > 12 will be met by adding excess hydroxide to all waste streams during the neutralization process, with the exception of the GP evaporator bottoms, until the final NaOH concentration is calculated to be 1.2 M (pH > 14). The calculation is based on total acid results from the lab. The lab determines total acid by titration to pH of 11 which includes all sulfates and nitrates as well as nitric acid. The calculation uses the lab results to determine the quantity of NaOH needed to reach a pH of 11. A second term in the calculation is used to determine the quantity of NaOH needed to reach a 1.2M excess. If the lab uses a method other than titration, LW will be notified for concurrence; the specific method will be included in the next WCP revision.

The GP evaporator is operated at a basic pH by adding NaOH to the evaporator feed. Hence, excess hydroxide is not added to the evaporator waste stream to exceed the requirement which is an approved deviation to this WCP. The pH of this stream is typically in the range of 13 to 14.

After neutralization, the nitrate concentration is between 1.0 M and 8.0 M for all the streams. The combined free hydroxide and nitrite concentration will exceed 1.1 M [1]. The combined free hydroxide and sodium nitrite concentration should exceed 1.1 M through the addition of excess sodium hydroxide to 1.2 M for streams HCAN-RW-05, HCAN-RW-06, HCAN-RW-08, HCAN-RW-09, HCAN-IW-01, and HCAN-IW-02. The free hydroxide of 1.1 M will also satisfy the WAC requirement for minimum inhibitor content for waste generated.

No chloride is utilized in the HM-process, the PVV Filter flush, and the HB-Line Phase II digested resin. Hence, this species is expected in trace amounts only. Fluoride is periodically used to ensure complete dissolution. The concentration of the fluoride in the HCAN-RW-06 (HAW) waste stream is calculated to be 0.03 M. The CSTF uncomplexed fluoride limit is ≤ 0.086 M; the Saltstone limit is equivalent to 0.26M, therefore, when the CSTF limit is met, the Saltstone limit will not be challenged.

Sulfate is present since ferrous sulfamate is added as a reducing agent in the First Cycle and Second Uranium processes. Ferrous sulfamate will not be used in the First Cycle A Bank as discussed in Section 2.1. Historically (as documented in WCP X-WCP-H-00008, revisions 0 through 10) HCAN-RW-05 is calculated to average 0.158 M sulfate over a year's period. HCAN-RW-03 and HCAN-RW-06 are all below the sulfate limit of ≤ 0.18 M set in the WAC; the Saltstone limit is equivalent to 0.72M. The concentration of corrosive species of H-Canyon's waste streams is presented in Table 9.

Table 9 – Expected Concentration of Corrosive Species

Designation	pH	Nitrate	Minimum Free Hydroxide	Fluoride Ion[2]	Chloride Ion	Sulfate Ion
WAC Limit	> 12	≤ 8.5M	≥ 1.1 M	≤ 0.086 M	≤ 0.11M	≤ 0.18 M
HCAN-RW-03	> 12	3.24 M	0.15 M	0.0026 M	0.007M	0.06 M
HCAN-RW-05	> 12	3.7 M	≥ 1.1 M	Trace	Trace	0.158 M[4]
HCAN-RW-06	> 12	4.1 M	≥ 1.1 M	Trace to 0.05M[6]	Trace	6.59E-04 M to 0.095 M
HCAN-RW-08	> 12	< 4.0 M[1]	≥ 1.1 M	Trace	Trace	0.1 M
HCAN-RW-09	> 12	1.0 M	> 1.1 M	Trace	Trace	Trace
HCAN-IW-01	> 12	0.460-1.04 M	> 1.1 M	Trace	Trace	0.043 M
HCAN-IW-02	> 12	0.24 M	> 1.1 M	0.006 M	0.071 M	0.008 M

1. The normal nitrate concentration in HCAN-RW-08 and HCAN-IW-02 can temporarily rise to a maximum 7.38 M when H-Canyon processes F/H-Area Laboratory LSR and 4.72 M for SRNL LSR [20] in the solution before neutralization.
2. Uncomplexed concentration
3. Estimated fluoride concentration for HEU legacy materials that may be dissolved with ~0.015-0.02M KF catalyst.
4. Historically, HCAN-RW-05 has been calculated to average 0.158 M sulfate over a year's period as stated in WCPs X-WCP-H-00008 revisions 0 through 10.

9.2 Requirements to Prevent Accumulation of Flammable Species [*A/C* CST SAC 5.8.2.15]

Waste streams other than PVV filter flush and spent HBL resin may come in contact with volatile flammable species and organic compounds. Various canyon processes will be utilized to minimize the total quantity of these products in the waste stream. Digested resin analysis indicates no significant flammability risk exists [29]. The concentration of these species will be insufficient to cause a fire or explosion under equilibrium conditions.

9.2.1 Organic Vapor Control [*A/C* CST SAC 5.8.2.15]

Prior to waste streams entering the CSTF, the waste streams shall be evaluated and shown to have less than, or equal to, a 5% organic contribution to the hydrogen LFL at 100°C. This includes volatile organics as well as ammonia. Neglecting any contribution from trace quantities of organic vapors, an ammonia concentration of 0.0164 wt% is shown to contribute less than 5% of the CLFL at 100°C [19]. Although the CSTF 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 [1].

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. 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 [1].

There are four regular waste streams being transferred to CSTF covered by this WCP that have contacted organic during process operations: HCAN-RW-03, HCAN-RW-05, HCAN-RW-06, and HCAN-RW-08. HCAN-RW-05, HCAN-RW-06, and HCAN-RW-08 are decanted and evaporated to reduce organic material. HCAN-RW-03 is skimmed, neutralized, and evaporated. This combined processing effectively removes all organics to trace levels. This conclusion is substantiated by a technical report on the efficiency of H-Canyon decanters [11, 12], a technical report on steam stripping of TBP during evaporation [13, 14], an engineering calculation on general organics stripping by evaporation [Ref. 15], and statistics on process sample analysis [17]. H-Canyon verifies the quality of streams HCAN-RW-03, HCAN-RW-05, HCAN-RW-06, HCAN-RW-08 through semi-annual analytical determinations of volatile and semi-volatile organics. Thus, all regular waste streams comply with the WAC.

CSTF reduces ammonia by atmospheric venting at the receiving pump tank. Upstream, H-Canyon reduces ammonia prior to evaporation by adding sodium nitrite to destroy precursors from the hydrolysis of ferrous sulfamate. Nitrite may also be introduced in the LAW and HAW evaporators to destroy ammonium that is present in the waste streams. Based on sample results, the ammonium concentration can also be adjusted to meet WAC requirements by dilution. H-Canyon also reduced the potential for additional ammonia since adopting manganese nitrate as a neutron poison instead of supplementary ferrous sulfamate prior to neutralization.

With organics reduced to trace quantities through decantation and evaporation, the WAC limit of 5% organic contribution to the hydrogen LFL is met by limiting the ammonia concentration to <0.0164 wt% (no adjustment of purge flow of receipt pump tanks) [11, 12, 13, 14, 15, 19]. Transfers containing ammonia concentrations of up to 20% organic contribution (<0.0656 wt% NH_3) [31] to the hydrogen LFL can be made provided the required purge flow of the receipt pump tanks is adjusted for the additional contribution of organics and CSTF approval is received. Reference 57 discusses the calculations and limits applied to the H-Canyon waste streams for ammonia concentration to ensure the CSTF limits are met. The analytical uncertainty is included and meets the 2-sigma requirement in the WAC.

An additional criterion for H-Canyon waste is the limitation of temperature due to the limited vapor pressure equilibrium data required to support the hydrogen LFL determinations. H-Canyon must demonstrate the waste transferred remains below 70°C. The temperature of waste is confirmed less than 50°C prior to steam jetting (steam jetting can increase temperature of the material being transferred up to 20°C).

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

- Less than, or equal to, a 20% organic contribution (<0.0656 wt% NH_3) to the hydrogen LFL in receipt pump tank (at 100°C), and
- Less than, or equal to, a 5% organic contribution (< 0.0164 wt% NH_3) to the hydrogen LFL in locations downstream of the receipt pump tank (at 100°C) [1].

The evaluation of effects downstream of the receipt pump tank may take credit for actual facility conditions in showing the organic contribution to the hydrogen LFL is less than, or equal to, 5 %. The required purge flow of receipt pump tanks for transfers exceeding a 5 % organic contribution (up to a 20 % organic contribution) is adjusted to account for the additional contribution of the organics. To transition the flow requirement back to the non-PVV flow requirement, sufficient pump tank flushes shall be performed to reduce the organic contribution to LFL to less than or equal to, 5 % (at 100°C) [19]. 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.

The HCAN-IW-01 (PVV Filter flush) and the HCAN-RW-09 (HB-Line Phase II spent resin) do not normally go through any evaporator process; they do not use or contact any organic material in its processing steps.

A HLW study [5] indicates that no volatile organic carbons (VOC) were detected in the vapor space of waste Tanks 39 and 43. The report analyzed the available data and determined that n-paraffin and TBP were not detected in the floating liquid surfaces of waste tanks, pump tanks and also in the waste that has been transferred from the canyons.

Occasionally, H-Canyon disposes of waste to CSTF that has not come into contact with organic or flammable material and does not contain any flammable matter. In this instance, decantation and evaporation to remove organic material is not required.

9.2.2 Hydrogen Generation Rate [*A/C* CST SAC 5.8.2.15 & 5.8.2.25]

Hydrogen generation rates (HGR) were calculated based upon the heat generation rate from the decay heat and both the nitrate and nitrite ion concentrations. To determine the maximum hydrogen generation rate for any stream, a final nitrate ion concentration of 1.0M was assumed. The final nitrite ion concentration was assumed to be 0 M for all streams. The actual nitrate ion concentrations of the waste streams are listed in Table 10. This assumption is quite conservative since the nitrate ion concentration is always greater than 1 M [1, 6]. The hydrogen generation calculation results listed in Table 10, Column (3), for H-Canyon streams sent to Tank 39 were made using 25°C. Table 10, Column (4), shows the hydrogen generation rates corrected to 90°C for the transfers made by steam jet.

All waste streams are below the HTF WAC hydrogen generation rate limit.

Hydrogen Production Rate (ft^3 H_2/gal/hr) =

Heat Generation Rate $(BTU/hr/gal)_{\alpha} * R_{\alpha} + (BTU/hr/gal)_{\beta/\gamma} * R_{\beta/\gamma}$ where

$R_{\alpha} = 134.7 - 82.3 * [NO^{-}_{eff}]^{1/3} - 13.6 * [NO^{-}_{eff}]^{2/3} + 11.8 * [NO^{-}_{eff}]$

$R_{\beta/\gamma} = 48.36 - 52.78 * [NO^{-}_{eff}]^{1/3} + 14.1 * [NO^{-}_{eff}]^{2/3} + 0.572 * [NO^{-}_{eff}]$

$[NO^{-}_{eff}] = [NO_3^{-}] + 0.5 * [NO_2^{-}]$

Where, R is expressed as ft^3 $H_2/10^6$ BTU.

Table 10 – Hydrogen Generation Rates

(1)	(2)	(3)	(4)	(5)	(7)
Stream #	Nitrate[1] (M)	HGR[2,3], **ft^3 H_2/hr/gal**	HGR at 90°C[4], **ft^3 H_2/hr/gal**	WAC Limit **ft^3 H_2/hr/gal**.	Ref
HCAN-RW-03	1.70	7.23E-11	9.04E-11	4.50E-06	27
HCAN-RW-05[5]	3.7	1.28E-06	1.97E-06	4.50E-06	44
HCAN-RW-06	4.1	3.24E-06	3.95E-06	4.50E-06	47
HCAN-RW-08[5]	3.7	1.28E-06	1.97E-06	4.50E-06	44
HCAN-RW-09	1.0	1.05E-06	1.60E-06	4.50E-06	29
HCAN-IW-01	0.460-1.04	3.34E-07	5.08E-07	4.50E-06	21
HCAN-IW-02[6]	0.03	1.28E-06	1.97E-06	4.50E-06	44

1. Bounding value for $[NO^-_{eff}]$ = 1.0 used (except for HCAN-IW-01 which used 0.46)
2. Includes measurement uncertainty associated with sample analysis
3. at 25° C.
4. Through transfer lines for which diversion boxes or pump pits are credited leak detection locations.
5. HCAN-RW-05 is a reasonable representation (characterization) of HCAN-RW-08 (see Section 4.0).
6. LSR material is mixed and processed with sump material in SSSR (HCAN-RW-08). The impact of the LSR material are an order of magnitude less than the sump material [20].

9.3 Prevent Formation of Shock Sensitive Compounds

The waste being sent to CSTF has the same constituents as the historical waste that has been discharged. An SRNL study that evaluated the waste stored in CSTF concluded that 10 out of the 14 explosive classes could not be formed in CSTF and the remaining four classes had adequate controls to prevent the formation or concentration of these compounds [7].

One of the controls to prevent the formation of explosive compounds is to limit the quantities of silver discharged to CSTF. In the past, acid flushing of silver nitrate coated Berl saddles, used to prevent the release of radioiodine, sent large quantities of silver to CSTF which resulted in the formation of silver nitride, a shock sensitive compound. Instead of flushing the Berl saddles, the saddles are collected after the useful life has expired and are treated as a mixed solid waste. Hence, no shock sensitive compounds are expected to form in in CSTF from H-Canyon waste transfers.

Table 11 – Concentration of Silver

Designation	Waste Stream Name	[Ag]	Reference
HCAN-RW-03	GP Evaporator Bottoms	< 0.5 mg/L	28
HCAN-RW-05	LAW from HM-processing	0.56 mg/L	8
HCAN-RW-06	HAW from HM-processing	0.08 mg/L	28
HCAN-RW-08	SSSR	0.56 mg/L	8
HCAN-IW-01	PVV Filter Flush	0.56 mg/L	8
HCAN-IW-02	Lab Sample Returns	10 mg/L	20

9.4 Requirements for Radionuclide Content [*A/C* CST SAC 5.8.2.15, 5.8.2.21, 5.8.2.25, & 5.8.2.51]

The inhalation dose potential (IDP) for each isotope was calculated from the concentrations of various isotopes utilized in the hydrogen calculations and the ICRP-68/72 adult dose values. IDP values for each waste stream are summarized in Table 12. The isotopic spectra for individual streams are provided in the associated references. The range of inhalation dose potential rates for the Sumps/Rerun stream, HCAN-RW-08 is representative of HAW and LAW process streams impacting the Sumps/Rerun stream. Reference 57 discusses the calculations for the inhalation dose potential of H-Canyon waste streams and provides assurance that adequate margin was used to protect the 2-sigma analytical uncertainty requirement in the WAC.

The following equation was utilized to determine the inhalation dose potential for each constituent:

$$\text{IDP} = \left(\frac{\text{grams of constituent}}{\text{L}}\right)\left(\frac{\text{rem}}{\text{g}}\right)\left(\frac{3.785\ \text{L}}{\text{gal}}\right)$$

Table 12 – Inhalation Dose Potential

Waste Stream Name	Designation	Low-Rem Supernate Transfers IDP (rem/gal)	WAC Limit (rem/gal)			Reference
			Non Sludge-slurry	Low-rem	Maximum	
GP Evaporator Bottoms	HCAN-RW-03	8.92E+02	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	27
LAW from HM-processing	HCAN-RW-05[1]	1.87E+08	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	44
HAW from HM-processing	HCAN-RW-06	1.47E+07	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	47
SSSR	HCAN-RW-08[1]	1.87E+08	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	44
Digested Reillex Resin	HCAN-RW-09	3.69E+07	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	29
PVV Filter Flush	HCAN-IW-01	8.83E+06	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	21
Lab Sample Returns	HCAN-IW-02	1.87E+08	≤ 9.80E+07	≤ 2.00E+08	< 1.50E+09	44

1. HCAN-RW-05 is a reasonable representation (characterization) of HCAN-RW-08 (see Section 4.0).
2. LSR material is mixed and processed with sump material in SSSR (HCAN-RW-08). The impact of the LSR material are an order of magnitude less than the sump material [20].

All waste streams are below the WAC limit for inhalation dose potential. All H-Canyon waste transfers are Low-Rem (< 2.0E+08 rem/gallon). All H-Canyon waste streams are below the WAC Low Rem Transfer inhalation dose potential (IDP) limit of 2.00E+08 Rem/gallon, therefore they are categorized as Low-Rem transfers. For Low-Rem transfers that exceed an IDP equal to 3.50E+07 Rem/gal, the WAC requires a sufficient flush of the waste header such that the inhalation dose potential of the residual waste in the core pipe is less than or equal to 3.50E+07 Rem/gal within 30 days of the completion of the last transfer. 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). Every 21 days an evaluation of the last transfer through the waste header(s) will be made; if the IDP is greater than 3.50E+07 Rem/gal [40], a flush of the waste header will be will be performed. If the IDP is equal to or less than 3.50E+07 Rem/gal, flushing will not be performed.

- Waste stream HCAN-RW-03 consists of solutions that do not contact materials that could result in an IDP in excess of 3.50E+07 rem/gal and is therefore exempt from the flush evaluation.
- Waste streams HCAN-RW-05, HCAN-RW-06 HCAN-RW-08, HCAN-RW-09, HCAN-IW-01, and HCAN-IW-02 are currently evaluated on the 21 day cycle. Procedure track and flag IDP (in terms of radioactivity concentration) to ensure the transfers or flushing of the waste header occurs within the 30 day frequency when the limit is exceeded.
- The special waste streams will be addressed in Special Waste Compliance Plans to ensure compliance with the IDP flush requirements.

Flushes following waste transfers using process water do not contain appreciable quantities of NO_{eff} (NO_2 and NO_3) so their hydrogen scavenging effects are not realized. But due to the infrequency of flushing following routine transfers and the fact there is very little radiation in the residual solutions and flush water to produce hydrogen, the consequences of transferring solutions with a NO_{eff} of < 1.00 are considered minute.

9.5 Requirements for Regulatory Compliance

Some H Canyon waste streams have heavy metals that exceed the RCRA toxicity limit. The primary process and liquid waste streams in H-Canyon were reviewed for their content of the RCRA metals, As, Ba, Cd, Cr, Pb, Hg, Se, and Ag. Only Ba, Cr, Pb, Hg, and Ag are found in measurable quantities in any of the streams. These metals are generally found in small or trace quantities as the result of impurities in the materials processed or the processing chemicals used in the canyon. Mercury, Hg, is the only one of these metals used as a process chemical and is found in large concentrations in a limited number of process streams. Chromium, Cr, is also found in large concentrations in waste streams being sent to High Level Waste (HLW), since it is a common corrosion product from the stainless steel vessels used in the canyon. The CSTF is allowed to receive these heavy metals based on limits contained in their industrial waste water permit.

Benzene is not utilized in the process and is not a constituent in the waste streams from the Canyon or Outside Facilities. Hence, benzene levels will be below the RCRA TCLP toxic waste concentration threshold. No RCRA hazardous "listed" wastes are used in the Canyon processes. Therefore, no “listed” waste will be transferred to CSTF as a result of these routine discharges from any of the streams.

An environmental evaluation checklist will be generated prior to processing new waste streams.

9.6 Requirements for Criticality Safety [*A/C* CST SAC 5.8.2.15 & DSA 6.5.2]

Waste received in CSTF shall be inherently safe with respect to criticality for any concentration and mass in the uncontrolled geometry of the waste tanks. 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. Reference 57 discusses the calculations, including the analytical uncertainty, and limits used to assure the H-Canyon waste streams are adequately poisoned and protect the 2-sigma analytical uncertainty requirement in the WAC.

The method below provides the required weight ratio of neutron poison to equivalent U-235 and equivalent Pu-239 to ensure the waste is inherently safe.

Neutron poisoning is required if sampling indicates that there is 15 grams or greater of equivalent U-235 in the neutralization tank. The HAW, LAW, and SSSR waste streams receive iron from residual ferrous sulfamate (FS) and FS degradation products from First Cycle, Second Uranium Cycle, and Sumps. Iron (Fe) and Manganese (Mn) are approved in the H-Canyon Double Contingency Analysis to serve as dual poisons for fissile material. Therefore, the Fe present from FS can be credited, and if additional poison is needed, Mn is added in the form of 50 % manganous nitrate. In this case, 29 and 14 grams of Mn are required to poison one gram of Pu-239 and U-235, respectively.

Plutonium, plutonium/uranium, or uranium discard streams may be poisoned with gadolinium (Gd) per the H-Canyon Double Contingency Analysis N-NCS-H-00243 events FS-5-002h, FS-5-002w, and FS-5-003. These streams are generally addressed with Special Waste Compliance Plans (SWCP). As a part of the SWCP, an impact analysis is performed by SRR Engineering to ensure enough iron (Fe) and manganese (Mn) is in the TF tanks to meet the downstream facility (e.g., DWPF) requirement.

HAW (HCAN-RW-06), LAW (HCAN-RW-05), SSSR (HCAN-RW-08), and GP Evaporator Bottoms (HCAN-RW-03) transfers to Liquid Waste Facilities from H-Canyon containing more than 15 grams of equivalent U-235 will be poisoned either by the addition of manganese or with iron from the residual ferrous sulfamate and associated degradation products, or the combination of both. All transfers to Tank 50 will be poisoned in a similar manner regardless of the fissile quantity. Procedural steps to control the ratios of Fe/Mn to equivalent U-235/Pu-239 are prescribed as nuclear criticality safety steps in the procedures listed in Attachment 12.4.

The equivalent U-235 for sludge slurries is determined utilizing the equivalency factors in Table 13. Waste transfers that contain U-235 should be considered Pu-239. If multiple neutron poisons are present in the waste stream, additional safe weight ratios for multiple neutron poison can be evaluated.

Manganese is used in a lower poison-to-fissile weight ratio than iron, which minimizes the waste produced. Therefore, manganese is preferred over iron as a neutron poison. In addition, unlike ferrous sulfamate (source for iron), manganese nitrate will not produce ammonia as a by-product which will reduce the ammonia scrubber water addition thus reducing waste volume. The reduction in ammonia will also help in the reduction of flammability and comply with the composite lower flammability limit (CLFL).

The four equations below show the single and multiple weight ratios for neutron poisons to equivalent U-235 and equivalent Pu-239 for mixed fissile waste streams. The equations below do not use equivalency factors of any kind.

Single and Multiple Safe Weight Ratios for Neutron Poisons to Equivalent U-235 [1, 50, 52]

For Fe Addition:

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

For Mn Addition:

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

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]

For Mn Addition:

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

The always safe weight ratios for neutron poisons to equivalent U-235 and Pu-239, taken from the WAC, are shown in Table 13.

Credit for any existing neutron poisons weight ratio can be applied to either fissile component in determining the neutron poisons needed to be added for a mixed waste stream. To avoid double counting, the neutron poisons present must be applied to only one of the fissile constituents until the safe neutron poison weight ratios are met.

Table 13 – 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
Fe	72	160	2.25
Mn	14	29	2.07
Gd	---	1	1

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

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

- ≤ 5.5 wt% U-235 (eq) enrichment [1, 53, 54]
- 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 2wt% [1, 54].

The above restrictions ensure that 2H evaporator system and Tanks 43H and 38 meet NCSE target enrichment limits and the DWPF Sludge Batch limits.

At this time, HTF is not transferring H-Canyon waste to Tanks 43, 38, or 22, nor are transfers of H-Canyon waste to these tanks authorized per the ERD [59], therefore this section does not apply.

9.7 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.

By dividing the BTU/hour limit for the pump tank by the pump tank capacity of 7200 gallons [48, 49], a "maximum" of 2.9 Btu/hr/gallon can be obtained

Table 14 – Heat Generation Rate

Stream #	Heat Generation Rate, **BTU/hr/gal**	Heat Generation Rate with 25% uncertainty added, **BTU/hr/gal**	WAC Limit, **BTU/hr/gal**	Ref.
HCAN-RW-03	1.10E-06	1.38E-06	2.9	27
HCAN-RW-05[1]	2.41E-02	3.01E-02	2.9	44
HCAN-RW-06	2.68E-01	3.35E-01	2.9	47
HCAN-RW-08[1]	2.41E-02	3.01E-02	2.9	44
HCAN-RW-09	1.90E-02	2.38E-02	2.9	29
HCAN-IW-01	4.48E-03	5.60E-03	2.9	21
HCAN-IW-02[2]	2.41E-02	3.01E-02	2.9	44

1. HCAN-RW-05 is a reasonable representation (characterization) of HCAN-RW-08 (see Section 4.0).
2. LSR material is mixed and processed with sump material in SSSR (HCAN-RW-08). The impact of the LSR material are an order of magnitude less than the sump material [20].

9.8 Implementation of CST SB/SB Administrative Controls [*A/C* CST SAC 5.8.2.15 & DSA 5.7.1]

Controls identified that directly protect the LW SB documents are recorded in the Linking Document Database (LDD) records, which identify implementation documents [9]. The implementing procedures are listed in Attachment 12.4.

The following SB/SB Administrative Control requirements will be implemented and appropriate steps annotated with $ signs:

1. Notification shall be provided to (and concurrence received from) the CSTF Shift Manager/FLM/Control Room Manager prior to intended transfer 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.
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 (leak detection boxes) associated with the transfer path.
   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. Transfer 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.
5. Transfers into the CSTF shall be secured following a seismic event.
6. Transfers into the CSTF shall be secured following notification of a CSTF wildland fire event.
7. Transfers into the CSTF shall be secured following notification of a CSTF control room abandonment event.

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 (and concurrence received from) the CSTF Shift Manager/FLM/Control Room Manager of the potential for an unintended transfer prior to the intended transfer.

9. Notification shall be given to (and concurrence received from) the CSTF Shift Manager/FLM/Control Room Manager prior to performing excavations potentially affecting CSTF transfer lines.

9.9 Requirements to Satisfy Downstream Facility Acceptance Criteria [*A/C* CST 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. There are currently no downstream facilities to consider.

9.10 Industrial Hygiene Concerns

Concentrations of ammonia in the waste stream at greater than 0.127 wt % in equilibrium at 70°C will cause the vapor space to reach concentrations of 1.49 vol % (425 times the Short Term Exposure Limit (STEL) of 35 ppm). Because equilibrium conditions are not expected to be reached and the pump tank is ventilated, these levels should not be reached. The odor detection limit for ammonia, 0.043 ppm, is significantly below the STEL which should provide personnel with an early indication that ammonia gas levels are rising and that the immediate area should be evacuated.

10.0 References

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3. WSRC-TR-98-00235, "Permanganate Degradation of Reillex HPQ Ion Exchange resin for use in HB-Line," B.W. Walker, December 21, 1998.
4. S-DSA-H-00001, "Savannah River Site, H-Canyon and Outside Facilities, H-Area Documented Safety Analysis".
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6. NMP-EHA-940044 and X-CLC-H-00005, "Estimation of Radiolytic Hydrogen Generation in H-Canyon Vessels," C.E. Pickett, April 1994.
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20. X-CLC-H-00493, “Impact of Lab Sample Returns on H-Canyon/H-Outside Facilities Liquid Waste Streams to Tank Farm and Effluent Treatment Facility.”
21. X-CLC-H-00507, “Nuclear Hydrogen Generation and Inhalation Dose Potential of Liquid Waste Stream HCAN-IW-01 (PVV Filter Flush Waste) from H-Canyon to H-Tank Farm.”
22. WSRC-SA-2002-00007, Concentration, Storage, and Transfer Facilities Documented Safety Analysis
23. S4 Manual, ENG.08, “Waste Acceptance Criteria (WAC), Waste Compliance Plan (WCP), and Special Waste Compliance Plan (SWCP) Procedure” (U).
24. WSRC-TR-2004-00328, “Characterization of H-Canyon Wastes When Processing Unirradiated Materials,” W.G. Dyer and L.B. Romanowski, May 2008.
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29. X-CLC-H-00551, “Hydrogen Generation and Inhalation Dose Potential Calculations for Digested HB Line Spent Resin from H-Canyon to H-Tank Farm.”
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11.0 Acronyms

AN	Ammonium nitrate
CLFL	Composite Lower Flammability Limit
CSTF	Concentration, Storage, and Transfer Facilities
DIRT	Data Integrity Review Team
DF	Decontamination Factor
HAW	High Activity Waste
HLW	High Level Waste
HM	H Modified
HTF	H-Area Tank Farm
IW	Irregular Waste
LAW	Low Activity Waste
LFL	Lower Flammability Limit
LLW	Low Level Waste
LW	Liquid Waste
LWE	Liquid Waste Engineering
LWEC	Liquid Waste Engineering Compliance
LWGR	Liquid Waste Generator Representative
LWM	Liquid Waste Management
LWO	Liquid Waste Operations
PDD	Program Description Document
PR	Problem Report
PVV	Process Vessel Vent
RCRA	Resource Conservation and Recovery Act
RW	Routine Waste
SIRIM	Site Item Reportability and Issue Management
STP	Standard Temperature and Pressure
SVOC	Semi-Volatile Organic Carbons
TBP	Tri-butyl Phosphate
TCLP	Toxicity Characteristic Leaching Procedure
VOC	Volatile Organic Carbons
WAC	Waste Acceptance Criteria
WCP	Waste Compliance Program
WCS	Waste Characterization System

12.0 Attachments

12.1 HM-Process Schematic

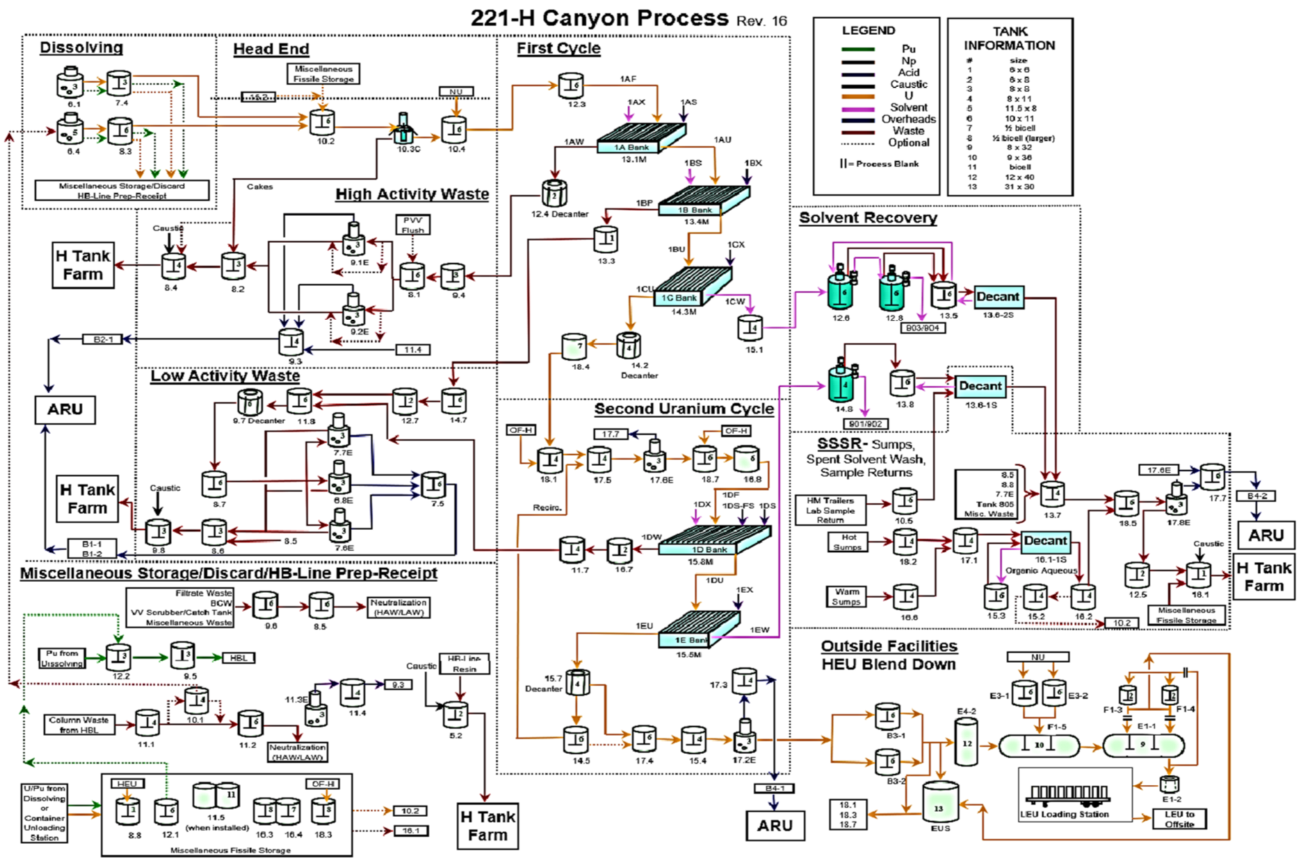
12.2 General Purpose Evaporator Schematic

12.3 PVV Filter Flush Schematic

12.4 H-Canyon and OF-H Procedures that Implement the HTF WAC

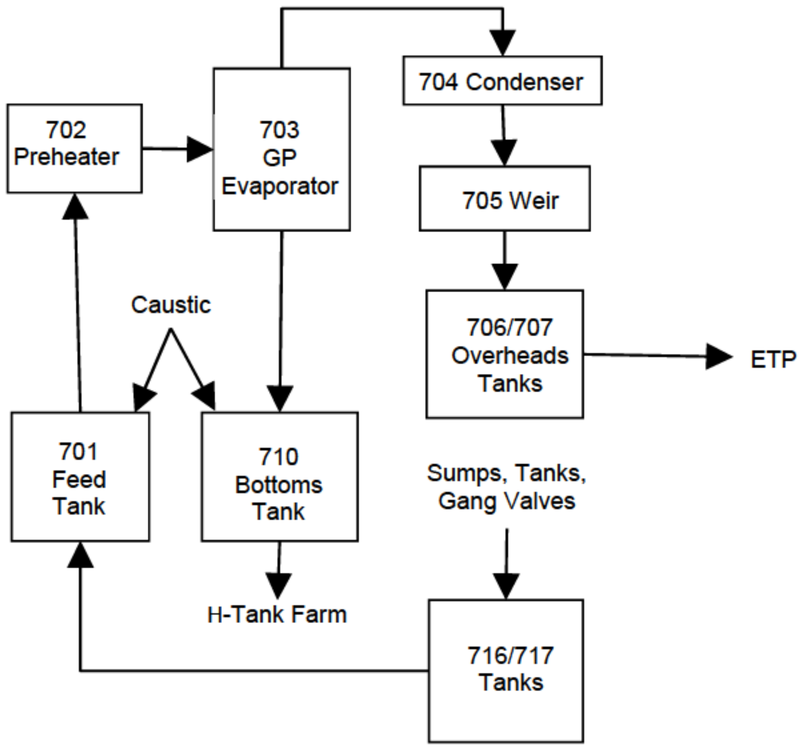
12.1 HM-Process Schematic

(For information Only, [4])



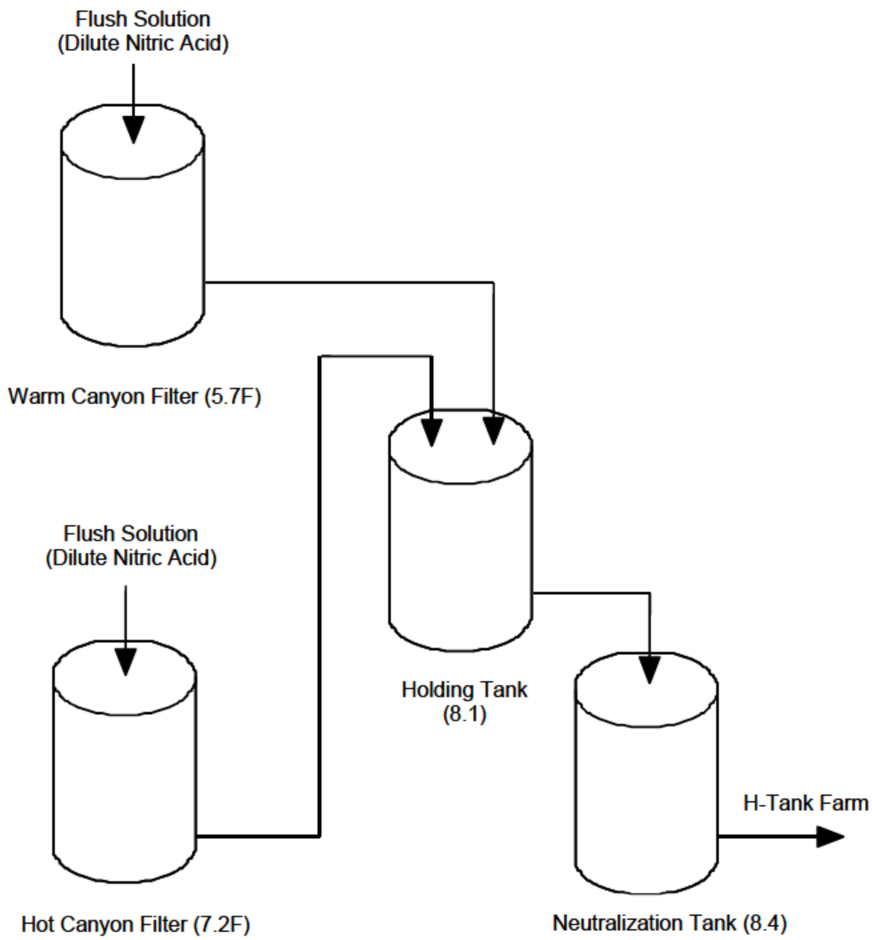
12.2 General Purpose Evaporator Schematic

NOTE: H-Canyon process configurations are subject to change. The process diagrams in this WCP are for information only and do not necessarily reflect the current configurations.



12.3 PVV Filter Flush Schematic

NOTE: H-Canyon process configurations are subject to change. The process diagrams in this WCP are for information only and do not necessarily reflect the current configurations.



12.4 H-Canyon and OF-H Procedures that Implement the HTF WAC

Stream #	Stream Description	Procedure #	Procedure Title
HCAN-RW-03	GPE	NOP 211-H-1160	Transferring From Tank 710 to H CST
HCAN-RW-03	GPE	NOP 211-H-1161	Transferring From Tank 710 to Feed Tank 701 *(sound isolation)*
HCAN-RW-03	GPE	NOP 211-H-1168	High Level Waste (HLW) Compliance Sampling of General Purpose Evaporator Bottoms Tank 710 *(sound isolation)*
HCAN-RW-03	GPE	NOP 211-H-4067	General Purpose Evaporator Bottoms Transfers From 703 To 710
HCAN-RW-03	GPE	NOP 211-H-4068	General Purpose (GP) Evaporator Acid Flush
HCAN-RW-05	LAW	NOP 221-H-4725	Adjusting Low Activity Waste In Tank 8.6
HCAN-RW-05	LAW	NOP 221-H-4743	Neutralizing Low Activity Waste in Tank 9.8
HCAN-RW-06	HAW	NOP 221-H-4710	Neutralizing High Activity Waste in Tank 8.4
HCAN-RW-06	HAW	NOP 221-H-4907	Receipt And Transfer Of Concentrate In Tank 8.2
HCAN-RW-08	SSSR	NOP 221-H-4783	Adjusting SSSR Material In Tank 12.5
HCAN-RW-08	SSSR	NOP 221-H-4784	Neutralizing SSSR in Tank 16.1
HCAN-RW-09	Digested Resin	NOP 221-H-4939* NOP 221-H-4905*	Resin Digestion in Tank 5.2 – Neptunium Resin Digestion in Tank 5.2 – Plutonium
HCAN-IW-01	PVV Flush	NOP 221-H-4751*	Receipt and Transfer of PVV Flush Solution in Tank 8.2
HCAN-IW-01	PVV Flush	NOP 221-H-4752*	Neutralizing PVV Filter Flush Solution in Tank 8.4.
HCAN-IW-02	LSR	NOP 221-H-4783	Adjusting SSSR Material In Tank 12.5
HCAN-IW-02	LSR	NOP 221-H-4784	Neutralizing SSSR in Tank 16.1
All	All	AOP 221-H-0014	Earthquake Response
All	All	AOP 221-H-0015	Severe Weather Response
All	All	211-H-RSE-5282	Field Operator Round Sheet *(excavation monitoring)*
All	All	NOP 221-H-6070	Surveillance Test Data Sheet for Safety Related Systems
-Flush	Flush	221-H-4789	Flushing Waste Header From Tank 16.1
-Flush	Flush	221-H-4796	Flushing Waste Header #1 From Tank 8.4

* These procedures are normally inactive and are activated when needed.