OSR 45-24 (Rev 4-30-2013)

Proc. Ref. E7, 2.31

Calculation Cover Sheet

Sheet 1 of 79

Project/Task MCU Next Generation Solvent Implementation	Calculation Number X-CLC-H-00958	Project/Task Number
Title MCU Next Generation Solvent Material Balance	Functional Classification PS Discipline Chemical	
Calculation Type ◉ Type 1 ○ Type 2	Type 1 Calculation Status ○ Preliminary ◉ Confirmed	
Computer Program Number Microsoft Excel, PI Processbook ☐ N/A	Version/Release Number Microsoft Office Professional Plus 2010 PI ProcessBook Version 3.2.0.0	
Purpose and Objective This calculation captures the flow sheet bases and assumptions for operation of the Modular Caustic-Side Solvent Extraction Unit (MCU) using Next Generation Solvent (NGS) and a blend of the MCU BOBCalixC6 based solvent with NGS.	DC/RO N/A	Date

Summary of Conclusion

The process flows for MCU are shown herein. Bases, assumptions, and the resultant material balance are presented in the accompanying text and appendices. The flow rates, batch sizes, and cycle times presented are time-averaged and may therefore not represent batch transfer flow rates. However, design flow rates based on process history or MCU hydraulics calculations are also provided. Two cases are analyzed in this calculation. The first is the NGS Only solvent at the maximum process flow rate of 8.5 gpm. The second is a blend of the NGS solvent with BOBCalixC6 based solvent at the maximum process flow rate of 8.5 gpm. The material balance calculation and results are included in Attachments A and B.

REVISIONS

Rev No.	Revision Description
3	Updated TOA Molecular Weight to 353.7 g/mol. Updated Strip and Scrub Stream densities. Clarified that chemical concentrations used in this document are nominal values. Revised Caustic Wash system to be once through rather than recycled. Updated References.
4	Added Caustic Wash Make-Up Tote (Stream 30) per M-DCP-H-15007. Revised Caustic Wash molarity to 0.025M NaOH. Updated References.

SIGN OFF

Rev No.	Originator (Print / Sign & Date)	Verification/Checking Method	Verification/Checker (Print / Sign & Date)	Manager (Print / Sign & Date)
4	Annah G. Garrison 8/5/15	☒ Design Check (GS/PS only) ☐ Document Review ☐ Qualification Testing ☐ Alternate Calculation ☐ Operational Testing	Celia I. Aponte 8/5/15	Earl A. Brass 8/12/15
		☐ Design Check (GS/PS only) ☐ Document Review ☐ Qualification Testing ☐ Alternate Calculation ☐ Operational Testing		

Additional Reviewer (Print Name) N/A	Signature	Date
Design Authority (Print Name) Carl Scherman (USQ-WPT-2015-00230)	Signature	Date 8/19/15
Release to Outside Agency (Print Name) N/A	Signature	Date
Security Classification of the Calculation N/A		

Calculation Continuation Sheet

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Introduction

This calculation performs the material balance for the Modular Caustic-Side Solvent Extraction Unit (MCU) using the maximum processing flow rate of 8.5 gpm of Clarified Salt Solution (CSS) feed. There are two cases included in this material balance calculation. The first case addresses the use of Next Generation Solvent (NGS) alone and the second case addresses a blended mixture of the NGS and the original MCU BOBCalixC6 based solvent (Blended Solvent).

Open Items

None

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Assumptions:

A-1 Conservation of Volume – Volume is conserved in the material balance to support closure of the calculation and to keep the calculation to a reasonable level of complexity.
Justification: The volumes within the MCU process are relatively small, the process is temperature controlled while operating, and the cold feeds chemical concentrations are dilute. Therefore, volume discrepancies will be minimal.
Sensitivity: Process flows and levels are monitored throughout the process. Minor changes in volume due to temperature variation are anticipated and will be minimal. Large changes in volume would be indicative of a process upset and would be detected through normal process monitoring.

A-2 Solids formation due to chemistry changes is not addressed in this material balance. The MCU operational strategy/Waste Acceptance Criteria (WAC) calls for all chemical adjustments to occur prior to filtration in the Actinide Removal Process (ARP), if required (R-22).
Justification: Solids Formation – High Level Waste (HLW) has been shown to precipitate solids after a pH change, such as during dilution with low hydroxide solutions (R-2). By adjusting the hydroxide concentration in advance of filtration, the MCU will be protected from rapid-forming solids. The strip solution is boric acid and the scrub solution is alkaline, but the boric acid strip is dilute and would only come into contact with the scrub solution by way of aqueous carryover into the organic stream sent to the strip.
Sensitivity: Solids formation and significant accumulation in the MCU process could lead to a process upset, such as aqueous flows exiting through an organic contactor outlet. This would be detected through process indications and monitoring. The compounds most likely to form as a result of dilution are aluminum hydroxide compounds.

A-3 Solids formation due to temperature changes is not addressed in this material balance.
Justification: Temperature changes may also initiate the formation of solid salts. The temperature of the CSS transferred to MCU is controlled by the Tank Farm WAC Section 11.12 (R-16). This calculation assumes that temperature changes in the process during normal operation are not substantive enough to cause solids to form.
Sensitivity: Solids formation and significant accumulation in the MCU process could lead to a process upset, such as aqueous flows exiting through an organic contactor outlet. This would be detected through process indications and monitoring. Temperatures in some of the process vessels may drop during colder weather months, particularly if the process is not running and transfers are not received from 512-S. Temperatures below 20 °C in the salt solution tanks may lead to precipitation of aluminum hydroxide compounds in the MCU process.

A-4 Process chemistry reacts instantaneously and proceeds to the most thermodynamically stable state.
Justification: Sufficient mixing occurs within the centrifugal contactors, and sufficient contact time is available for initial process chemistry interactions to proceed.

Sensitivity: Slow or failed process chemistry interactions could cause reduced extraction or reduced stripping, which would be indicated in lower than normal DF, or lower than normal CF with accumulation of cesium in the solvent.

A-5 Soluble cesium in the CSS feed stream is shown as cesium hydroxide. Cesium may also exist as a nitrate in the CSS. After coming into contact with the boric acid strip solution Cs_3BO_3 (most thermodynamically stable complex) is formed. The Cs_3BO_3 exits with the strip effluent (streams 25, 26, 27). The residual Cs_3BO_3 in stream 16 reacts with the caustic wash (0.03 M NaOH) to form cesium hydroxide and a borate anion.
Justification: Because the concentration of cesium is low, the form (hydroxide vs. nitrate) in the feed is insignificant from a waste chemistry perspective. Also, the majority of cesium nitrate that is extracted will react with the caustic scrub to form the hydroxide. The cesium hydroxide in the scrub product reacts with the boric acid strip solution to form the cesium borate. The NGS system operates on a pH swing principle which drives the transfer of ions between the aqueous and solvent phases depending on the pH of the aqueous phase and anion pair in the organic phase.
Sensitivity: Cesium nitrate and cesium hydroxide forms are equally extractable forms of cesium. The downstream DSS impacts are minimal whether the incoming cesium is in a nitrate or hydroxide form. Assuming the stripped cesium is cesium borate maximizes the borate sent to DWPF.

A-6 Cold feed chemicals can be delivered as needed.
Justification: MCU has completed several years of operation without a process shutdown due to lack of cold feed chemical supplies.
Sensitivity: An interruption in cold feeds availability would cause the MCU facility to shut down.

A-7 The residual Cs-137 in the solvent is set as a constant since the calculation is not capable of stage by stage calculation. The value is set at the value estimated by SASSE shown in Reference R-19 (Attachment 4 values) which analyzes MCU processing at 8.5 gpm with a Concentration Factor (CF) of 15. These cesium activity values are shown in Table 1. The residual cesium in these streams is assumed to stay in the process at steady state.

Table 1. Cesium Carryover Values

Stream Number	Stream Name	Cs-137 Concentration [Ci/gal]
7	Scrub to Extraction Bank (Aqueous)	1.61
16	Solvent to Wash (Organic)	0.23

Justification: This assumption is conservative as previous testing by Savannah River National Laboratory (SRNL) (R-15) has determined that the NGS flowsheet is more effective at stripping Cs from the solvent. The values listed above represent conservative Cs activity values since the evaluation tripled the Distribution Coefficients (DCs) for extraction and also increased the DCs in the stripping section to maximize the Cs activity.
Sensitivity: The cesium retained in the solvent shown in the table below is conservatively high. However, the CF is limited to a maximum of 15 due to the flow ratios used in the MCU process.

A-8 The extraction contactors will decontaminate Clarified Salt Solution (CSS) from ARP down to 0.011 Ci Cs-137/gal or less.

A-8.1 The extraction contactors will achieve a cesium Decontamination Factor (DF_{Cs}) of at least 100 (R-14, R-30). This DF_{Cs} is required to decontaminate the maximum feed (1.1 Ci Cs-137/gal) down to 0.011 Ci Cs-137/gal.

A-8.2 To maintain the specified DF (Salt Processing Strategy goal and waste volume reduction to DWPF), process stability, the CF is between 12 and 15. However, 15 is chosen here because it maximizes the cesium in the stream to DWPF.

Justification: With the D values (cesium distribution values) shown from full size contactor testing (R-16), this DF_{Cs} should be readily achievable (R-26). A CF of 15 is conservative because maximizes the cesium sent to DWPF (R-30).
Sensitivity: A lower DF would cause more curies of cesium to go to Tank 50. Reduced stripping would cause more curies of cesium to be retained in the solvent. A higher CF is not possible due to flow ratios in the MCU process.

A-9 This material balance is a representative snapshot of typical operating conditions. Solvent losses to the SE and DSS streams are attributed to entrainment carryover losses. Partitioning or degradation of solvent components is not modeled in this material balance.
Justification: Conservation of mass is maintained (total mass flow rate does not change).
Sensitivity: Partitioning or evaporation of solvent components would lead to a depletion of those compounds in the Solvent Hold Tank (SHT), which is sampled periodically to ensure the solvent remains within target values.

A-10 Chemical concentrations used in this calculation are nominal values.
Justification: This material balance was designed to be a representative snapshot of typical operating conditions at MCU. Maximum or low values for processing parameters (e.g., flow rates, concentration) are not evaluated in order to maintain a reasonable level of complexity in the calculation.

Sensitivity: The salt solution feed is qualified to be within the feed range for MCU. Higher or lower concentrations of chemicals will have minor effects on stripping or extraction. Procurement specifications are in place to minimize variations in chemical concentrations (See attachment 8 of Reference R-31 for cold feed chemical maximum concentrations).

A-11 The temperature of stream 24A (Strip Feed to Heater) is assumed to be 27 °C.
Justification: The size of the MCU strip feed preheater was chosen to raise the strip aqueous solution from ambient conditions to 27 °C (R-27). The base assumptions for the solution physical properties in R-27 (assumed to be those of water) remain valid for the boric acid strip solution. Based on the MSDS (R-28) the boric acid strip solution is >99 wt.% water. The strip feed preheater interlock is at 34 °C (R-23).
Sensitivity: The strip bank temperatures are controlled to 33± 3°C. If the preheater were unable to heat the strip feed to the desire pre-heat temperatures, the strip contactor bank temperatures may be somewhat impacted. Reduced strip contactor bank temperatures could cause a minor drop in cesium stripping efficiency, possibly leading to slightly increased accumulation of cesium in the solvent.

A-12 Aqueous carryover into the organic streams is negligible.
Justification: Other phase carryover varies based on the density and viscosity of the organic and aqueous phases. The contactors are designed to limit other phase carryover to less than 1% and have been observed in testing to be typically less than 0.05% (R-5).
Sensitivity: Excessive other phase carryover in the organic streams could neutralize the strip and cause ineffective stripping, which would cause accumulation of cesium in the solvent.

A-13 Only cesium is extracted in this balance.
Justification: The extractants (BOBCalix and MaxCalix) have been shown to be selective for cesium. Sodium and potassium have been shown to be extracted in minor amounts, however, the scrub is designed to minimize the impact of these constituents (R-33).
Sensitivity: Significant extraction of other components could have a deleterious impact on cesium extraction or cesium stripping, potentially leading to failed extraction (DF less than 100) or accumulation of cesium in the solvent.

Inputs:

I-1 The estimated fraction of Cs-137 of the total cesium is 0.225 (R-3).

I-2 Cs-137 specific activity is 87 Ci/g (R-4).

I-3 Solvent flow rate is 1/4 of the CSS flow rate fed to the extraction contactors (R-5).

I-4 The Organic to Aqueous flow ratio (O/A) in the Scrub, Strip and Caustic Wash contactors is 3.75. This determines the cold chemical feed rates for Scrub, Strip, and Wash banks (R-5).

I-5 The Scrub feed is 0.025 M sodium hydroxide (R-5), the density is 1.005 g/mL (R-25).

I-6 The Wash feed is 0.025 M sodium hydroxide (R-29), the density is 1.005 g/mL (R-25).

I-7 The Strip feed is 0.01 M boric acid (R-5), the density is 1.002 g/mL (R-25).

I-8 Barium-137m is not extracted with the Cs-137.

I-8.1 Ba-137m is the daughter product of Cs-137 and it is in secular equilibrium with Cs-137 at 94.6 % except immediately after extraction of the cesium (R-4, R-6)

I-8.2 The DSS Decanter provides a residence time of ≥10 half-lives of Ba-137m for DSS flow rates up to 9 gpm (R-7)

I-9 Maximum vessel capacities are given in Attachment C and these are derived from the available tank volume according to Reference R-8. The operating volume used in Attachments A and B the volume to reach the high level alarm set points according to Reference R-23, except for the SHT. The SHT operating volume is equal to the total system solvent inventory rather than the residual amount in the tank when the contactors are operating. The solvent loop is a continuous recycle stream in the process.

I-10 Solvent carryover from the contactors has been measured along with performance data for the coalescers and decanters. Based on Integrated testing and V-5 and V-10 testing with NGS, coalescer inputs are set to the long-term average solvent carryover. (R-1, R-15) Decanter outputs are set to the performance criteria for the decanters. Testing showed the decanter outputs were achievable (R-9). NGS testing has shown that these carryover inputs are conservative (R-26). The organic carryover in aqueous values are as follows for all cases:

DSS coalescer input = 1000 ppm solvent
DSS decanter output = 70 ppm solvent
Strip Effluent (SE) coalescer input = 1000 ppm solvent
SE decanter output = 70 ppm solvent

I-11 The CSS will be fed to the contactors with radiological species concentrations equal to Table C of Reference R-11. This includes a Cs-137 concentration of 1.1 Ci/gal, which is the maximum Cs-137 concentration that can be accepted into 512-S and MCU without modification (R-12).

I-12 Chemistry of the CSS feed is from the "Filtrate to LWHT" stream (stream 11 of Reference R-10) in the Average Feed cases of Reference R-10.

I-12.1 Component mass quantities, except Cs^+ species, are adjusted to maintain molar concentrations at the current MCU maximum volumetric flow rate of 8.5 gpm. This is accomplished with a flow ratio:

Adjusted Quantity = Initial Quantity * (8.5 gpm / Initial Flow Rate)

I-12.2 The cesium species are adjusted to match the curie concentration from basis I-11.

I-13 Based on the O/A ratios in inputs I-3 and I-4 and the maximum Cs concentration that can be processed through MCU (I-11), the maximum Cs concentration in the SE stream is 16.5 Ci/gal.

I-14 The design flow rate of streams designated "batch" are reported in Attachment G (streams 1-5, 10, 12, 26-27, 31-32, 46-49, 52 are "batch", streams 54-56 are also "batch" but those flowrates depend on the pump on the unloading tanker truck). The design flow rates calculated in the MCU Process Systems Hydraulic Calculation (R-20) and the MCU Process Contactor Drain Tank Pump Hydraulic Calculation (R-21) were compared to process history available from PI (recorded in Attachment G). These values were used to determine the Design Flow Rates in Attachments A and B. Where process history is not available, the design flow rates calculated in Reference R-20 are used. Design flow rates for streams which are continuous are set equal to the calculated volumetric flowrate for that stream (all other remaining streams are considered continuous. The design flow rate for solvent streams 14, 15, 16, 19, 20, and 22 are set equal to the maximum organic flow rate for the BOBCalix Flowsheet of 2.83 gpm (based on a BOBCalix Flowsheet Organic to Aqueous ratio of 1/3 in the Extraction bank) (R-24).

I-15 The temperature of Streams 1, 2, and 3 are between 20 and 29°C per the Defense Waste Processing Facility (DWPF) to H-Tank Farm (HTF) Waste Compliance Plan (WCP) (R-22). The remaining NGS process temperatures listed in Attachments A and B are consistent with the set points for BOBCalix based solvent system (R-24).

I-16 The maximum salt solution volumetric flow rate is 8.5 gpm (R-24).

I-17 The design flow rate for the Caustic Wash Makeup Tote is 1.0 gpm, and is operated in a "batch" method (R-34, R-35)

Case Specific Bases:

NGS Only Case:

I-18 The solvent composition is as follows (R-13, R-18):

0.5 M	Cs-7SB (modifier) (MW 338.35)
0.05 M	MaxCalix (extractant) (MW 955.31)
0.003 M	TiDG (suppressor) (MW 516.3)
Balance	Isopar L® (diluent) (MW 163)

Density: 0.8386 g/ml

Blended Solvent Case:

I-19 NGS concentrated solution blended with BOBCalixC6 based solvent. The NGS at MCU is a blended form. The blended solvent composition is as follows (R-13, R-18):

0.5 M	Cs-7SB (modifier) (MW 338.35)
0.0465 M	MaxCalix (extractant) (MW 955.31)
0.0035 M	BOBCalixC6 (extractant) (MW 1149.64)
0.003 M	TiDG (suppressor) (MW 516.3)
0.0015 M	Trioctylamine (TOA) (suppressant) (MW 353.7)
Balance	Isopar L® (diluent) (MW 163)

Density: 0.8384 g/ml

I-20 Only pure NGS constituents will be added to the SHT via the Solvent Feed (Stream 52) to make up for gradual process losses so that the solvent composition will gradually transition to the NGS Only Case (R-30).

Analytical Methods and Computations

The material balance is a time-averaged, steady-state calculation setup in Microsoft Excel. There are two cases presented in this calculation. The cases are detailed in the table below. The cell by cell calculation equations and formulas are documented in Attachment D, E, and F.

Table 2: Case Breakdown

Case Title	Attachment	Description	CSS (gpm)	CF	CSS (Ci/gal)
NGS Only Case	A	This case represents the solvent being pure Next Generation Solvent	8.5	15	1.1
Blended Solvent Case	B	This case represents the solvent being a "blended" mixture of original CSSX solvent and NGS.	8.5	15	1.1

Streams 1, 2, 3, 4, 5, 32, 46, 52, 54, 55, and 56 are batch transfers to the process. The mass and volumetric flow rates reported in Attachments A and B reflect a continuous flow for the sake of clarity. Where available, historical process information and information from the MCU Hydraulic Calculations (R-20, R-21) were used to calculate design flow rates in Attachment G. The design flow rates are also reported in Attachments A and B. Design flow rates were not reported for streams 54, 55, and 56, as the flow rates of those streams will be determined by the pump supplied by the tanker.

The process historical flow rates in Attachment G were calculated from tank volumes using the following formula:

$$Q = (\Delta V)/(\Delta t)$$

Where: Q = Volumetric flow rate
V = Volume in the tank at time t
t = time at which the tank volume was recorded

Results

The material balance calculation is setup in Microsoft Excel. It is a time averaged steady-state calculation. Batch processes are averaged over the cycle time; therefore, all flows appear to be continuous. The row labeled batch/cont in the table indicates whether the flow is actually continuous (such as streams to and from the contactors) or batch (such as CSS transfers from ARP). The material balance calculation results can be seen in Attachments A and B for the cases in Table 2 and the corresponding flow diagram follows as Attachment C.

Conclusion

The results obtained in this calculation are a good representation of the chemistry and flow conditions expected during radiological operations of the MCU.

Attachments

Attachment A NGS Only Case Calculation Spreadsheet
Attachment B Blended Solvent Case Calculation Spreadsheet
Attachment C MCU Flow Diagram
Attachment D Calculation Equations and Spreadsheet Formulas
Attachment E NGS Only Case Feed Spreadsheet & Formulas
Attachment F Blended Solvent Case Feed Spreadsheet & Formulas
Attachment G Design Flow Rate Calculation

		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1 SSRT 1 and 2 will not be used simultaneously, however, both are shown here as receiving CSS	Feed to SSRT 2 SSRT 1 and 2 will not be used simultaneously, however, both are shown here as receiving CSS	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Mass Rate	lb/hr	5 31E+03	5 31E+03	5 31E+03	5 31E+03	5 31E+03	5 31E+03	2 87E+02	5 59E+03	5 60E+03	5 88E+03	5 88E+03	2 87E+02	8 86E+02	8 86E+02	8 86E+02	2 85E+02	8 86E+02	8 92E+02	8 92E+02	8 87E+02	2 86E+02	2 86E+02	2 86E+02
Volumetric Rate	gpm	8 50	8 50	8 50	8 50	8 50	8 50	0 57	9 07	9 08	9 64	9 64	0 57	2 11	2 11	2 11	0 57	2 11	2 13	2 13	2 11	0 57	0 57	0 57
Gamma Activity	Ci/gal	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 61E+00	1 19E+00	1 22E-02	1 12E-02	1 12E-02		4 45E+00	4 45E+00	2 30E-01	2 76E-04	2 30E-01	2 30E-01	2 30E-01	5 27E+00			
Conc [Na^+]	M	5 6	5 6	5 6	5 6	5 6	5 6	0 025	5 3	5 2	4 9	4 9	0 025				0 025							
Conc [BO_3^-]	M								1 81E-06	1 81E-06	1 71E-06	1 71E-06					2 90E-05					0 01	0 01	0 01
OH^- Mass Rate	lb/hr	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 21E-01	1 52E+02	1 52E+02	1 52E+02	1 52E+02	1 21E-01	8 13E-03	8 13E-03		1 21E-01	4 20E-04	4 22E-04	4 22E-04	9 62E-03			
BO_3^- Mass Rate	lb/hr								4 84E-04	4 84E-04	4 84E-04	4 84E-04				4 84E-04	4 84E-04					1 68E-01	1 68E-01	1 68E-01
density	lb/gal	10 40	10 40	10 40	10 40	10 40	10 40	8 39	10 28	10 27	10 17	10 17	8 38	7 00	7 00	6 99	8 39	6 99	6 99	6 99	7 00	8 36	8 36	8 36
Design Flow Rate	gpm	158	158	156	75	73	8 5	0 57	9 07	9 08	16	93	0 57	2 83	2 83	2 83	0 57	2 83	2 83	2 83	2 83	0 57	0 57	0 57
Temperature	° C	29	29	29	23	23	23	Ambient	23	23	Ambient	Ambient	Ambient	Ambient	33	33	33	33	23	23	23	Ambient	27	33
Major Components																								
water	lb/hr	3 53E+03	3 53E+03	3 53E+03	3 53E+03	3 53E+03	3 53E+03	2 86E+02	3 82E+03	3 82E+03	4 10E+03	4 10E+03	2 86E+02				2 85E+02					2 86E+02	2 86E+02	2 86E+02
NaOH	lb/hr	1 64E+02	1 64E+02	1 64E+02	1 64E+02	1 64E+02	1 64E+02	2 85E-01	1 64E+02	1 64E+02	1 65E+02	1 65E+02	2 85E-01				2 84E-01							
NaNO2	lb/hr	4 88E+01	4 88E+01	4 88E+01	4 88E+01	4 88E+01	4 88E+01		4 88E+01	4 88E+01	4 88E+01	4 88E+01												
NaNO3	lb/hr	1 14E+03	1 14E+03	1 14E+03	1 14E+03	1 14E+03	1 14E+03		1 14E+03	1 14E+03	1 14E+03	1 14E+03												
KNO3	lb/hr	2 71E+00	2 71E+00	2 71E+00	2 71E+00	2 71E+00	2 71E+00		2 71E+00	2 71E+00	2 71E+00	2 71E+00												
CsOH	lb/hr	7 13E-02	7 13E-02	7 13E-02	7 13E-02	7 13E-02	7 13E-02	6 99E-03	7 83E-02	8 43E-04	8 21E-04	8 21E-04		7 17E-02	7 17E-02		1 19E-06	3 70E-03	3 72E-03	3 72E-03	8 48E-02			
H3BO3	lb/hr																					1 76E-01	1 76E-01	1 76E-01
Cs3BO3	lb/hr								3 77E-03	3 77E-03	3 77E-03	3 77E-03				3 77E-03								
Na2C2O4	lb/hr	1 05E+01	1 05E+01	1 05E+01	1 05E+01	1 05E+01	1 05E+01		1 05E+01	1 05E+01	1 05E+01	1 05E+01												
Na2SO4	lb/hr	1 61E+02	1 61E+02	1 61E+02	1 61E+02	1 61E+02	1 61E+02		1 61E+02	1 61E+02	1 61E+02	1 61E+02												
NaAl(OH)4	lb/hr	1 42E+02	1 42E+02	1 42E+02	1 42E+02	1 42E+02	1 42E+02		1 42E+02	1 42E+02	1 42E+02	1 42E+02												
Σ misc Na Salts	lb/hr	1 04E+02	1 04E+02	1 04E+02	1 04E+02	1 04E+02	1 04E+02		1 04E+02	1 04E+02	1 04E+02	1 04E+02												
Solvent Components																								
Isopar L	lb/hr							2 11E-01	4 21E-01	4 13E+00	2 89E-01	2 89E-01		6 55E+02	6 55E+02	6 55E+02	2 11E-01	6 55E+02	6 59E+02	6 59E+02	6 56E+02			
Cs-7SB	lb/hr							5 77E-02	1 15E-01	1 13E+00	7 90E-02	7 90E-02		1 79E+02	1 79E+02	1 79E+02	5 77E-02	1 79E+02	1 80E+02	1 80E+02	1 79E+02			
MaxCalix	lb/hr							1 63E-02	3 24E-02	3 18E-01	2 23E-02	2 23E-02		5 05E+01	5 05E+01	5 05E+01	1 63E-02	5 05E+01	5 08E+01	5 08E+01	5 05E+01			
TiDG	lb/hr							5 28E-04	1 05E-03	1 03E-02	7 23E-04	7 23E-04		1 64E+00	1 64E+00	1 64E+00	5 28E-04	1 64E+00	1 65E+00	1 65E+00	1 64E+00			
Cesium Balance																								
Total Cs^+	lbmol/hr	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 67E-05	5 47E-04	5 62E-06	5 48E-06	5 48E-06		4 78E-04	4 78E-04	2 47E-05	7 96E-09	2 47E-05	2 48E-05	2 484E-05	5 66E-04			
Total Cs^+	lb/hr	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 20E-03	7 27E-02	7 47E-04	7 28E-04	7 28E-04		6 36E-02	6 36E-02	3 28E-03	1 06E-06	3 28E-03	3 30E-03	3 30E-03	7 52E-02			
Total Cs-137	lb/hr	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 40E-03	1 63E-02	1 68E-04	1 64E-04	1 64E-04		1 43E-02	1 43E-02	7 38E-04	2 38E-07	7 38E-04	7 43E-04	7 43E-04	1 69E-02			
Vessel Information																								
Operating Volume	gal	7200	7200	7200	7195	7195	7195	NA	NA	NA	6790	6790	6265	NA	NA	NA	NA	237	237	237	NA	4753	4753	4753
Cycle time	hrs	14 1	14 1	14 1	14 1	14 1	14 1	NA	NA	NA	11 7	11 7	183 2	NA	NA	NA	NA	recycled	recycled	recycled	NA	139 0	139 0	139 0
batch/cont		batch	batch	batch	batch	batch	cont	cont	cont	cont	batch	batch	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont
Na	lbmol/hr	2 38E+01	2 38E+01	2 38E+01	2 38E+01	2 38E+01	2 38E+01	7 14E-03	2 39E+01	2 39E+01	2 39E+01	2 39E+01	7 14E-03				7 09E-03							
BO3	lbmol/hr								8 23E-06	8 23E-06	8 23E-06	8 23E-06				8 23E-06	8 23E-06					2 85E-03	2 85E-03	2 85E-03

		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
Radiological Summary	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1	Feed to SSRT 2	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Cs-137	Ci/gal	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 61E+00	1 19E+00	1 22E-02	1 12E-02	1 12E-02		4 45E+00	4 45E+00	2 30E-01	2 76E-04	2 30E-01	2 30E-01	2 30E-01	5 27E+00			
Ba-137m	Ci/gal	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 52E+00	1 12E+00	1 15E-02	1 06E-02	1 06E-02		4 21E+00	4 21E+00	2 18E-01	2 61E-04	2 18E-01	2 18E-01	2 18E-01	4 99E+00			
H-3	Ci/gal	3 96E-04	3 96E-04	3 96E-04	3 96E-04	3 96E-04	3 96E-04		3 96E-04	3 96E-04	3 96E-04	3 96E-04												
C-14	Ci/gal	1 03E-05	1 03E-05	1 03E-05	1 03E-05	1 03E-05	1 03E-05		1 03E-05	1 03E-05	1 03E-05	1 03E-05												
Co-60	Ci/gal	1 02E-05	1 02E-05	1 02E-05	1 02E-05	1 02E-05	1 02E-05		1 02E-05	1 02E-05	1 02E-05	1 02E-05												
Ni-59	Ci/gal	3 11E-08	3 11E-08	3 11E-08	3 11E-08	3 11E-08	3 11E-08		3 11E-08	3 11E-08	3 11E-08	3 11E-08												
Ni-63	Ci/gal	1 20E-05	1 20E-05	1 20E-05	1 20E-05	1 20E-05	1 20E-05		1 20E-05	1 20E-05	1 20E-05	1 20E-05												
Se-79	Ci/gal	5 94E-07	5 94E-07	5 94E-07	5 94E-07	5 94E-07	5 94E-07		5 94E-07	5 94E-07	5 94E-07	5 94E-07												
Sr-90	Ci/gal	8 13E-04	8 13E-04	8 13E-04	8 13E-04	8 13E-04	8 13E-04		8 13E-04	8 13E-04	8 13E-04	8 13E-04												
Y-90	Ci/gal	9 06E-04	9 06E-04	9 06E-04	9 06E-04	9 06E-04	9 06E-04		9 06E-04	9 06E-04	9 06E-04	9 06E-04												
Nb-94	Ci/gal	5 62E-11	5 62E-11	5 62E-11	5 62E-11	5 62E-11	5 62E-11		5 62E-11	5 62E-11	5 62E-11	5 62E-11												
Tc-99	Ci/gal	2 19E-04	2 19E-04	2 19E-04	2 19E-04	2 19E-04	2 19E-04		2 19E-04	2 19E-04	2 19E-04	2 19E-04												
Sb-125	Ci/gal	5 53E-05	5 53E-05	5 53E-05	5 53E-05	5 53E-05	5 53E-05		5 53E-05	5 53E-05	5 53E-05	5 53E-05												
Sn-126	Ci/gal	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06		2 98E-06	2 98E-06	2 98E-06	2 98E-06												
I-129	Ci/gal	1 10E-07	1 10E-07	1 10E-07	1 10E-07	1 10E-07	1 10E-07		1 10E-07	1 10E-07	1 10E-07	1 10E-07												
Cs-134	Ci/gal	1 21E-03	1 21E-03	1 21E-03	1 21E-03	1 21E-03	1 21E-03		1 21E-03	1 21E-03	1 21E-03	1 21E-03												
Cs-135	Ci/gal	2 38E-06	2 38E-06	2 38E-06	2 38E-06	2 38E-06	2 38E-06		2 38E-06	2 38E-06	2 38E-06	2 38E-06												
Pm-147	Ci/gal	6 35E-05	6 35E-05	6 35E-05	6 35E-05	6 35E-05	6 35E-05		6 35E-05	6 35E-05	6 35E-05	6 35E-05												
Eu-154	Ci/gal	1 95E-05	1 95E-05	1 95E-05	1 95E-05	1 95E-05	1 95E-05		1 95E-05	1 95E-05	1 95E-05	1 95E-05												
Th-232	Ci/gal	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13		4 61E-13	4 61E-13	4 61E-13	4 61E-13												
U-232	Ci/gal	4 91E-10	4 91E-10	4 91E-10	4 91E-10	4 91E-10	4 91E-10		4 91E-10	4 91E-10	4 91E-10	4 91E-10												
U-233	Ci/gal	1 22E-08	1 22E-08	1 22E-08	1 22E-08	1 22E-08	1 22E-08		1 22E-08	1 22E-08	1 22E-08	1 22E-08												
U-234	Ci/gal	1 51E-07	1 51E-07	1 51E-07	1 51E-07	1 51E-07	1 51E-07		1 51E-07	1 51E-07	1 51E-07	1 51E-07												
U-235	Ci/gal	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09		2 27E-09	2 27E-09	2 27E-09	2 27E-09												
U-236	Ci/gal	2 87E-08	2 87E-08	2 87E-08	2 87E-08	2 87E-08	2 87E-08		2 87E-08	2 87E-08	2 87E-08	2 87E-08												
U-238	Ci/gal	1 71E-07	1 71E-07	1 71E-07	1 71E-07	1 71E-07	1 71E-07		1 71E-07	1 71E-07	1 71E-07	1 71E-07												
Np-237	Ci/gal	5 89E-08	5 89E-08	5 89E-08	5 89E-08	5 89E-08	5 89E-08		5 89E-08	5 89E-08	5 89E-08	5 89E-08												
Pu-238	Ci/gal	5 41E-04	5 41E-04	5 41E-04	5 41E-04	5 41E-04	5 41E-04		5 41E-04	5 41E-04	5 41E-04	5 41E-04												
Pu-239	Ci/gal	2 16E-05	2 16E-05	2 16E-05	2 16E-05	2 16E-05	2 16E-05		2 16E-05	2 16E-05	2 16E-05	2 16E-05												
Pu-240	Ci/gal	4 83E-06	4 83E-06	4 83E-06	4 83E-06	4 83E-06	4 83E-06		4 83E-06	4 83E-06	4 83E-06	4 83E-06												
Pu-241	Ci/gal	4 44E-04	4 44E-04	4 44E-04	4 44E-04	4 44E-04	4 44E-04		4 44E-04	4 44E-04	4 44E-04	4 44E-04												
Pu-242	Ci/gal	2 52E-08	2 52E-08	2 52E-08	2 52E-08	2 52E-08	2 52E-08		2 52E-08	2 52E-08	2 52E-08	2 52E-08												
Am-241	Ci/gal	1 92E-06	1 92E-06	1 92E-06	1 92E-06	1 92E-06	1 92E-06		1 92E-06	1 92E-06	1 92E-06	1 92E-06												
Am-242m	Ci/gal	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09		2 27E-09	2 27E-09	2 27E-09	2 27E-09												
Cm-244	Ci/gal	5 50E-07	5 50E-07	5 50E-07	5 50E-07	5 50E-07	5 50E-07		5 50E-07	5 50E-07	5 50E-07	5 50E-07												
Cm-245	Ci/gal	2 88E-10	2 88E-10	2 88E-10	2 88E-10	2 88E-10	2 88E-10		2 88E-10	2 88E-10	2 88E-10	2 88E-10												
Na-22	Ci/gal	7 50E-05	7 50E-05	7 50E-05	7 50E-05	7 50E-05	7 50E-05		7 50E-05	7 50E-05	7 50E-05	7 50E-05												
Al-26	Ci/gal	3 01E-07	3 01E-07	3 01E-07	3 01E-07	3 01E-07	3 01E-07		3 01E-07	3 01E-07	3 01E-07	3 01E-07												
Sb-126	Ci/gal	4 18E-07	4 18E-07	4 18E-07	4 18E-07	4 18E-07	4 18E-07		4 18E-07	4 18E-07	4 18E-07	4 18E-07												
Sb-126m	Ci/gal	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06		2 98E-06	2 98E-06	2 98E-06	2 98E-06												
Sm-151	Ci/gal	5 29E-05	5 29E-05	5 29E-05	5 29E-05	5 29E-05	5 29E-05		5 29E-05	5 29E-05	5 29E-05	5 29E-05												
Eu-152	Ci/gal	2 56E-07	2 56E-07	2 56E-07	2 56E-07	2 56E-07	2 56E-07		2 56E-07	2 56E-07	2 56E-07	2 56E-07												
Eu-155	Ci/gal	2 99E-06	2 99E-06	2 99E-06	2 99E-06	2 99E-06	2 99E-06		2 99E-06	2 99E-06	2 99E-06	2 99E-06												
Ra-226	Ci/gal	2 12E-09	2 12E-09	2 12E-09	2 12E-09	2 12E-09	2 12E-09		2 12E-09	2 12E-09	2 12E-09	2 12E-09												
Ra-228	Ci/gal	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13		4 61E-13	4 61E-13	4 61E-13	4 61E-13												
Ac-227	Ci/gal	6 15E-13	6 15E-13	6 15E-13	6 15E-13	6 15E-13	6 15E-13		6 15E-13	6 15E-13	6 15E-13	6 15E-13												
Th-229	Ci/gal	4 13E-11	4 13E-11	4 13E-11	4 13E-11	4 13E-11	4 13E-11		4 13E-11	4 13E-11	4 13E-11	4 13E-11												
Th-230	Ci/gal	2 47E-10	2 47E-10	2 47E-10	2 47E-10	2 47E-10	2 47E-10		2 47E-10	2 47E-10	2 47E-10	2 47E-10												
Pa-231	Ci/gal	1 71E-12	1 71E-12	1 71E-12	1 71E-12	1 71E-12	1 71E-12		1 71E-12	1 71E-12	1 71E-12	1 71E-12												
Pu-244	Ci/gal	1 15E-10	1 15E-10	1 15E-10	1 15E-10	1 15E-10	1 15E-10		1 15E-10	1 15E-10	1 15E-10	1 15E-10												
Am-243	Ci/gal	7 63E-10	7 63E-10	7 63E-10	7 63E-10	7 63E-10	7 63E-10		7 63E-10	7 63E-10	7 63E-10	7 63E-10												
Cm-242	Ci/gal	1 04E-09	1 04E-09	1 04E-09	1 04E-09	1 04E-09	1 04E-09		1 04E-09	1 04E-09	1 04E-09	1 04E-09												
Cm-243	Ci/gal	6 15E-10	6 15E-10	6 15E-10	6 15E-10	6 15E-10	6 15E-10		6 15E-10	6 15E-10	6 15E-10	6 15E-10												
Cm-247	Ci/gal	2 02E-10	2 02E-10	2 02E-10	2 02E-10	2 02E-10	2 02E-10		2 02E-10	2 02E-10	2 02E-10	2 02E-10												
Cm-248	Ci/gal	8 84E-20	8 84E-20	8 84E-20	8 84E-20	8 84E-20	8 84E-20		8 84E-20	8 84E-20	8 84E-20	8 84E-20												
Bk-249	Ci/gal	7 34E-27	7 34E-27	7 34E-27	7 34E-27	7 34E-27	7 34E-27		7 34E-27	7 34E-27	7 34E-27	7 34E-27												
Cf-249	Ci/gal	3 85E-10	3 85E-10	3 85E-10	3 85E-10	3 85E-10	3 85E-10		3 85E-10	3 85E-10	3 85E-10	3 85E-10												
Cf-251	Ci/gal	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10		4 56E-10	4 56E-10	4 56E-10	4 56E-10												
Cf-252	Ci/gal	6 18E-22	6 18E-22	6 18E-22	6 18E-22	6 18E-22	6 18E-22		6 18E-22	6 18E-22	6 18E-22	6 18E-22												

		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
Additional Soluble Chemicals	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1	Feed to SSRT 2	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Sr(NO3)2	lb/hr	4 05E-06	4 05E-06	4 05E-06	4 05E-06	4 05E-06	4 05E-06		4 05E-06	4 05E-06	4 05E-06	4 05E-06												
Na2CO3	lb/hr	8 31E+01	8 31E+01	8 31E+01	8 31E+01	8 31E+01	8 31E+01		8 31E+01	8 31E+01	8 31E+01	8 31E+01												
Na3PO4	lb/hr	1 68E+00	1 68E+00	1 68E+00	1 68E+00	1 68E+00	1 68E+00		1 68E+00	1 68E+00	1 68E+00	1 68E+00												
NaHgOOH	lb/hr	7 47E-03	7 47E-03	7 47E-03	7 47E-03	7 47E-03	7 47E-03		7 47E-03	7 47E-03	7 47E-03	7 47E-03												
AgNO3	lb/hr	8 51E-05	8 51E-05	8 51E-05	8 51E-05	8 51E-05	8 51E-05		8 51E-05	8 51E-05	8 51E-05	8 51E-05												
NaAs(OH)4	lb/hr	3 47E-02	3 47E-02	3 47E-02	3 47E-02	3 47E-02	3 47E-02		3 47E-02	3 47E-02	3 47E-02	3 47E-02												
Ba(NO3)2	lb/hr	4 28E-06	4 28E-06	4 28E-06	4 28E-06	4 28E-06	4 28E-06		4 28E-06	4 28E-06	4 28E-06	4 28E-06												
Ca(NO3)2	lb/hr	2 90E-02	2 90E-02	2 90E-02	2 90E-02	2 90E-02	2 90E-02		2 90E-02	2 90E-02	2 90E-02	2 90E-02												
Cd(NO3)2	lb/hr	1 46E-03	1 46E-03	1 46E-03	1 46E-03	1 46E-03	1 46E-03		1 46E-03	1 46E-03	1 46E-03	1 46E-03												
NaCl	lb/hr	8 96E+00	8 96E+00	8 96E+00	8 96E+00	8 96E+00	8 96E+00		8 96E+00	8 96E+00	8 96E+00	8 96E+00												
Co(NO3)3	lb/hr	3 61E-04	3 61E-04	3 61E-04	3 61E-04	3 61E-04	3 61E-04		3 61E-04	3 61E-04	3 61E-04	3 61E-04												
Na2CrO4	lb/hr	8 14E-02	8 14E-02	8 14E-02	8 14E-02	8 14E-02	8 14E-02		8 14E-02	8 14E-02	8 14E-02	8 14E-02												
Cu(NO3)2	lb/hr	9 21E-02	9 21E-02	9 21E-02	9 21E-02	9 21E-02	9 21E-02		9 21E-02	9 21E-02	9 21E-02	9 21E-02												
Fe(NO3)3	lb/hr	4 25E-03	4 25E-03	4 25E-03	4 25E-03	4 25E-03	4 25E-03		4 25E-03	4 25E-03	4 25E-03	4 25E-03												
NaF	lb/hr	1 04E+01	1 04E+01	1 04E+01	1 04E+01	1 04E+01	1 04E+01		1 04E+01	1 04E+01	1 04E+01	1 04E+01												
Mg(NO3)2	lb/hr	1 72E-05	1 72E-05	1 72E-05	1 72E-05	1 72E-05	1 72E-05		1 72E-05	1 72E-05	1 72E-05	1 72E-05												
Mn(NO3)4	lb/hr	2 51E-04	2 51E-04	2 51E-04	2 51E-04	2 51E-04	2 51E-04		2 51E-04	2 51E-04	2 51E-04	2 51E-04												
Nd(NO3)3	lb/hr	8 66E-04	8 66E-04	8 66E-04	8 66E-04	8 66E-04	8 66E-04		8 66E-04	8 66E-04	8 66E-04	8 66E-04												
Ni(NO3)2	lb/hr	6 36E-04	6 36E-04	6 36E-04	6 36E-04	6 36E-04	6 36E-04		6 36E-04	6 36E-04	6 36E-04	6 36E-04												
Pb(NO3)2	lb/hr	8 36E-04	8 36E-04	8 36E-04	8 36E-04	8 36E-04	8 36E-04		8 36E-04	8 36E-04	8 36E-04	8 36E-04												
Ru(NO3)4	lb/hr	1 84E-02	1 84E-02	1 84E-02	1 84E-02	1 84E-02	1 84E-02		1 84E-02	1 84E-02	1 84E-02	1 84E-02												
Na2SeO4	lb/hr	8 70E-02	8 70E-02	8 70E-02	8 70E-02	8 70E-02	8 70E-02		8 70E-02	8 70E-02	8 70E-02	8 70E-02												
Na2SiO3	lb/hr	2 58E-02	2 58E-02	2 58E-02	2 58E-02	2 58E-02	2 58E-02		2 58E-02	2 58E-02	2 58E-02	2 58E-02												
NaZn(OH)3	lb/hr	8 51E-02	8 51E-02	8 51E-02	8 51E-02	8 51E-02	8 51E-02		8 51E-02	8 51E-02	8 51E-02	8 51E-02												
Zr(O)(NO3)2	lb/hr	3 65E-03	3 65E-03	3 65E-03	3 65E-03	3 65E-03	3 65E-03		3 65E-03	3 65E-03	3 65E-03	3 65E-03												

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction **Note: This stream is treated as continuous to facilitate the material balance However, the SED organic boot pumps over as a batch Gamma Activity in this stream is set equal to residual in the solvent This stream is expected to be 0 23 Ci/gal	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent *Note: This stream is treated as continuous makeup for solvent losses However, fresh solvent is added to the system via drum as needed	Influents to CDT	Scrub to Feed Tank *Note: The design flowrate depends on the pump provided by the truck	Strip to Feed Tank *Note: The design flowrate depends on the pump provided by the truck	Caustic Wash to CST *Note: The design flowrate depends on the pump provided by the truck
Mass Rate	lb/hr	2 86E+02	2 86E+02	2 86E+02	Not Normally Used (NNU)	Upset Only	NNU	NNU	5 49E+00	NNU	NNU	2 87E-01	NNU	NNU	NNU	NNU	2 85E+02	2 85E+02	3 94E-01	NNU	2 87E+02	2 86E+02	2 85E+02
Volumetric Rate	gpm	0 57	0 57	0 57					0 013			0 001					0 57	0 57	0 001		0 57	0 57	0 57
Gamma Activity	Ci/gal	1 73E+01	1 65E+01	1 65E+01					2 35E-01			**						2 76E-04					
Conc [Na^+]	M																0 025	0 025			0 025		0 025
Conc [BO_3^-]	M	9 96E-03	9 94E-03	9 94E-03								2 41E-02						2 90E-05				0 01	
OH^- Mass Rate	lb/hr								2 65E-06								1 21E-01	1 21E-01			1 21E-01		1 21E-01
BO_3^- Mass Rate	lb/hr	1 67E-01	1 67E-01	1 67E-01								4 84E-04						4 84E-04				1 68E-01	
density	lb/gal	8 36	8 36	8 36					6 99			6 99					8 38	8 39	6 99		8 38	8 36	8 38
Design Flow Rate	gpm	0 57	10	14	8 5	15	1	20	0 50	33	33	0 50	27 75	17	9	28 50	0 57	0 57	5				
Temperature	° C	33	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient
Major Components																							
water	lb/hr	2 86E+02	2 86E+02	2 86E+02													2 85E+02	2 85E+02			2 86E+02	2 86E+02	2 85E+02
NaOH	lb/hr																2 84E-01	2 84E-01			2 85E-01		2 84E-01
NaNO2	lb/hr																						
NaNO3	lb/hr																						
KNO3	lb/hr																						
CsOH	lb/hr								2 34E-05									1 19E-06					
H3BO3	lb/hr																					1 76E-01	
Cs3BO3	lb/hr	7 67E-02	7 29E-02	7 29E-02								3 77E-03											
Na2C2O4	lb/hr																						
Na2SO4	lb/hr																						
NaAl(OH)4	lb/hr																						
Σ misc Na Salts	lb/hr																						
Solvent Components																							
Isopar L	lb/hr	2 11E-01	2 12E-03	2 12E-03					4 06E+00			2 09E-01						2 11E-01	2 92E-01				
Cs-7SB	lb/hr	5 77E-02	5 77E-04	5 77E-04					1 11E+00			5 71E-02						5 77E-02	7 95E-02				
MaxCalix	lb/hr	1 63E-02	1 63E-04	1 63E-04					3 12E-01			1 61E-02						1 63E-02	2 25E-02				
TiDG	lb/hr	5 28E-04	5 28E-06	5 28E-06					1 01E-02			5 23E-04						5 28E-04	7 28E-04				
Cesium Balance																							
Total Cs^+	lbmol/hr	5 03E-04	4 78E-04	4 78E-04					1 56E-07			2 47E-05						7 96E-09					
Total Cs^+	lb/hr	6 68E-02	6 36E-02	6 36E-02					2 07E-05			3 28E-03						1 06E-06					
Total Cs-137	lb/hr	1 50E-02	1 43E-02	1 43E-02					4 67E-06			7 38E-04						2 38E-07					
Vessel Information																							
Operating Volume	gal	NA	749	749	NA	NA	310	760	8 8	NA	NA	8 8	310	310		310	7899	NA	50	NA	6265	4753	7899
Cycle time	hrs	NA	21 9	21 9	NA	NA	NA	NA	0 3	NA	NA	0 3	NA	NA	NA	NA	232 3	NA	NA	NA	183 2	139 0	232 3
batch/cont		cont	batch	batch	NA	NA	batch	batch	batch	NA	NA	batch	batch	batch	batch	batch	cont	cont	batch	NA	batch	batch	batch
Na	lbmol/hr																7 09E-03	7 09E-03			7 14E-03		7 09E-03
BO3	lbmol/hr	2 85E-03	2 84E-03	2 84E-03								8 23E-06						8 23E-06				2 85E-03	

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
Radiological Summary	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent	Influents to CDT	Scrub to Feed Tank	Strip to Feed Tank	Wash to CST
Cs-137	Ci/gal	1 73E+01	1 65E+01	1 65E+01					2 35E-01			2 30E-01						2 76E-04					
Ba-137m	Ci/gal	1 64E+01	1 56E+01	1 56E+01					2 22E-01			2 18E-01						2 61E-04					
H-3	Ci/gal																						
C-14	Ci/gal																						
Co-60	Ci/gal																						
Ni-59	Ci/gal																						
Ni-63	Ci/gal																						
Se-79	Ci/gal																						
Sr-90	Ci/gal																						
Y-90	Ci/gal																						
Nb-94	Ci/gal																						
Tc-99	Ci/gal																						
Sb-125	Ci/gal																						
Sn-126	Ci/gal																						
I-129	Ci/gal																						
Cs-134	Ci/gal																						
Cs-135	Ci/gal																						
Pm-147	Ci/gal																						
Eu-154	Ci/gal																						
Th-232	Ci/gal																						
U-232	Ci/gal																						
U-233	Ci/gal																						
U-234	Ci/gal																						
U-235	Ci/gal																						
U-236	Ci/gal																						
U-238	Ci/gal																						
Np-237	Ci/gal																						
Pu-238	Ci/gal																						
Pu-239	Ci/gal																						
Pu-240	Ci/gal																						
Pu-241	Ci/gal																						
Pu-242	Ci/gal																						
Am-241	Ci/gal																						
Am-242m	Ci/gal																						
Cm-244	Ci/gal																						
Cm-245	Ci/gal																						
Na-22	Ci/gal																						
Al-26	Ci/gal																						
Sb-126	Ci/gal																						
Sb-126m	Ci/gal																						
Sm-151	Ci/gal																						
Eu-152	Ci/gal																						
Eu-155	Ci/gal																						
Ra-226	Ci/gal																						
Ra-228	Ci/gal																						
Ac-227	Ci/gal																						
Th-229	Ci/gal																						
Th-230	Ci/gal																						
Pa-231	Ci/gal																						
Pu-244	Ci/gal																						
Am-243	Ci/gal																						
Cm-242	Ci/gal																						
Cm-243	Ci/gal																						
Cm-247	Ci/gal																						
Cm-248	Ci/gal																						
Bk-249	Ci/gal																						
Cf-249	Ci/gal																						
Cf-251	Ci/gal																						
Cf-252	Ci/gal																						

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
Additional Soluble Chemicals	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent	Influents to CDT	Scrub to Feed Tank	Strip to Feed Tank	Wash to CST
Sr(NO3)2	lb/hr																						
Na2CO3	lb/hr																						
Na3PO4	lb/hr																						
NaHgOOH	lb/hr																						
AgNO3	lb/hr																						
NaAs(OH)4	lb/hr																						
Ba(NO3)2	lb/hr																						
Ca(NO3)2	lb/hr																						
Cd(NO3)2	lb/hr																						
NaCl	lb/hr																						
Co(NO3)3	lb/hr																						
Na2CrO4	lb/hr																						
Cu(NO3)2	lb/hr																						
Fe(NO3)3	lb/hr																						
NaF	lb/hr																						
Mg(NO3)2	lb/hr																						
Mn(NO3)4	lb/hr																						
Nd(NO3)3	lb/hr																						
Ni(NO3)2	lb/hr																						
Pb(NO3)2	lb/hr																						
Ru(NO3)4	lb/hr																						
Na2SeO4	lb/hr																						
Na2SiO3	lb/hr																						
NaZn(OH)3	lb/hr																						
Zr(O)(NO3)2	lb/hr																						

		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1 SSRT 1 and 2 will not be used simultaneously, however, both are shown here as receiving CSS	Feed to SSRT 2 SSRT 1 and 2 will not be used simultaneously, however, both are shown here as receiving CSS	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Mass Rate	lb/hr	5 31E+03	5 31E+03	5 31E+03	5 31E+03	5 31E+03	5 31E+03	2 87E+02	5 59E+03	5 59E+03	5 87E+03	5 87E+03	2 87E+02	8 91E+02	8 91E+02	8 91E+02	2 85E+02	8 90E+02	8 92E+02	8 92E+02	8 91E+02	2 86E+02	2 86E+02	2 86E+02
Volumetric Rate	gpm	8 50	8 50	8 50	8 50	8 50	8 50	0 57	9 07	9 08	9 64	9 64	0 57	2 11	2 11	2 11	0 57	2 12	2 13	2 13	2 11	0 57	0 57	0 57
Gamma Activity	Ci/gal	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 61E+00	1 19E+00	1 22E-02	1 12E-02	1 12E-02		4 45E+00	4 45E+00	2 30E-01	2 76E-04	2 29E-01	2 30E-01	2 30E-01	5 27E+00			
Conc [Na^+]	M	5 6	5 6	5 6	5 6	5 6	5 6	0 025	5 3	5 2	4 9	4 9	0 025				0 025							
Conc [BO_3^-]	M								1 81E-06	1 81E-06	1 71E-06	1 71E-06					2 90E-05					0 01	0 01	0 01
OH^- Mass Rate	lb/hr	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 51E+02	1 21E-01	1 52E+02	1 52E+02	1 52E+02	1 52E+02	1 21E-01	8 13E-03	8 13E-03		1 21E-01	4 20E-04	4 22E-04	4 22E-04	9 62E-03			
BO_3^- Mass Rate	lb/hr								4 84E-04	4 84E-04	4 84E-04	4 84E-04				4 84E-04	4 84E-04					1 68E-01	1 68E-01	1 68E-01
density	lb/gal	10 40	10 40	10 40	10 40	10 40	10 40	8 39	10 28	10 26	10 16	10 16	8 38	7 03	7 03	7 03	8 39	6 99	6 99	6 99	7 04	8 36	8 36	8 36
Design Flow Rate	gpm	158	158	156	75	73	8 5	0 57	9 07	9 08	16	93	0 57	2 83	2 83	2 83	0 57	2 83	2 83	2 83	2 83	0 57	0 57	0 57
Temperature	° C	29	29	29	23	23	23	Ambient	23	23	Ambient	Ambient	Ambient	Ambient	33	33	33	33	23	23	23	Ambient	27	33
Major Components																								
water	lb/hr	3 53E+03	3 53E+03	3 53E+03	3 53E+03	3 53E+03	3 53E+03	2 86E+02	3 82E+03	3 82E+03	4 10E+03	4 10E+03	2 86E+02				2 85E+02					2 86E+02	2 86E+02	2 86E+02
NaOH	lb/hr	1 64E+02	1 64E+02	1 64E+02	1 64E+02	1 64E+02	1 64E+02	2 85E-01	1 64E+02	1 64E+02	1 65E+02	1 65E+02	2 85E-01				2 84E-01							
NaNO2	lb/hr	4 88E+01	4 88E+01	4 88E+01	4 88E+01	4 88E+01	4 88E+01		4 88E+01	4 88E+01	4 88E+01	4 88E+01												
NaNO3	lb/hr	1 14E+03	1 14E+03	1 14E+03	1 14E+03	1 14E+03	1 14E+03		1 14E+03	1 14E+03	1 14E+03	1 14E+03												
KNO3	lb/hr	2 71E+00	2 71E+00	2 71E+00	2 71E+00	2 71E+00	2 71E+00		2 71E+00	2 71E+00	2 71E+00	2 71E+00												
CsOH	lb/hr	7 13E-02	7 13E-02	7 13E-02	7 13E-02	7 13E-02	7 13E-02	6 99E-03	7 83E-02	-2 86E-03	-2 88E-03	-2 88E-03		7 17E-02	7 17E-02		1 19E-06	3 70E-03	3 72E-03	3 72E-03	8 48E-02			
H3BO3	lb/hr																					1 76E-01	1 76E-01	1 76E-01
Cs3BO3	lb/hr								3 77E-03	3 77E-03	3 77E-03	3 77E-03				3 77E-03								
Na2C2O4	lb/hr	1 05E+01	1 05E+01	1 05E+01	1 05E+01	1 05E+01	1 05E+01		1 05E+01	1 05E+01	1 05E+01	1 05E+01												
Na2SO4	lb/hr	1 61E+02	1 61E+02	1 61E+02	1 61E+02	1 61E+02	1 61E+02		1 61E+02	1 61E+02	1 61E+02	1 61E+02												
NaAl(OH)4	lb/hr	1 42E+02	1 42E+02	1 42E+02	1 42E+02	1 42E+02	1 42E+02		1 42E+02	1 42E+02	1 42E+02	1 42E+02												
Σ misc Na Salts	lb/hr	1 04E+02	1 04E+02	1 04E+02	1 04E+02	1 04E+02	1 04E+02		1 04E+02	1 04E+02	1 04E+02	1 04E+02												
Solvent Components																								
Isopar L	lb/hr							2 11E-01	4 20E-01	4 13E+00	2 89E-01	2 89E-01		6 59E+02	6 59E+02	6 58E+02	2 11E-01	6 58E+02	6 63E+02	6 63E+02	6 59E+02			
Cs-7SB	lb/hr							5 77E-02	1 15E-01	1 13E+00	7 90E-02	7 90E-02		1 79E+02	1 79E+02	1 79E+02	5 77E-02	1 79E+02	1 80E+02	1 80E+02	1 79E+02			
MaxCalix	lb/hr							1 52E-02	3 01E-02	2 96E-01	2 07E-02	2 07E-02		4 70E+01	4 70E+01	4 70E+01	1 51E-02	4 70E+01	4 73E+01	4 73E+01	4 70E+01			
TiDG	lb/hr							5 28E-04	1 05E-03	1 03E-02	7 23E-04	7 23E-04		1 64E+00	1 64E+00	1 64E+00	5 28E-04	1 64E+00	1 65E+00	1 65E+00	1 64E+00			
BOBCalix	lb/hr							1 37E-03	2 73E-03	2 68E-02	1 88E-03	1 88E-03		4 26E+00	4 26E+00	4 25E+00	1 37E-03	4 25E+00	4 28E+00	4 28E+00	4 26E+00			
TOA	lb/hr							1 81E-04	3 60E-04	3 54E-03	2 48E-04	2 48E-04		5 61E-01	5 61E-01	5 61E-01	1 81E-04	5 61E-01	5 65E-01	5 65E-01	5 61E-01			
Cesium Balance																								
Total Cs^+	lbmol/hr	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 75E-04	4 67E-05	5 47E-04	5 62E-06	5 48E-06	5 48E-06		4 78E-04	4 78E-04	2 47E-05	7 96E-09	2 47E-05	2 48E-05	2 484E-05	5 66E-04			
Total Cs^+	lb/hr	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 32E-02	6 20E-03	7 27E-02	7 47E-04	7 28E-04	7 28E-04		6 36E-02	6 36E-02	3 28E-03	1 06E-06	3 28E-03	3 30E-03	3 30E-03	7 52E-02			
Total Cs-137	lb/hr	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 42E-02	1 40E-03	1 63E-02	1 68E-04	1 64E-04	1 64E-04		1 43E-02	1 43E-02	7 38E-04	2 38E-07	7 38E-04	7 43E-04	7 43E-04	1 69E-02			
Vessel Information																								
Operating Volume	gal	7200	7200	7200	7195	7195	7195	NA	NA	NA	6790	6790	6265	NA	NA	NA	NA	237	237	237	NA	4753	4753	4753
Cycle time	hrs	14 1	14 1	14 1	14 1	14 1	14 1	NA	NA	NA	11 7	11 7	183 2	NA	NA	NA	NA	recycled	recycled	recycled	NA	139 0	139 0	139 0
batch/cont		batch	batch	batch	batch	batch	cont	cont	cont	cont	batch	batch	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont	cont
Na	lbmol/hr	2 38E+01	2 38E+01	2 38E+01	2 38E+01	2 38E+01	2 38E+01	7 14E-03	2 39E+01	2 39E+01	2 39E+01	2 39E+01	7 14E-03				7 09E-03							
BO3	lbmol/hr								8 23E-06	8 23E-06	8 23E-06	8 23E-06				8 23E-06	8 23E-06					2 85E-03	2 85E-03	2 85E-03

		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
Radiological Summary	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1	Feed to SSRT 2	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Cs-137	Ci/gal	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 10E+00	1 61E+00	1 19E+00	1 22E-02	1 12E-02	1 12E-02		4 45E+00	4 45E+00	2 30E-01	2 76E-04	2 29E-01	2 30E-01	2 30E-01	5 27E+00			
Ba-137m	Ci/gal	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 04E+00	1 52E+00	1 12E+00	1 15E-02	1 06E-02	1 06E-02		4 21E+00	4 21E+00	2 18E-01	2 61E-04	2 16E-01	2 18E-01	2 18E-01	4 99E+00			
H-3	Ci/gal	3 96E-04	3 96E-04	3 96E-04	3 96E-04	3 96E-04	3 96E-04		3 96E-04	3 96E-04	3 96E-04	3 96E-04												
C-14	Ci/gal	1 03E-05	1 03E-05	1 03E-05	1 03E-05	1 03E-05	1 03E-05		1 03E-05	1 03E-05	1 03E-05	1 03E-05												
Co-60	Ci/gal	1 02E-05	1 02E-05	1 02E-05	1 02E-05	1 02E-05	1 02E-05		1 02E-05	1 02E-05	1 02E-05	1 02E-05												
Ni-59	Ci/gal	3 11E-08	3 11E-08	3 11E-08	3 11E-08	3 11E-08	3 11E-08		3 11E-08	3 11E-08	3 11E-08	3 11E-08												
Ni-63	Ci/gal	1 20E-05	1 20E-05	1 20E-05	1 20E-05	1 20E-05	1 20E-05		1 20E-05	1 20E-05	1 20E-05	1 20E-05												
Se-79	Ci/gal	5 94E-07	5 94E-07	5 94E-07	5 94E-07	5 94E-07	5 94E-07		5 94E-07	5 94E-07	5 94E-07	5 94E-07												
Sr-90	Ci/gal	8 13E-04	8 13E-04	8 13E-04	8 13E-04	8 13E-04	8 13E-04		8 13E-04	8 13E-04	8 13E-04	8 13E-04												
Y-90	Ci/gal	9 06E-04	9 06E-04	9 06E-04	9 06E-04	9 06E-04	9 06E-04		9 06E-04	9 06E-04	9 06E-04	9 06E-04												
Nb-94	Ci/gal	5 62E-11	5 62E-11	5 62E-11	5 62E-11	5 62E-11	5 62E-11		5 62E-11	5 62E-11	5 62E-11	5 62E-11												
Tc-99	Ci/gal	2 19E-04	2 19E-04	2 19E-04	2 19E-04	2 19E-04	2 19E-04		2 19E-04	2 19E-04	2 19E-04	2 19E-04												
Sb-125	Ci/gal	5 53E-05	5 53E-05	5 53E-05	5 53E-05	5 53E-05	5 53E-05		5 53E-05	5 53E-05	5 53E-05	5 53E-05												
Sn-126	Ci/gal	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06		2 98E-06	2 98E-06	2 98E-06	2 98E-06												
I-129	Ci/gal	1 10E-07	1 10E-07	1 10E-07	1 10E-07	1 10E-07	1 10E-07		1 10E-07	1 10E-07	1 10E-07	1 10E-07												
Cs-134	Ci/gal	1 21E-03	1 21E-03	1 21E-03	1 21E-03	1 21E-03	1 21E-03		1 21E-03	1 21E-03	1 21E-03	1 21E-03												
Cs-135	Ci/gal	2 38E-06	2 38E-06	2 38E-06	2 38E-06	2 38E-06	2 38E-06		2 38E-06	2 38E-06	2 38E-06	2 38E-06												
Pm-147	Ci/gal	6 35E-05	6 35E-05	6 35E-05	6 35E-05	6 35E-05	6 35E-05		6 35E-05	6 35E-05	6 35E-05	6 35E-05												
Eu-154	Ci/gal	1 95E-05	1 95E-05	1 95E-05	1 95E-05	1 95E-05	1 95E-05		1 95E-05	1 95E-05	1 95E-05	1 95E-05												
Th-232	Ci/gal	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13		4 61E-13	4 61E-13	4 61E-13	4 61E-13												
U-232	Ci/gal	4 91E-10	4 91E-10	4 91E-10	4 91E-10	4 91E-10	4 91E-10		4 91E-10	4 91E-10	4 91E-10	4 91E-10												
U-233	Ci/gal	1 22E-08	1 22E-08	1 22E-08	1 22E-08	1 22E-08	1 22E-08		1 22E-08	1 22E-08	1 22E-08	1 22E-08												
U-234	Ci/gal	1 51E-07	1 51E-07	1 51E-07	1 51E-07	1 51E-07	1 51E-07		1 51E-07	1 51E-07	1 51E-07	1 51E-07												
U-235	Ci/gal	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09		2 27E-09	2 27E-09	2 27E-09	2 27E-09												
U-236	Ci/gal	2 87E-08	2 87E-08	2 87E-08	2 87E-08	2 87E-08	2 87E-08		2 87E-08	2 87E-08	2 87E-08	2 87E-08												
U-238	Ci/gal	1 71E-07	1 71E-07	1 71E-07	1 71E-07	1 71E-07	1 71E-07		1 71E-07	1 71E-07	1 71E-07	1 71E-07												
Np-237	Ci/gal	5 89E-08	5 89E-08	5 89E-08	5 89E-08	5 89E-08	5 89E-08		5 89E-08	5 89E-08	5 89E-08	5 89E-08												
Pu-238	Ci/gal	5 41E-04	5 41E-04	5 41E-04	5 41E-04	5 41E-04	5 41E-04		5 41E-04	5 41E-04	5 41E-04	5 41E-04												
Pu-239	Ci/gal	2 16E-05	2 16E-05	2 16E-05	2 16E-05	2 16E-05	2 16E-05		2 16E-05	2 16E-05	2 16E-05	2 16E-05												
Pu-240	Ci/gal	4 83E-06	4 83E-06	4 83E-06	4 83E-06	4 83E-06	4 83E-06		4 83E-06	4 83E-06	4 83E-06	4 83E-06												
Pu-241	Ci/gal	4 44E-04	4 44E-04	4 44E-04	4 44E-04	4 44E-04	4 44E-04		4 44E-04	4 44E-04	4 44E-04	4 44E-04												
Pu-242	Ci/gal	2 52E-08	2 52E-08	2 52E-08	2 52E-08	2 52E-08	2 52E-08		2 52E-08	2 52E-08	2 52E-08	2 52E-08												
Am-241	Ci/gal	1 92E-06	1 92E-06	1 92E-06	1 92E-06	1 92E-06	1 92E-06		1 92E-06	1 92E-06	1 92E-06	1 92E-06												
Am-242m	Ci/gal	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09	2 27E-09		2 27E-09	2 27E-09	2 27E-09	2 27E-09												
Cm-244	Ci/gal	5 50E-07	5 50E-07	5 50E-07	5 50E-07	5 50E-07	5 50E-07		5 50E-07	5 50E-07	5 50E-07	5 50E-07												
Cm-245	Ci/gal	2 88E-10	2 88E-10	2 88E-10	2 88E-10	2 88E-10	2 88E-10		2 88E-10	2 88E-10	2 88E-10	2 88E-10												
Na-22	Ci/gal	7 50E-05	7 50E-05	7 50E-05	7 50E-05	7 50E-05	7 50E-05		7 50E-05	7 50E-05	7 50E-05	7 50E-05												
Al-26	Ci/gal	3 01E-07	3 01E-07	3 01E-07	3 01E-07	3 01E-07	3 01E-07		3 01E-07	3 01E-07	3 01E-07	3 01E-07												
Sb-126	Ci/gal	4 18E-07	4 18E-07	4 18E-07	4 18E-07	4 18E-07	4 18E-07		4 18E-07	4 18E-07	4 18E-07	4 18E-07												
Sb-126m	Ci/gal	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06	2 98E-06		2 98E-06	2 98E-06	2 98E-06	2 98E-06												
Sm-151	Ci/gal	5 29E-05	5 29E-05	5 29E-05	5 29E-05	5 29E-05	5 29E-05		5 29E-05	5 29E-05	5 29E-05	5 29E-05												
Eu-152	Ci/gal	2 56E-07	2 56E-07	2 56E-07	2 56E-07	2 56E-07	2 56E-07		2 56E-07	2 56E-07	2 56E-07	2 56E-07												
Eu-155	Ci/gal	2 99E-06	2 99E-06	2 99E-06	2 99E-06	2 99E-06	2 99E-06		2 99E-06	2 99E-06	2 99E-06	2 99E-06												
Ra-226	Ci/gal	2 12E-09	2 12E-09	2 12E-09	2 12E-09	2 12E-09	2 12E-09		2 12E-09	2 12E-09	2 12E-09	2 12E-09												
Ra-228	Ci/gal	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13	4 61E-13		4 61E-13	4 61E-13	4 61E-13	4 61E-13												
Ac-227	Ci/gal	6 15E-13	6 15E-13	6 15E-13	6 15E-13	6 15E-13	6 15E-13		6 15E-13	6 15E-13	6 15E-13	6 15E-13												
Th-229	Ci/gal	4 13E-11	4 13E-11	4 13E-11	4 13E-11	4 13E-11	4 13E-11		4 13E-11	4 13E-11	4 13E-11	4 13E-11												
Th-230	Ci/gal	2 47E-10	2 47E-10	2 47E-10	2 47E-10	2 47E-10	2 47E-10		2 47E-10	2 47E-10	2 47E-10	2 47E-10												
Pa-231	Ci/gal	1 71E-12	1 71E-12	1 71E-12	1 71E-12	1 71E-12	1 71E-12		1 71E-12	1 71E-12	1 71E-12	1 71E-12												
Pu-244	Ci/gal	1 15E-10	1 15E-10	1 15E-10	1 15E-10	1 15E-10	1 15E-10		1 15E-10	1 15E-10	1 15E-10	1 15E-10												
Am-243	Ci/gal	7 63E-10	7 63E-10	7 63E-10	7 63E-10	7 63E-10	7 63E-10		7 63E-10	7 63E-10	7 63E-10	7 63E-10												
Cm-242	Ci/gal	1 04E-09	1 04E-09	1 04E-09	1 04E-09	1 04E-09	1 04E-09		1 04E-09	1 04E-09	1 04E-09	1 04E-09												
Cm-243	Ci/gal	6 15E-10	6 15E-10	6 15E-10	6 15E-10	6 15E-10	6 15E-10		6 15E-10	6 15E-10	6 15E-10	6 15E-10												
Cm-247	Ci/gal	2 02E-10	2 02E-10	2 02E-10	2 02E-10	2 02E-10	2 02E-10		2 02E-10	2 02E-10	2 02E-10	2 02E-10												
Cm-248	Ci/gal	8 84E-20	8 84E-20	8 84E-20	8 84E-20	8 84E-20	8 84E-20		8 84E-20	8 84E-20	8 84E-20	8 84E-20												
Bk-249	Ci/gal	7 34E-27	7 34E-27	7 34E-27	7 34E-27	7 34E-27	7 34E-27		7 34E-27	7 34E-27	7 34E-27	7 34E-27												
Cf-249	Ci/gal	3 85E-10	3 85E-10	3 85E-10	3 85E-10	3 85E-10	3 85E-10		3 85E-10	3 85E-10	3 85E-10	3 85E-10												
Cf-251	Ci/gal	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10		4 56E-10	4 56E-10	4 56E-10	4 56E-10												
Cf-252	Ci/gal	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10	4 56E-10		4 56E-10	4 56E-10	4 56E-10	4 56E-10												

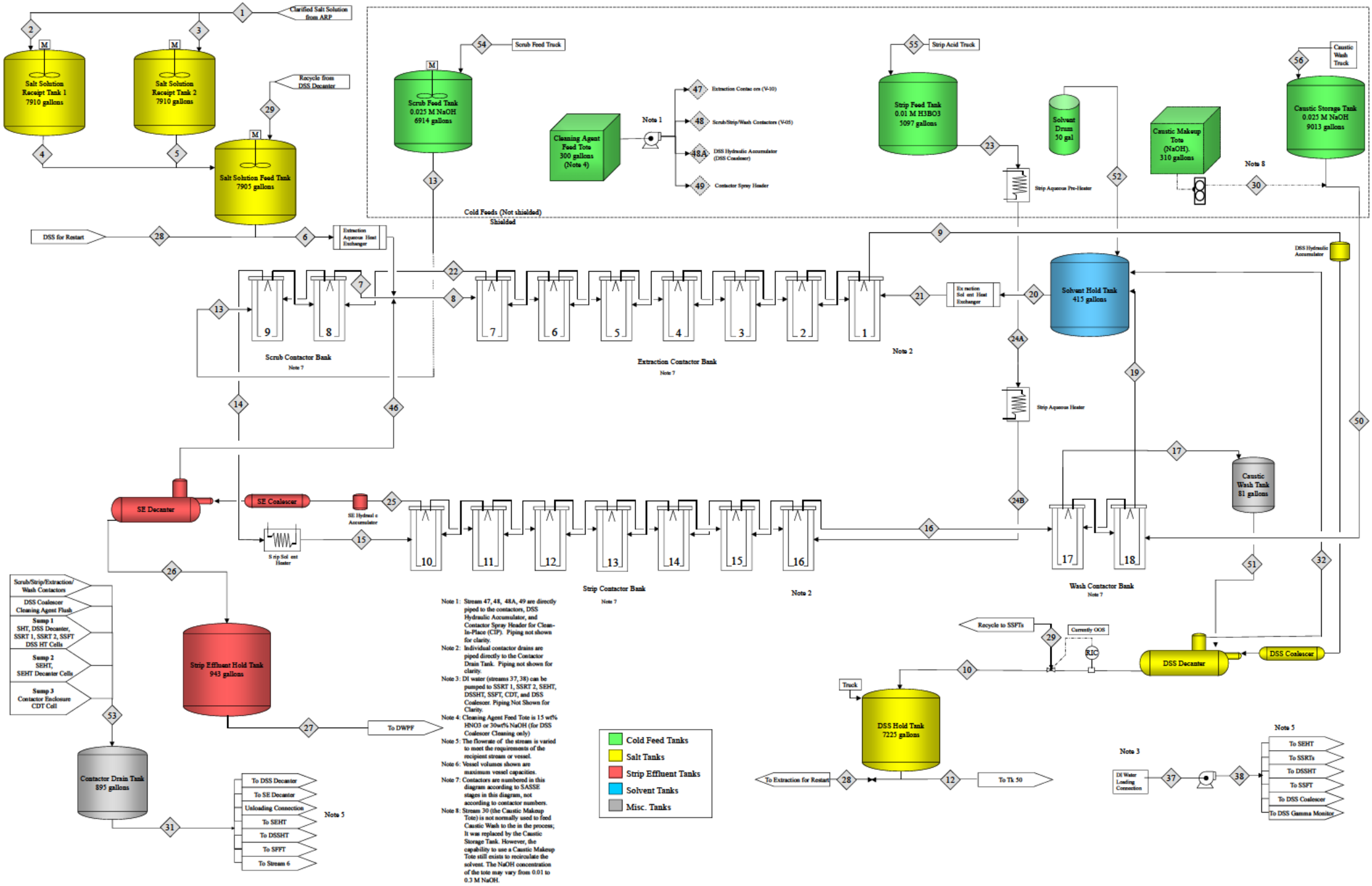
		1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24A	24B
Additional Soluble Chemicals	Units	Clarified Salt Soln from 512-S	Feed to SSRT 1	Feed to SSRT 2	Salt Soln from SSRT 1	Salt Soln from SSRT 2	Salt Soln to CSSX	Scrub to Extract	Extract Feed	Extract to DSS Coalescer	DSS to Hold Tank	DSS to Tank 50	Scrub Feed	Solvent to Strip Heater	Solvent to Strip	Solvent to Wash	Caustic Wash to DSS Decanter	Solvent to SHT	Solvent to Extract Solvent Heat Exchanger	Solvent to Extract	Solvent to Scrub	Strip Feed to Pre-Heater	Strip Feed to Heater	Strip Feed
Sr(NO3)2	lb/hr	4 05E-06	4 05E-06	4 05E-06	4 05E-06	4 05E-06	4 05E-06		4 05E-06	4 05E-06	4 05E-06	4 05E-06												
Na2CO3	lb/hr	8 31E+01	8 31E+01	8 31E+01	8 31E+01	8 31E+01	8 31E+01		8 31E+01	8 31E+01	8 31E+01	8 31E+01												
Na3PO4	lb/hr	1 68E+00	1 68E+00	1 68E+00	1 68E+00	1 68E+00	1 68E+00		1 68E+00	1 68E+00	1 68E+00	1 68E+00												
NaHgOOH	lb/hr	7 47E-03	7 47E-03	7 47E-03	7 47E-03	7 47E-03	7 47E-03		7 47E-03	7 47E-03	7 47E-03	7 47E-03												
AgNO3	lb/hr	8 51E-05	8 51E-05	8 51E-05	8 51E-05	8 51E-05	8 51E-05		8 51E-05	8 51E-05	8 51E-05	8 51E-05												
NaAs(OH)4	lb/hr	3 47E-02	3 47E-02	3 47E-02	3 47E-02	3 47E-02	3 47E-02		3 47E-02	3 47E-02	3 47E-02	3 47E-02												
Ba(NO3)2	lb/hr	4 28E-06	4 28E-06	4 28E-06	4 28E-06	4 28E-06	4 28E-06		4 28E-06	4 28E-06	4 28E-06	4 28E-06												
Ca(NO3)2	lb/hr	2 90E-02	2 90E-02	2 90E-02	2 90E-02	2 90E-02	2 90E-02		2 90E-02	2 90E-02	2 90E-02	2 90E-02												
Cd(NO3)2	lb/hr	1 46E-03	1 46E-03	1 46E-03	1 46E-03	1 46E-03	1 46E-03		1 46E-03	1 46E-03	1 46E-03	1 46E-03												
NaCl	lb/hr	8 96E+00	8 96E+00	8 96E+00	8 96E+00	8 96E+00	8 96E+00		8 96E+00	8 96E+00	8 96E+00	8 96E+00												
Co(NO3)3	lb/hr	3 61E-04	3 61E-04	3 61E-04	3 61E-04	3 61E-04	3 61E-04		3 61E-04	3 61E-04	3 61E-04	3 61E-04												
Na2CrO4	lb/hr	8 14E-02	8 14E-02	8 14E-02	8 14E-02	8 14E-02	8 14E-02		8 14E-02	8 14E-02	8 14E-02	8 14E-02												
Cu(NO3)2	lb/hr	9 21E-02	9 21E-02	9 21E-02	9 21E-02	9 21E-02	9 21E-02		9 21E-02	9 21E-02	9 21E-02	9 21E-02												
Fe(NO3)3	lb/hr	4 25E-03	4 25E-03	4 25E-03	4 25E-03	4 25E-03	4 25E-03		4 25E-03	4 25E-03	4 25E-03	4 25E-03												
NaF	lb/hr	1 04E+01	1 04E+01	1 04E+01	1 04E+01	1 04E+01	1 04E+01		1 04E+01	1 04E+01	1 04E+01	1 04E+01												
Mg(NO3)2	lb/hr	1 72E-05	1 72E-05	1 72E-05	1 72E-05	1 72E-05	1 72E-05		1 72E-05	1 72E-05	1 72E-05	1 72E-05												
Mn(NO3)4	lb/hr	2 51E-04	2 51E-04	2 51E-04	2 51E-04	2 51E-04	2 51E-04		2 51E-04	2 51E-04	2 51E-04	2 51E-04												
Nd(NO3)3	lb/hr	8 66E-04	8 66E-04	8 66E-04	8 66E-04	8 66E-04	8 66E-04		8 66E-04	8 66E-04	8 66E-04	8 66E-04												
Ni(NO3)2	lb/hr	6 36E-04	6 36E-04	6 36E-04	6 36E-04	6 36E-04	6 36E-04		6 36E-04	6 36E-04	6 36E-04	6 36E-04												
Pb(NO3)2	lb/hr	8 36E-04	8 36E-04	8 36E-04	8 36E-04	8 36E-04	8 36E-04		8 36E-04	8 36E-04	8 36E-04	8 36E-04												
Ru(NO3)4	lb/hr	1 84E-02	1 84E-02	1 84E-02	1 84E-02	1 84E-02	1 84E-02		1 84E-02	1 84E-02	1 84E-02	1 84E-02												
Na2SeO4	lb/hr	8 70E-02	8 70E-02	8 70E-02	8 70E-02	8 70E-02	8 70E-02		8 70E-02	8 70E-02	8 70E-02	8 70E-02												
Na2SiO3	lb/hr	2 58E-02	2 58E-02	2 58E-02	2 58E-02	2 58E-02	2 58E-02		2 58E-02	2 58E-02	2 58E-02	2 58E-02												
NaZn(OH)3	lb/hr	8 51E-02	8 51E-02	8 51E-02	8 51E-02	8 51E-02	8 51E-02		8 51E-02	8 51E-02	8 51E-02	8 51E-02												
Zr(O)(NO3)2	lb/hr	3 65E-03	3 65E-03	3 65E-03	3 65E-03	3 65E-03	3 65E-03		3 65E-03	3 65E-03	3 65E-03	3 65E-03												

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction **Note: This stream is treated as continuous to facilitate the material balance However, the SED organic boot pumps over as a batch Gamma Activity in this stream is set equal to residual in the solvent This stream is expected to be 0 23 Ci/gal	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent *Note: This stream is treated as continuous makeup for solvent losses However, fresh solvent is added to the system via drum as needed	Influents to CDT	Scrub to Feed Tank *Note: The design flowrate depends on the pump provided by the truck	Strip to Feed Tank *Note: The design flowrate depends on the pump provided by the truck	Caustic Wash to CST *Note: The design flowrate depends on the pump provided by the truck
Mass Rate	lb/hr	2 86E+02	2 86E+02	2 86E+02	Not Normally Used (NNU)	Upset Only	NNU	NNU	5 49E+00	NNU	NNU	2 87E-01	NNU	NNU	NNU	NNU	2 85E+02	2 85E+02	3 94E-01	NNU	2 87E+02	2 86E+02	2 85E+02
Volumetric Rate	gpm	0 57	0 57	0 57					0 013			0 001					0 57	0 57	0 001		0 57	0 57	0 57
Gamma Activity	Ci/gal	1 73E+01	1 65E+01	1 65E+01					2 35E-01			**						2 76E-04					
Conc [Na^+]	M																0 025	0 025			0 025		0 025
Conc [BO_3^-]	M	9 96E-03	9 94E-03	9 94E-03								2 41E-02						2 90E-05				0 01	
OH^- Mass Rate	lb/hr								2 65E-06								1 21E-01	1 21E-01			1 21E-01		1 21E-01
BO_3^- Mass Rate	lb/hr	1 67E-01	1 67E-01	1 67E-01								4 84E-04						4 84E-04				1 68E-01	
density	lb/gal	8 36	8 36	8 36					6 99			6 99					8 38	8 39	6 99		8 38	8 36	8 38
Design Flow Rate	gpm	0 57	10	14	8 5	15	1	20	0 50	33	33	0 50	27 75	17	9	28 50	0 57	0 57	5				
Temperature	° C	33	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient
Major Components																							
water	lb/hr	2 86E+02	2 86E+02	2 86E+02													2 85E+02	2 85E+02			2 86E+02	2 86E+02	2 85E+02
NaOH	lb/hr																2 84E-01	2 84E-01			2 85E-01		2 84E-01
NaNO2	lb/hr																						
NaNO3	lb/hr																						
KNO3	lb/hr																						
CsOH	lb/hr								2 34E-05									1 19E-06					
H3BO3	lb/hr																					1 76E-01	
Cs3BO3	lb/hr	7 67E-02	7 29E-02	7 29E-02								3 77E-03											
Na2C2O4	lb/hr																						
Na2SO4	lb/hr																						
NaAl(OH)4	lb/hr																						
Σ misc Na Salts	lb/hr																						
Solvent Components																							
Isopar L	lb/hr	2 11E-01	2 11E-03	2 11E-03					4 05E+00			2 09E-01						2 11E-01	2 91E-01				
Cs-7SB	lb/hr	5 77E-02	5 77E-04	5 77E-04					1 11E+00			5 71E-02						5 77E-02	7 96E-02				
MaxCalix	lb/hr	1 51E-02	1 52E-04	1 52E-04					2 91E-01			1 50E-02						1 51E-02	2 09E-02				
TiDG	lb/hr	5 28E-04	5 29E-06	5 29E-06					1 01E-02			5 23E-04						5 28E-04	7 28E-04				
BOBCalix	lb/hr	1 37E-03	1 37E-05	1 37E-05					2 63E-02			1 36E-03						1 37E-03	1 89E-03				
TOA	lb/hr	1 81E-04	1 81E-06	1 81E-06					3 47E-03			1 79E-04						1 81E-04	2 49E-04				
Cesium Balance																							
Total Cs^+	lbmol/hr	5 03E-04	4 78E-04	4 78E-04					1 56E-07			2 47E-05						7 96E-09					
Total Cs^+	lb/hr	6 68E-02	6 36E-02	6 36E-02					2 07E-05			3 28E-03						1 06E-06					
Total Cs-137	lb/hr	1 50E-02	1 43E-02	1 43E-02					4 67E-06			7 38E-04						2 38E-07					
Vessel Information																							
Operating Volume	gal	NA	749	749	NA	NA	310	760	8 8	NA	NA	8 8	310	310		310	7899	NA	50	NA	6265	4753	7899
Cycle time	hrs	NA	21 9	21 9	NA	NA	NA	NA	0 3	NA	NA	0 3	NA	NA	NA	NA	232 3	NA	NA	NA	183 2	139 0	232 3
batch/cont		cont	batch	batch	NA	NA	batch	batch	batch	NA	NA	batch	batch	batch	batch	batch	cont	cont	batch	NA	batch	batch	batch
Na	lbmol/hr																7 09E-03	7 09E-03			7 14E-03		7 09E-03
BO3	lbmol/hr	2 85E-03	2 84E-03	2 84E-03								8 23E-06						8 23E-06				2 85E-03	

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
Radiological Summary	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent	Influents to CDT	Scrub to Feed Tank	Strip to Feed Tank	Wash to CST
Cs-137	Ci/gal	1 73E+01	1 65E+01	1 65E+01					2 35E-01			2 30E-01						2 76E-04					
Ba-137m	Ci/gal	1 64E+01	1 56E+01	1 56E+01					2 22E-01			2 18E-01						2 61E-04					
H-3	Ci/gal																						
C-14	Ci/gal																						
Co-60	Ci/gal																						
Ni-59	Ci/gal																						
Ni-63	Ci/gal																						
Se-79	Ci/gal																						
Sr-90	Ci/gal																						
Y-90	Ci/gal																						
Nb-94	Ci/gal																						
Tc-99	Ci/gal																						
Sb-125	Ci/gal																						
Sn-126	Ci/gal																						
I-129	Ci/gal																						
Cs-134	Ci/gal																						
Cs-135	Ci/gal																						
Pm-147	Ci/gal																						
Eu-154	Ci/gal																						
Th-232	Ci/gal																						
U-232	Ci/gal																						
U-233	Ci/gal																						
U-234	Ci/gal																						
U-235	Ci/gal																						
U-236	Ci/gal																						
U-238	Ci/gal																						
Np-237	Ci/gal																						
Pu-238	Ci/gal																						
Pu-239	Ci/gal																						
Pu-240	Ci/gal																						
Pu-241	Ci/gal																						
Pu-242	Ci/gal																						
Am-241	Ci/gal																						
Am-242m	Ci/gal																						
Cm-244	Ci/gal																						
Cm-245	Ci/gal																						
Na-22	Ci/gal																						
Al-26	Ci/gal																						
Sb-126	Ci/gal																						
Sb-126m	Ci/gal																						
Sm-151	Ci/gal																						
Eu-152	Ci/gal																						
Eu-155	Ci/gal																						
Ra-226	Ci/gal																						
Ra-228	Ci/gal																						
Ac-227	Ci/gal																						
Th-229	Ci/gal																						
Th-230	Ci/gal																						
Pa-231	Ci/gal																						
Pu-244	Ci/gal																						
Am-243	Ci/gal																						
Cm-242	Ci/gal																						
Cm-243	Ci/gal																						
Cm-247	Ci/gal																						
Cm-248	Ci/gal																						
Bk-249	Ci/gal																						
Cf-249	Ci/gal																						
Cf-251	Ci/gal																						
Cf-252	Ci/gal																						

		25	26	27	28	29	30	31	32	37	38	46	47	48	48A	49	50	51	52	53	54	55	56
Additional Soluble Chemicals	Units	Strip to Coalescer	Strip Eff to SEHT	Strip Eff to DWPF	DSS for Startup	DSS Recycle	Caustic Makeup Tote	CDT Rework	Recovered Solvent to SHT	DI water to Pump	DI water to Process	Recovered Solvent to Extraction	CIP flush (per batch) Exctraction	CIP flush (per batch) Scrub/ Strip/ Wash Contactors	CIP flush (per batch) Hydraulic Accumulator	CIP flush (per batch) Contactor Spray Header	Caustic Wash Feed	Spent Caustic Wash	Fresh Solvent	Influents to CDT	Scrub to Feed Tank	Strip to Feed Tank	Wash to CST
Sr(NO3)2	lb/hr																						
Na2CO3	lb/hr																						
Na3PO4	lb/hr																						
NaHgOOH	lb/hr																						
AgNO3	lb/hr																						
NaAs(OH)4	lb/hr																						
Ba(NO3)2	lb/hr																						
Ca(NO3)2	lb/hr																						
Cd(NO3)2	lb/hr																						
NaCl	lb/hr																						
Co(NO3)3	lb/hr																						
Na2CrO4	lb/hr																						
Cu(NO3)2	lb/hr																						
Fe(NO3)3	lb/hr																						
NaF	lb/hr																						
Mg(NO3)2	lb/hr																						
Mn(NO3)4	lb/hr																						
Nd(NO3)3	lb/hr																						
Ni(NO3)2	lb/hr																						
Pb(NO3)2	lb/hr																						
Ru(NO3)4	lb/hr																						
Na2SeO4	lb/hr																						
Na2SiO3	lb/hr																						
NaZn(OH)3	lb/hr																						
Zr(O)(NO3)2	lb/hr																						

Attachment C - MCU Flow Diagram



Formula Names

Name	Definition/Description	Calculation Location
BOB	BOBCalix Concentration (M) [Blended Solvent Case]	Feed Sheet [Blended Solvent Case]
BOB_wtper	BOB wt.% in solvent [Blended Solvent Case]	Calculated in Feed Sheet [Blended Solvent Case]
CF	Concentration Factor	Feed Sheet – Value of 15
Cs	Total Cesium (lbmol/hr)	Row 36 on Calc Sheet
Cs_Carryover	Residual Cs-137 in solvent	Calc!$A$5 – Value of 0.23 Ci/gal
CsDF	Cs DF	Feed Sheet – Value of 100
EOA	Extract Organic to Aqueous ratio (V-10)	Feed Sheet – Value of 0.25
EXTcarryover	Solvent Extraction (V-10) Carryover	Calculated in Feed Sheet
EXTentrainment	DSS [Extraction (V-10)] Entrainment Post Decanter	Calculated in Feed Sheet
EXTentrainmentPPM	DSS Decanter Solvent Entrainment (ppm)	Feed Sheet – Value of 70
Feed	Stream Component Concentrations (M)	Calculated in Feed Sheet Column D
Final	Final Na concentration (M)	Calculated in Feed Sheet
gpm	Stream Volumetric Flow Rate - Gallons per minute	Calc Row 4
Isopar_wtper	Isopar wt.% in solvent	Calculated in Feed Sheet
Max	MaxCalix Concentration (M)	Feed Sheet
Max_wtper	MaxCalix wt.% in solvent	Calculated in Feed Sheet
Modifier	Cs7SB concentration in solvent (M)	Feed Sheet
Modifier_wtper	Cs7SB wt.% in solvent	Calculated in Feed Sheet
MW	Species Molecular weight	Calc Column A
Na	Sodium molar rate (lbmol/hr)	Calc Row 43
pph	Stream mass flow rate (lb/hr)	Calc Row 3
SEentrainmentPPM	SE Decanter Solvent Entrainment (ppm)	Feed Sheet – Value of 70
SG	Stream Density (lb/gal)	Row 13 in Calc Sheet
SOA	Scrub/Strip/Wash Organic to Aqueous (V-05)	Feed Sheet – Value of 3.75
solvDF	Solvent DF	Feed Sheet – Value of 100
solvSG	Solvent Density (lb/gal)	Feed Sheet – Value of 6.99
SSWcarryover	V-05 Solvent Carryover (Strip, Scrub, Wash)	Calculated in Feed Sheet
SSWentrainment	SE V-05 Entrainment Strip Effluent - Post Decanter	Calculated in Feed Sheet
str1		Calc Column D
str10		Calc Column M
str12		Calc Column N
str13		Calc Column O
str14		Calc Column P
str15		Calc Column Q
str16		Calc Column R
str17		Calc Column S
str19		Calc Column T
str2		Calc Column E
str20		Calc Column V

Name	Definition/Description	Calculation Location
str21		Calc Column W
str22		Calc Column X
str23		Calc Column Y
str24A		Calc Column Z
str24B		Calc Column AA
str25		Calc Column AA
str26		Calc Column AB
str27		Calc Column AC
str28		Calc Column AD
str29		Calc Column AE
str3		Calc Column F
str30		Calc Column AG
str31		Calc Column AH
str32		Calc Column AI
str37		Calc Column AK
str38		Calc Column AL
str4		Calc Column G
str46		Calc Column AM
str47		Calc Column AO
str48		Calc Column AP
str48A		Calc Column AQ
str49		Calc Column AR
str5		Calc Column H
str50		Calc Column AS
str51		Calc Column AT
str52		Calc Column AU
str53		Calc Column AV
str54		Calc Column AW
str55		Calc Column AX
str56		Calc Column AY
str6		Calc Column I
str7		Calc Column J
str8		Calc Column K
str9		Calc Column L
Target	Na Aqueous Feed Concentration (M)	Feed Sheet – Value of 5.6
TiDG	TiDG Concentration (M)	Feed Sheet
TiDG_wtper	TiDG wt.% in solvent	Calculated in Feed Sheet
TOA	TOA Concentration (M) [Blended Solvent Case]	Feed Sheet [Blended Solvent Case]
TOA_wtper	TOA wt.% in solvent [Blended Solvent Case]	Calculated in Feed Sheet [Blended Solvent Case]

Equations Used In NGS Only and Blended Solvent Case Calculations

A. **Stream Composition**:

Major Components:
Water, NaOH, $NaNO_2$, $NaNO_3$, KNO_3, CsOH, H_3BO_3, Cs_3BO_3, $Na_2C_2O_4$, Na_2SO_4, $NaAl(OH)_4$

Additional Soluble Chemicals:
$Sr(NO_3)_2$, Na_2CO_3, Na_3PO_4, NaHgOOH , $AgNO_3$, $NaAs(OH)_4$, $Ba(NO_3)_2$, $Ca(NO_3)_2$, $Cd(NO_3)_2$, NaCl, $Co(NO_3)_3$, Na_2CrO_4, $Cu(NO_3)_2$, $Fe(NO_3)_3$, NaF, $Mg(NO_3)_2$, $Mn(NO_3)_4$, $Nd(NO_3)_3$, $Ni(NO_3)_2$, $Pb(NO_3)_2$, $Ru(NO_3)_4$, Na_2SeO_4, Na_2SiO_3, $NaZn(OH)_3$, $Zr(O)(NO_3)_2$

Solvent:
Isopar L, Cs-7SB, MaxCalix, TiDG (Pure NGS)

Isopar L, Cs-7SB, MaxCalix, TiDG, BOBCalix, TOA (Blended solvent)

B. Stream Mass Rate

Equation 1 – Mass Rate

$$Stream\ Mass\ \ Rate\ (lb/hr) = \sum Major\ Component\ Mass\ Rate + \sum Solvent\ Mass\ Rate + \sum Additional\ Soluble\ Chemicals\ Mass\ Rate$$

Equation 2 – Mass Rate (accounts for free borate anion in stream)

$$Stream\ Mass\ \ Rate\ (lb/hr) = \sum Major\ Component\ Mass\ Rate + \sum Solvent\ Mass\ Rate + \sum Additional\ Soluble\ Chemicals\ Mass\ Rate + Borate\ Anion\ Mass\ Rate$$

Equation 3 – Mass Rate

$$Stream\ Mass\ Rate\ (lb/hr) = Density\ \left(\frac{lb}{gal}\right) * Volumetric\ rate\ \left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right)$$

Equation 4 – Mass Rate

$$Stream\ Mass\ \ Rate\ (lb/hr) = \sum Major\ Component\ Mass\ Rate + \sum Solvent\ Mass\ Rate + \sum Additional\ Soluble\ Chemicals\ Mass\ Rate + \left(BO_3\frac{lbmol}{hr} - \left(Cs_3BO_3\frac{lb}{hr}\right) \div \left(Cs_3BO_3\ MW\ \frac{lbmol}{lb}\right)\left(\frac{lbmol\ BO_3}{lbmol\ Cs_3BO_3}\right)\right) * \left(BO_3\ MW\frac{lb}{lbmol}\right)$$

C. Stream Volumetric Rate

Equation 5 – Volumetric Rate

$$Stream\ Volumetric\ Rate\ (gpm) = \frac{Mass\ Flow\ Rate\ (lb/hr)}{Stream\ Density\ (lb/gal)} * \left(\frac{hr}{60\ min}\right)$$

Equation 6 – Stream Volumetric Rate

$$Stream\ Volumetric\ Rate\ (gal/min) = CSS\ Volumetric\ Rate\ \left(\frac{gal}{min}\right) * Extraction\ V\text{-}10\ Organic\ to\ Aqueous\ ratio\ (0.25)$$

Equation 7 – Solvent Volumetric Rate

$$Solvent\ Volumetric\ Rate\ (gal/min) = STR20\ Vol\ rate\ \left(\frac{gal}{min}\right) - EXT_{carryover}\left(\frac{gal}{hr}\right) * \left(\frac{hr}{60\ min}\right)$$

D. Stream Gamma Activity

Equation 8 – Gamma Activity

$$Stream\ Gamma\ Activity\ (Ci/gal) = \left(Cs\ \frac{lbmol}{hr}\right) * \left(132.91\frac{lb\ Cs}{lbmol\ Cs}\right) * \left(453.6\frac{g\ Cs}{lb\ Cs}\right) * \left(0.225\frac{g\ Cs_{137}}{g\ Cs}\right) * \left(87\frac{Ci\ Cs_{137}}{g\ Cs_{137}}\right) * \left(\frac{hr}{60\ min}\right) * \left(\frac{1}{Vol\ flow\ rate\ (gpm)}\right)$$

Equation 9 – Gamma Activity

$$Stream\ Gamma\ Activity\ (Ci/gal) = STR1\left(Cs\ \frac{Ci}{gal}\right) * CF$$

E. Stream Sodium Concentration

Equation 10 – Sodium Concentration

$$Stream\ Na\ Concentration\ (M) = \left(Na\ \frac{lbmol}{hr}\right) * \left(453.6\frac{mol\ Na}{lbmol\ Na}\right) * \left(\frac{hr}{60\ min}\right) * \left(\frac{1}{Vol\ flow\ rate\ (gpm)}\right) * \left(\frac{gal}{3.7854\ l}\right)$$

F. Stream Borate Concentration

Equation 11 – Borate Concentration

$$Stream\ BO_3\ Concentration\ (M) = \left(BO_3\ \frac{lbmol}{hr}\right) * \left(453.6\frac{mol\ BO_3}{lbmol\ BO_3}\right) * \left(\frac{hr}{60\ min}\right) * \left(\frac{1}{Vol\ flow\ rate\ (gpm)}\right) * \left(\frac{gal}{3.7854\ l}\right)$$

G. Stream Hydroxide Mass Rate

Equation 12 – Hydroxide Mass Rate

$$Stream\ Hydroxide\ Mass\ Rate\ (lb/hr) = \frac{\sum OH\ species\ \left(\frac{lb}{hr}\right) * (No.of\ OH\ moles\ in\ molecule) * (Molecular\ Weight\ OH\ \ lb/lbmol)}{Molecular\ Weight\ of\ Molecule\ (lb/lbmol)}$$

OH Species	OH moles per molecule
NaOH	1
CsOH	1
NaHgOOH	1
$NaAs(OH)_4$	4
$NaAl(OH)_4$	4
$NaZn(OH)_3$	3

Equation 13 – Hydroxide Mass Rate

$$OH^- \ Mass\ Rate\ (lb/hr) = [Na^+]\left(\frac{mol}{l}\right)\left(\frac{mol\ OH^-}{mol\ Na^+}\right) * OH^- MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right) * \left(\frac{3.7854\ l}{gal}\right) * Vol\ rate\left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right)$$

Equation 14 – Hydroxide Mass Rate

$$OH\ mass\ rate\ \left(\frac{lb}{hr}\right) = Cs^+ molar\ rate\ \left(\frac{lbmol}{hr}\right) * OH\ MW\left(\frac{lb}{lbmol}\right)$$

H. Stream Borate Mass Rate

Equation 15 – Borate Mass Rate

$$BO_3\ Mass\ Rate\ (lb/hr) = BO_3\left(\frac{lbmol}{hr}\right) * MWBO_3\left(\frac{lb}{lbmol}\right)$$

I. Stream Density

Equation 16 - Density

$$Stream\ Density\ (lb/gal) = \left(\frac{Mass\ Rate\ \ lb/hr}{Volumetric\ Rate\ \ gal/min}\right) * \left(\frac{hr}{60\ min}\right)$$

J. Stream Major Components Mass Rate

Equation 17 – Water Mass Rate

$$Water\ Mass\ Rate = Stream\ Mass\ Rate\ \left(\frac{lb}{hr}\right) - NaOH\ or\ Boric\ Acid\ Mass\ Rate\ \left(\frac{lb}{hr}\right)$$

Equation 18 – Stream 25 Water Mass Rate

This accounts for the water generated in the formation of Cs_3BO_3 in the reaction between solvent entrained cesium hydroxide (CsOH) and the aqueous boric acid (H_3BO_3).

$$Water\ Mass\ Rate\ (lb/hr) = STR24B\ water\ mass\ rate + CsOH\left(\frac{lb}{hr}\right) \div MW\ CsOH\left(\frac{lb\ CsOH}{lbmol\ CsOH}\right)\left(\frac{lbmol\ H_2O}{lbmol\ CsOH}\right) * MW\ H_2O\left(\frac{lb\ H_2O}{lbmol\ H_2O}\right)$$

Equation 19 – CsOH Mass Rate

$$CsOH(lb/hr) = Cs^+\ Molar\ Rate\ \left(\frac{lbmol}{hr}\right) * CsOH\ MW\left(\frac{lb}{lbmol}\right)$$

Equation 20 – NaOH Mass Rate

$$NaOH(lb/hr) = Na^+\ Molar\ Rate\ \left(\frac{lbmol}{hr}\right) * NaOH\ MW\left(\frac{lb}{lbmol}\right)$$

Equation 21 – NaOH Mass Rate

$$NaOH\ Mass\ Rate\ (lb/hr) = [Na^+]\left(\frac{mol}{l}\right)\left(\frac{mol\ NaOH}{mol\ Na^+}\right) * NaOHMW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right) * \left(\frac{3.7854\ l}{gal}\right) * Vol\ rate\left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right)$$

Equation 22 – Cs_3BO_3 mass rate

$$Cs_3BO_3\ mass\ rate\ (lb/hr) = \left(Cs^+\ molar\ rate\ \frac{lbmol}{hr}\right) * \left(\frac{lbmol\ Cs_3BO_3}{3\ lbmol\ Cs^+}\right) * \left(MW\ Cs_3BO_3\ \frac{lb}{lbmol}\right)$$

Equation 23 – Boric Acid Mass Rate

$$H_3BO_3\ Mass\ Rate\ (lb/hr) = [BO_3{}^-]\left(\frac{mol}{l}\right)\left(\frac{mol\ NaOH}{mol\ Na^+}\right) * H_3BO_3MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right) * \left(\frac{3.7854\ l}{gal}\right) * Vol\ rate\left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right)$$

K. <u>Stream Isopar L Mass Rate</u>

Equation 24 – Isopar L Mass Rate

$$Isopar\ L\ (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Isopar_wtper$$

Equation 25 – SE Post Decanter Isopar L Entrainment

$$Isopar\ L\ (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * Isopar_wtper$$

Equation 26 – Extraction V-10 Isopar L Carryover

$$Isopar\ L\ (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Isopar_wtper$$

Equation 27 – DSS Isopar L Entrainment

$$Isopar\ L\ (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * Isopar_wtper$$

Equation 28 – Isopar L Mass Rate

$$Isopar\ L\ (lb/hr) = Stream\ mass\ rate\ \left(\frac{lb}{hr}\right) - Mass\ rate\ major\ components\ \frac{lb}{hr} - \text{Cs-7SB}\frac{lb}{hr} - MaxCalix\frac{lb}{hr} - TiDG\frac{lb}{hr}$$

L. <u>Stream Modifier (Cs-7SB) Mass Rate</u>

Equation 29 – Modifier Mass Rate

$$Cs\text{-}7SB\ (lb/hr) = Modifier\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * SSWcarryover\ \left(\frac{gal}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 30 – Modifier Mass Rate

$$Cs\text{-}7SB\ (lb/hr) = Modifier\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * Vol\ rate\ \left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 31 – Modifier Mass Rate

$$\text{Cs-7SB } (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Modifier_wtper$$

Equation 32 – SE Post Decanter Modifier Entrainment

$$\text{Cs-7SB } (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * Modifier_wtper$$

Equation 33 – Extraction V-10 Modifier Carryover

$$\text{Cs-7SB } (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Modifier_wtper$$

Equation 34 – DSS Modifier Entrainment

$$\text{Cs-7SB } (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * Modifier_wtper$$

M. Stream Extractant (maxCalix) Mass Rate

Equation 35 – Extractant Mass Rate

$$MaxCalix\ (lb/hr) = Max\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * SSWcarryover\ \left(\frac{gal}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 36 – Extractant Mass Rate

$$MaxCalix\ (lb/hr) = Max\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * Vol\ rate\ \left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 37 – Extractant Mass Rate

$$MaxCalix\ (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Max_wtper$$

Equation 38 – SE Post Decanter Extractant Entrainment

$$MaxCalix\ (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * Max_wtper$$

Equation 39 – Extraction V-10 Extractant Carryover

$$MaxCalix\ (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * Max_wtper$$

Equation 40 – DSS Extractant Entrainment

$$MaxCalix\ (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * Max_wtper$$

N. Stream Suppressor (TiDG) Mass Rate

Equation 41 – Suppressor Mass Rate

$$TiDG\ (lb/hr) = TiDG\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * SSWcarryover\ \left(\frac{gal}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 42 – Suppressor Mass Rate

$$TiDG\ (lb/hr) = TiDG\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * Vol\ rate\ \left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 43 – Suppressor Mass Rate

$$TiDG\ (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * TiDG_wtper$$

Equation 44 – SE Post Decanter Suppressor Entrainment

$$TiDG\ (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * TiDG_wtper$$

Equation 45 – Extraction V-10 Suppressor Carryover

$$TiDG\ (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * TiDG_wtper$$

Equation 46 – DSS Suppressor Entrainment

$$TiDG\ (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * TiDG_wtper$$

O. Stream Total Cesium ($Cs^{\pm}$) Molar Rate

Equation 47 – Total Cs^+ Molar Rate

$$Stream\ Cs^+\ Molar\ Rate\ (lbmol/hr) = \frac{CsOH\ \ lb/hr}{Molecular\ Weight\ of\ CsOH\ (lb/lbmol)}$$

Equation 48 – Total Cs^+ Molar Rate

$$Stream\ Cs^+\ Molar\ Rate\ (lbmol/hr) = \frac{Cs^+\ \ lb/hr}{Molecular\ Weight\ of\ Cs\ (lb/lbmol)}$$

Equation 49 – Total Cs^+ Molar Rate

$$STR17\ Cs^+\ molar\ rate = STR16\ Cs^+\ molar\ rate\ \left(\frac{lbmol}{hr}\right) * MaxCalix\ molar\ rate\ ratio\ \frac{STR17}{STR16}$$

Equation 50 – Total Cs^+ Molar Rate

$$Str10\ Cs^+\ Molar\ Rate\ (lbmol/hr) = STR8\ Cs^+\ \frac{lbmol}{hr} \div CsDF + STR51\ Cs^+\frac{lbmol}{hr}$$

Equation 51 – Total Cs^+ Molar Rate

$$\begin{aligned} &Str9\ Cs^+\ Molar\ Rate\ (lbmol/hr) \\ &\quad = STR8\ Cs^+\ \frac{lbmol}{hr} \div CsDF + STR21\ Cs^+\ molar\ rate\ \left(\frac{lbmol}{hr}\right) \\ &\quad * MaxCalix\ molar\ rate\ ratio\ \frac{STR9}{STR21} \end{aligned}$$

P. Stream Total $Cs^{\pm}$ Mass Rate (lb/hr)

Equation 52 – Total Cs^+ Mass Rate

$$Stream\ Total\ Cs^+mass\ rate\ (lb/hr) = Total\ Cs^+molar\ rate\ \left(\frac{lbmol}{hr}\right) * MW\left(\frac{lb}{lbmol}\right)$$

Equation 53 – Total Cs^+ Mass Rate

$$Stream\ Total\ Cs^+mass\ rate\ (lb/hr) = Cs - 137\ mass\ rate\ \left(\frac{lb}{hr}\right) \div 0.225$$

Q. Stream Cs-137 mass rate (lb/hr)

Equation 54 – Cs-137 Mass Rate

$$Cs\text{-}137\ mass\ rate\ (lb/hr) = Total\ Cs^+\ mass\ rate\ \left(\frac{lb}{hr}\right) * Cs\text{-}137\ fraction\ of\ total\ Cs\ (0.225)$$

Equation 55 – Cs-137 Mass Rate

$$Cs\text{-}137\ mass\ rate\ (lb/hr) = Gamma\ Activity\ \left(\frac{Ci}{gal}\right) * Vol\ rate\left(\frac{gal}{min}\right) * \left(\frac{60\ min}{hr}\right) \div \left[\left(\frac{Ci}{g}\right) * \left(\frac{lb}{453.6\ g}\right)\right]$$

R. Stream Cycle Time (Row 41)

Equation 56 – Cycle Time

$$Stream\ Cycle\ Time\ (hr) = \frac{Operating\ Volume\ (gal)}{Volumetric\ Rate\ (gal/min)} * \left(\frac{hr}{60\ min}\right)$$

Equation 57 – Cycle Time

$$Stream\ Cycle\ Time\ (hr) = \frac{Operating\ Volume\ (gal)}{Design\ Flow\ Rate\ (gal/min)} * \left(\frac{hr}{60\ min}\right)$$

S. Stream Na Molar Rate

Equation 58 – Sodium Molar Rate

$$Stream\ Na\ Molar\ Rate\ (lbmol/hr) = \frac{\sum Na\ species\ \left(\frac{lbmol}{hr}\right) * (No.\ of\ Na\ moles\ per\ molecule)}{Molecular\ Weight\ of\ Molecule\ (lb/lbmol)}$$

Na Species	Na atoms per molecule
NaOH	1
$NaNO_2$	1
$NaNO_3$	1
$Na_2C_2O_4$	2
Na_2SO_4	2
NaAl	1
Na_2CO_3	2
Na_3PO_4	3
NaHgOOH	1
$NaAs(OH)_4$	1
NaCl	1
Na_2CrO_4	2
NaF	1
Na_2SeO_4	2
Na_2SiO_3	2
$NaZn(OH)_3$	1

Equation 59 – Na^+ Molar Rate

$$Na^+\ Molar\ Rate\ (lbmol/hr) = [Na^+]\frac{mol}{l} * \left(\frac{3.7854\ l}{gal}\right) * \left(\frac{60\ min}{hr}\right) * Vol\ rate\left(\frac{gal}{min}\right) * \left(\frac{lbmol}{453.6\ mol}\right)$$

Equation 60 –Na^+ Molar Rate

$$Molar\ rate_i\ (lbmol/hr) = \ Mass\ rate_i\ \left(\frac{lb}{hr}\right) \div MW_i\ \left(\frac{lb}{lbmol}\right)$$

T. Stream Borate Molar Rate

Equation 61 – Borate Molar Rate

$$Stream\ BO_3\ Molar\ Rate\ (lbmol/hr) = \frac{H_3BO_3\ lb/hr}{MWof\ H_3BO_3\ (lb/lbmol)} + \frac{Cs_3BO_3\ lb/hr}{MW\ of\ Cs_3BO_3\ (lb/lbmol)}$$

U. Stream Suppressor (TOA) Mass Rate [Only Used in Blended Solvent Case]

Equation 62 – TOA Mass Rate

$$TOA\ (lb/hr) = TOA\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * SSWcarryover\ \left(\frac{gal}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 63 –TOA Mass Rate

$$TOA\ (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * TOA_wtper$$

Equation 64 – SE Post Decanter TOA Entrainment

$$TOA\ (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * TOA_wtper$$

Equation 65 – Extraction V-10 TOA Carryover

$$TOA\ (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * TOA_wtper$$

Equation 66 – DSS TOA Entrainment

$$TOA\ (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * TOA_wtper$$

V. Stream BOBCalix Mass Rate [Only Used in Blended Solvent Case]

Equation 67 – BOBCalix Mass Rate

$$BOBCalix\ (lb/hr) = BOB\ \left(\frac{mol}{l}\right) * \left(3.7854\frac{l}{gal}\right) * SSWcarryover\ \left(\frac{gal}{hr}\right) * MW\left(\frac{g}{mol}\right) * \left(\frac{lb}{453.6\ g}\right)$$

Equation 68 –BOBCalix Mass Rate

$$BOBCalix\ \ (lb/hr) = SSWcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * BOB_wtper$$

Equation 69 – SE Post Decanter BOBCalix Entrainment

$$BOBCalix\ (lb/hr) = SSWentrainment\left(\frac{lb}{hr}\right) * BOB_wtper$$

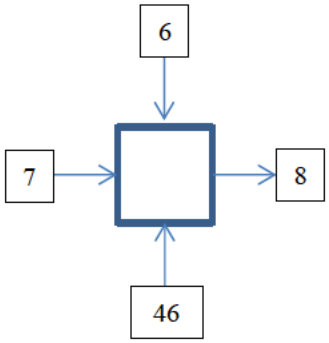
Equation 70 – Extraction V-10 BOBCalix Carryover

$$BOBCalix\ (lb/hr) = EXTcarryover\left(\frac{gal}{hr}\right) * solvSG\ \left(\frac{lb}{gal}\right) * BOB_wtper$$

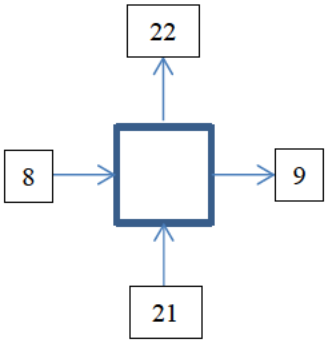
Equation 71 – DSS BOBCalix Entrainment

$$BOBCalix\ \ (lb/hr) = EXTentrainment\left(\frac{lb}{hr}\right) * BOB_wtper$$

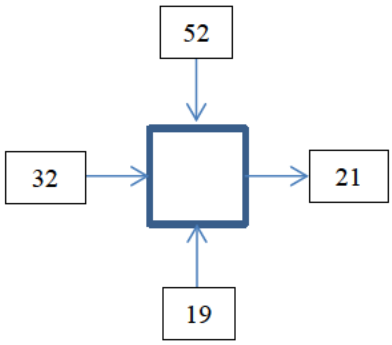
Visual Representation of Material Balance



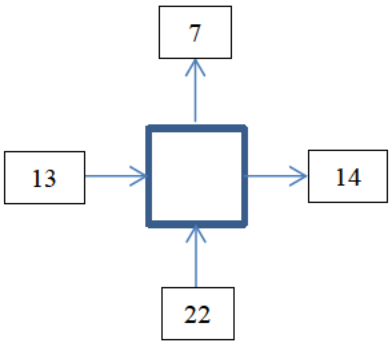
Balance between Extraction and Scrub Bank



Extraction Contactor Bank Balance

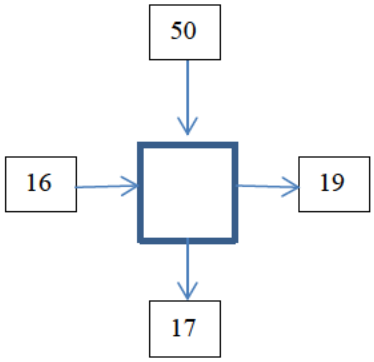


Solvent Hold Tank Balance

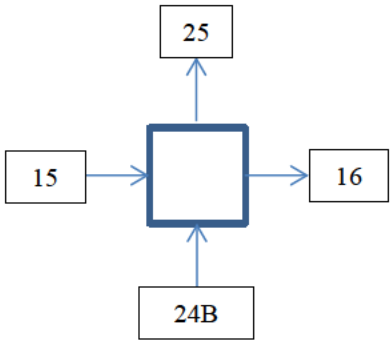


Scrub Contactor Bank Balance

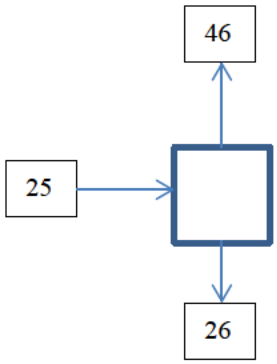
Caustic Wash Tank Balance



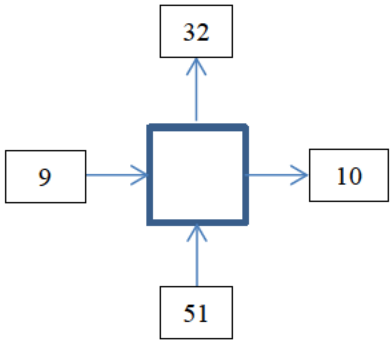
Wash Contactor Bank Balance



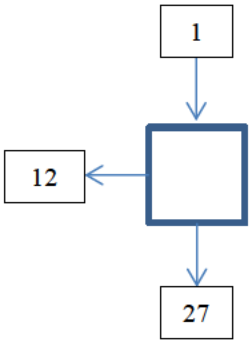
Strip Contactor Bank Balance



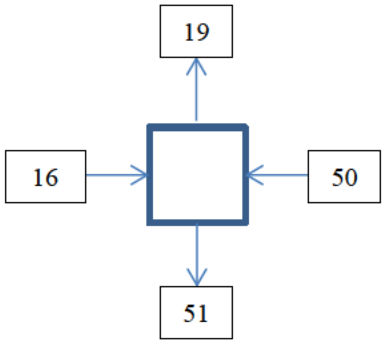
Strip Decanter/Coalescer Balance



DSS Decanter/Coalescer Balance



Overall MCU Balance



Wash Bank/Caustic Wash Tank Balance

Stream Parameter	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5	Stream 6	Stream 7
Mass Rate	Equation 1	STR1	STR1	STR1	STR1	STR1	Equation 1
Volumetric Rate	Equation 5	STR1	STR1	STR1	STR1	STR1	STR13
Gamma Activity	Equation 8	STR1	STR1	STR1	STR1	STR1	Input A-7
$[Na^+]$	Equation 10	STR1	STR1	STR1	STR1	STR1	Input I-5
$[BO_3^-]$	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OH^- Mass Rate	Equation 12	STR1	STR1	STR1	STR1	STR1	Equation 13
BO_3^- Mass Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Density	Input I-12	STR1	STR1	STR1	STR1	STR1	Equation 16
Design Flow Rate	Input (Att. G)	Input (Att. G)	Input (Att. G)	Input (Att. G)	Input (Att. G)	Input I-14	Input I-14
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate	***	STR1	STR1	STR1	STR1	STR1	STR13, Equation 19, Equation 21
Isopar L	N/A	N/A	N/A	N/A	N/A	N/A	Equation 24
Cs-7SB	N/A	N/A	N/A	N/A	N/A	N/A	Equation 29
MaxCalix	N/A	N/A	N/A	N/A	N/A	N/A	Equation 35
TiDG	N/A	N/A	N/A	N/A	N/A	N/A	Equation 41
[Blended Solvent Case] BOBCalix	N/A	N/A	N/A	N/A	N/A	N/A	Equation 67
[Blended Solvent Case] TOA	N/A	N/A	N/A	N/A	N/A	N/A	Equation 62
Total Cs^+ molar rate	Equation 47	STR1	STR1	STR1	STR1	STR1	Equation 48
Total Cs^+ mass rate	Equation 52	STR1	STR1	STR1	STR1	STR1	Equation 53
Total Cs-137 mass rate	Equation 54	STR1	STR1	STR1	STR1	STR1	Equation 55
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	Equation 56	STR1	STR1	Equation 56	Equation 56	Equation 56	N/A
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate	Equation 58	STR1	STR1	STR1	STR1	STR1	Equation 60
BO_3^- Molar Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radiological Summary**	***	STR1	STR1	STR1	STR1	STR1	Input A-7
Additional Soluble Chemicals	***	STR1	STR1	STR1	STR1	STR1	N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.
***Calculated in Feed tab (Attachment E and F) of the Excel spreadsheet.

Stream Parameter	Stream 8	Stream 9	Stream 10	Stream 12	Stream 13	Stream 14	Stream 15
Mass Rate	STR6+STR7+STR46	STR8+STR21-STR22	STR9+STR51-STR32	STR10	Equation 3	Equation 1	STR14
Volumetric Rate	STR6+STR7+STR46	STR8+STR21-STR22	STR9+STR51-STR32	STR10	Input I-4	STR22	STR14
Gamma Activity	Equation 8	Equation 8	Equation 8	STR10	N/A	Equation 8	STR14
$[Na^+]$	Equation 10	Equation 10	Equation 10	STR10	Input I-5	N/A	N/A
$[BO_3^-]$	Equation 11	Equation 11	Equation 11	STR10	N/A	N/A	N/A
Hydroxide Mass Rate	Equation 12	Equation 12	Equation 12	STR10	Equation 12	Equation 14	STR14
BO_3^- Mass Rate	Equation 15	Equation 15	Equation 15	STR10	N/A	N/A	N/A
Density	Equation 16	Equation 16	Equation 16	STR10	Input I-5	Equation 16	STR14
Design Flow Rate	Input I-14	Input I-14	Input Att. G	Input Att. G	Input I-3 & I-4	Input I-14	STR14
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate	STR6+STR7+STR46	Equation 19, STR8+STR21-STR22	STR9+STR51-STR32	STR10	Equation 13,Equation 17	Equation 19	STR14
Isopar L	STR6+STR7+STR46	Equation 26	Equation 27	STR10	N/A	STR13+STR22-STR7	STR14
Cs-7SB	STR6+STR7+STR46	Equation 33	Equation 34	STR10	N/A	STR13+STR22-STR7	STR14
MaxCalix	STR6+STR7+STR46	Equation 39	Equation 40	STR10	N/A	STR13+STR22-STR7	STR14
TiDG	STR6+STR7+STR46	Equation 45	Equation 46	STR10	N/A	STR13+STR22-STR7	STR14
[Blended Solvent Case] BOBCalix	STR6+STR7+STR46	Equation 70	Equation 71	STR10	N/A	STR13+STR22-STR7	STR14
[Blended Solvent Case] TOA	STR6+STR7+STR46	Equation 65	Equation 66	STR10	N/A	STR13+STR22-STR7	STR14
Total Cs^+ molar rate	STR6+STR7+STR46	Equation 51	Equation 50	STR10	N/A	STR25 - STR16	STR14
Total Cs^+ mass rate	STR6+STR7+STR46	Equation 52	Equation 52	STR10	N/A	STR25 - STR16	STR14
Total Cs-137 mass rate	STR6+STR7+STR46	Equation 54	Equation 54	STR10	N/A	STR25 - STR16	STR14
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	N/A	N/A	Equation 56	STR10	Equation 56	N/A	N/A
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate	Equation 58	Equation 58	Equation 58	STR10	Equation 60	N/A	N/A
BO_3^- Molar Rate	Equation 61	Equation 61	Equation 61	STR10	N/A	N/A	N/A
Radiological Summary**	Equation 8, STR6+STR7+STR46	Equation 8, STR8+STR21-STR22	Equation 8, STR9+STR51-STR32	STR10	N/A	Equation 8	STR14
Additional Soluble Chemicals	STR6+STR7+STR46	STR8+STR21-STR22	STR9+STR51-STR32	STR10	N/A	N/A	N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

Stream Parameter	Stream 16	Stream 17	Stream 19	Stream 20	Stream 21	Stream 22
Mass Rate	Equation 1	Equation 2	STR16+STR50-STR17	Equation 3	STR20	Equation 1
Volumetric Rate	STR22	STR50	Equation 5	Equation 6	STR20	Equation 7
Gamma Activity	Input A-7	Equation 8	Equation 8	Equation 8	STR20	Equation 8
$[Na^+]$	N/A	Input I-6	N/A	N/A	N/A	N/A
$[BO_3^-]$	N/A	Equation 11	N/A	N/A	N/A	N/A
Hydroxide Mass Rate	N/A	Equation 12	Equation 12	Equation 12	STR20	Equation 14
BO_3^- Mass Rate	Equation 15	Equation 15	N/A	N/A	N/A	N/A
Density	Equation 16	Equation 16	Input I-18	Input I-18	STR20	Equation 16
Design Flow Rate	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate	Equation 22	STR50,Equation 20, Equation 19	Equation 19	Equation 19	STR20	Equation 19
Isopar L	STR14+STR24B-STR25	Equation 24	STR16+STR50-STR17	Equation 28	STR20	STR20+STR8-STR9
Cs-7SB	STR14+STR24B-STR25	Equation 31	STR16+STR50-STR17	Equation 30	STR20	STR20+STR8-STR9
MaxCalix	STR14+STR24B-STR25	Equation 37	STR16+STR50-STR17	Equation 36	STR20	STR20+STR8-STR9
TiDG	STR14+STR24B-STR25	Equation 43	STR16+STR50-STR17	Equation 42	STR20	STR20+STR8-STR9
[Blended Solvent Case] BOBCalix	STR14+STR24B-STR25	Equation 68	STR16+STR50-STR17	Equation 67	STR20	STR20+STR8-STR9
[Blended Solvent Case] TOA	STR14+STR24B-STR25	Equation 63	STR16+STR50-STR17	Equation 62	STR20	STR20+STR8-STR9
Total Cs^+ molar rate	Equation 48	Equation 49	STR16+STR50-STR17	STR19+STR32+STR52	STR20	STR20+STR8-STR9
Total Cs^+ mass rate	Equation 53	Equation 52	STR16+STR50-STR17	STR19+STR32+STR52	STR20	STR20+STR8-STR9
Total Cs-137 mass rate	Equation 55	Equation 54	STR16+STR50-STR17	STR19+STR32+STR52	STR20	STR20+STR8-STR9
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	N/A	N/A	Input	Input	Input	N/A
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate	N/A	Equation 59	N/A	N/A	N/A	N/A
BO_3^- Molar Rate	Equation 61	STR16	N/A	N/A	N/A	N/A
Radiological Summary**	Input A-7	Equation 8	Equation 8	Equation 8	STR20	Equation 8
Additional Soluble Chemicals	N/A	N/A	N/A	N/A	N/A	N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

Stream Parameter	Stream 23	Stream 24A	Stream 24B	Stream 25	Stream 26	Stream 27	Stream 28[a]
Mass Rate	Equation 3	STR23	STR23	Equation 4	Equation 4	STR26	
Volumetric Rate	Input I-4	STR23	STR23	STR26 + STR46	STR23	STR26	
Gamma Activity	N/A	N/A	N/A	Equation 8	Equation 9	STR26	
$[Na^+]$	N/A	N/A	N/A	N/A	N/A	N/A	
$[BO_3^-]$	Input I-7	STR23	STR23	Equation 11	Equation 11	STR26	
Hydroxide Mass Rate	N/A	N/A	N/A	N/A	N/A	N/A	
BO_3^- Mass Rate	Equation 15	STR23	STR23	Equation 15	Equation 15	STR26	
Density	Input I-7	STR23	STR23	Equation 16	Equation 16	STR26	
Design Flow Rate	Input I-14	Input I-14	Input I-14	Input I-14	Input Att. G	Input Att. G	Input I-14
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate	Equation 17 & Equation 23	STR23	STR23	Equation 18,Equation 22	STR25,Equation 22	STR26	
Isopar L	N/A	N/A	N/A	Equation 24	Equation 25	STR26	
Cs-7SB	N/A	N/A	N/A	Equation 31	Equation 32	STR26	
MaxCalix	N/A	N/A	N/A	Equation 37	Equation 38	STR26	
TiDG	N/A	N/A	N/A	Equation 43	Equation 44	STR26	
[Blended Solvent Case] BOBCalix	N/A	N/A	N/A	Equation 68	Equation 69	STR26	
[Blended Solvent Case] TOA	N/A	N/A	N/A	Equation 63	Equation 64	STR26	
Total Cs^+ molar rate	N/A	N/A	N/A	STR26+ STR46	Equation 48	STR26	
Total Cs^+ mass rate	N/A	N/A	N/A	STR26+ STR46	Equation 53	STR26	
Total Cs-137 mass rate	N/A	N/A	N/A	STR26+ STR46	Equation 55	STR26	
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	Equation 56	STR23	STR23	N/A	Equation 56	STR26	N/A
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate	N/A	N/A	N/A	N/A	N/A	N/A	
BO_3^- Molar Rate	Equation 61	STR23	STR23	STR15-STR16+STR24B	STR25-STR46	STR26	
Radiological Summary**	N/A	N/A	N/A	Equation 8	Equation 8	STR26	
Additional Soluble Chemicals	N/A	N/A	N/A	N/A	N/A	N/A	

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

[a] Stream not normally used.

Stream Parameter	Stream 29[b]	Stream 30	Stream 31[b]	Stream 32	Stream 37[b]	Stream 38[b]	Stream 46
Mass Rate				Equation 1			Equation 1
Volumetric Rate				Equation 5			Equation 5
Gamma Activity				Equation 8			N/A
$[Na^+]$				N/A			N/A
$[BO_3^-]$				N/A			Equation 11
Hydroxide Mass Rate				Equation 12			N/A
BO3- Mass Rate				N/A			Equation 15
Density				Input I-18			Input I-18
Design Flow Rate	Input I-14	Input I-17	Input (Att. G)	Input (Att. G)	Input I-14	Input I-14	Input (Att. G)
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate				Equation 19			Equation 22
Isopar L				STR9+STR51-STR10			STR25-STR26
Cs-7SB				STR9+STR51-STR10			STR25-STR26
MaxCalix				STR9+STR51-STR10			STR25-STR26
TiDG				STR9+STR51-STR10			STR25-STR26
[Blended Solvent Case] BOBCalix				STR9+STR51-STR10			STR25-STR26
[Blended Solvent Case] TOA				STR9+STR51-STR10			STR25-STR26
Total Cs^+ molar rate				STR9+STR51-STR10			STR16
Total Cs^+ mass rate				Equation 52			Equation 52
Total Cs-137 mass rate				Equation 54			Equation 54
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	N/A	N/A	N/A	Equation 57	N/A	N/A	Equation 57
batch/cont	Input I-14	Input I-17	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate				N/A			N/A
BO_3^- Molar Rate				N/A			Equation 61
Radiological Summary**				Equation 8			STR16, Equation 8
Additional Soluble Chemicals				N/A			N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

[b] Upset Only.

Stream Parameter	Stream 47[c]	Stream 48	Stream 48A	Stream 49	Stream 50	Stream 51	Stream 52
Mass Rate					Equation 3	Equation 2	Equation 1
Volumetric Rate					Input I-4	STR17	Equation 5
Gamma Activity					N/A	Equation 8	N/A
$[Na^+]$					Input I-6	Equation 10	N/A
$[BO_3^-]$					N/A	Equation 11	N/A
Hydroxide Mass Rate					Equation 12	Equation 12	N/A
BO3- Mass Rate					N/A	Equation 15	N/A
Density					Input I-6	Equation 16	Input I-18
Design Flow Rate	Input (Att. G)	Input (Att. G)	Input (Att. G)	Input (Att. G)	Input I-14	Input I-14	Input (Att. G)
Temperature	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate					Equation 17 & Equation 21	STR17, Equation 19	N/A
Isopar L					N/A	STR17	STR20-STR19-STR32
Cs-7SB					N/A	STR17	STR20-STR19-STR32
MaxCalix					N/A	STR17	STR20-STR19-STR32
TiDG					N/A	STR17	STR20-STR19-STR32
[Blended Solvent Case] BOBCalix					N/A	STR17	STR20-STR19-STR32
[Blended Solvent Case] TOA					N/A	STR17	STR20-STR19-STR32
Total Cs^+ molar rate					N/A	STR17	N/A
Total Cs^+ mass rate					N/A	STR17	N/A
Total Cs-137 mass rate					N/A	STR17	N/A
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	N/A	N/A	N/A	N/A	Equation 56	N/A	N/A
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate					Equation 60	Equation 58	N/A
BO_3^- Molar Rate					N/A	STR17	N/A
Radiological Summary**					N/A	Equation 8	N/A
Additional Soluble Chemicals					N/A	N/A	N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

[c] Stream not normally used.

Stream Parameter	Stream 53[d]	Stream 54	Stream 55	Stream 56
Mass Rate		STR13	STR23	STR50
Volumetric Rate		STR13	STR23	STR50
Gamma Activity		N/A	N/A	N/A
$[Na^+]$		STR13	N/A	STR50
$[BO_3^-]$		N/A	STR23	N/A
Hydroxide Mass Rate		STR13	N/A	STR50
BO3- Mass Rate		N/A	STR23	N/A
Density		STR13	STR23	STR50
Design Flow Rate		*e*	*e*	*e*
Temperature	Input I-15	Input I-15	Input I-15	Input I-15
Major Components Mass Rate		STR13	STR23	STR50
Isopar L		N/A	N/A	N/A
Cs-7SB		N/A	N/A	N/A
MaxCalix		N/A	N/A	N/A
TiDG		N/A	N/A	N/A
[Blended Solvent Case] BOBCalix		N/A	N/A	N/A
[Blended Solvent Case] TOA		N/A	N/A	N/A
Total Cs^+ molar rate		N/A	N/A	N/A
Total Cs^+ mass rate		N/A	N/A	N/A
Total Cs-137 mass rate		N/A	N/A	N/A
Operating Volume	Input I-9	Input I-9	Input I-9	Input I-9
Cycle time	N/A	STR13	Equation 56	Equation 56
batch/cont	Input I-14	Input I-14	Input I-14	Input I-14
Na^+ Molar Rate		STR13	N/A	STR50
BO_3^- Molar Rate		N/A	STR23	N/A
Radiological Summary**		N/A	N/A	N/A
Additional Soluble Chemicals		N/A	N/A	N/A

**Cs-137 is equal to the stream Gamma Activity. Ba-137m is 0.946*Cs-137 activity.

[d] Stream not normally used.
[e] The design flowrate depends on the pump provided by the truck.

	A	B	C	D	E	F	G	H	I	J	K
1	Aqueous Feed Flow From MCU										
2	All Molecular Weights taken from Reference R-32 CRC Handbook of Chemistry and Physics. 94th Ed. 2013-2014.										
3		**MW (g/mol**	**mg/L**	**mol/L**	**lb/gal**	**lb/hr**	8.50	gpm			
4	water	18.02				3532.60					
5	NaOH	40	3.85E+04	0.96	0.32	163.95					
6	NaNO2	69	1.15E+04	0.17	0.10	48.78					
7	NaNO3	85	2.68E+05	3.15	2.24	1140.71					
8	KOH	56.11	0.00E+00	0.00	0.00	0.00					
9	KNO3	101.11	6.37E+02	0.01	0.01	2.71					
10	CsOH	149.91	1.67E+01	0.0001	0.0001	0.071					
11	H3BO3	61.83	0.00E+00	0.00	0.00	0.00					
12	BCs3O3	457.53	0.00E+00	0.00	0.00	0.00					
13	Na2C2O4	134.02	2.46E+03	0.02	0.02	10.48					
14	Na2SO4	142.05	3.77E+04	0.27	0.31	160.62					
15	NaAl(OH)4	118.01	3.33E+04	0.28	0.28	141.79					
16	misc Na Salts		2.14E+04	0.47	0.20	104.42					
17			**Na (M) =**	**5.60**	**Density (lb/gal) =**	**10.40**					
18			Target	5.60	5.60		new Density		10.40	lb/gal	
19				22.66573335				0.00	delta Ci/gal		
20											

	A	B	C	D	E	F	G	H	I	J	K
21	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
22	Maximum Cs-137 in Feed Stream	1.10E+00	Ci/gal								
23	CF	15	unitless	CF							
24	DF	100	unitless	CsDF							
25	Solvent DF	100	unitless	solvDF							
26	Solvent Density	0.8386	g/ml								
27	Solvent Density	6.99	lb/gal	solvSG							
28	Extract Organic to Aqueous (V-10)	0.25	unitless	EOA							
29	Scrub/Strip/Wash Organic to Aqueous (V-05)	3.75	unitless	SOA							
30	Contactor Solvent Carryover	1000	ppm								
31	DSS Decanter Solvent Entrainment	70	ppm	EXTentrainmentPPM							
32	SE Decanter Solvent Entrainment	70	ppm	SEentrainmentPPM							
33	Maximum Salt Solution Feed Flow Rate	8.5	gpm								

	A	B	C	D	E	F	G	H	I	J	K
34	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
35	Ratio of Scrub to Salt Solution Feed Flow Rate	1/15									
36	Scrub Flow Rate	0.57	gpm								
37	Solvent Flow Rate	2.13	gpm								
38	Extraction (V-10) Carryover	0.80	gal/hr	EXTCarryover							
39	DSS [Extraction (V-10)] Entrainment Post	0.39	lb/hr	EXTentrainment							
40	V-05 Carryover (Strip, Scrub, Wash)	0.041	gal/hr	SSWcarryover							
41	SE V-05 Entrainment Strip Effluent - Post Decanter	0.00	lb/hr	SSWentrainment							
42	Solvent Composition										
43	Cs-7SB	0.5	M	Modifier							
44	MaxCalix	0.05	M	Max							
45	TiDG	0.003	M	TiDG							
46	**Solvent Weight %**										
47	Isopar L	73.95%	wt	Isopar_wtper							
48	Cs-7SB	20.17%	wt	Modifier_wtper							
49	MaxCalix	5.70%	wt	Max_wtper							
50	TiDG	0.18%	wt	TiDG_wtper							
51											
52											
53											

	A	B	C	D	E	F	G	H	I	J	K
54											
55	**Extraction Carryover**										
56		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	DSS Solvent Carryover Post-Decanter gal/hr	
57	Maximum Salt Solution Feed	8.50	510	10.40	5.31E+03	5.59E+03	5.59E+00	7.99E-01	3.91E-01	5.60E-02	
58	Scrub	0.57	34	8.38	2.85E+02						
59	Total V-10	9.07	544		5.59E+03						
60											
61	**Strip Effluent Carryover**										
62		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	SE Solvent Carryover Post-Decanter gal/hr	
63	Strip	0.57	34.2	8.36	2.86E+02	2.86E+02	2.86E-01	4.09E-02	2.00E-02	2.86E-03	
64								3.80E-02			
65	**Solvent Weight % Calculation (Assumes 1 L control Volume)**										
66		1	L								
67		**MW (g/gm**	**g**	**lbs**	**wt%**						
68	Isopar L	163	620.1	1.3671	0.7394593						
69	Cs-7SB	338.35	169.2	0.3730	0.201735						
70	MaxCalix	955.31	47.8	0.1053	0.0569586						
71	TiDG	516.3	1.5	0.0034	0.001847						
72			838.6								

	A	B	C	D	E	F	G	H	I	J	K
73	**MCU Feed Radiological**										
74	**Taken from X-CLC-H-00575, R4**										
75		Ci/gal									
76	Cs-137										
77	Ba-137m										
78	H-3	3.96E-04									
79	C-14	1.03E-05									
80	Co-60	1.02E-05									
81	Ni-59	3.11E-08									
82	Ni-63	1.20E-05									
83	Se-79	5.94E-07									
84	Sr-90	8.13E-04									
85	Y-90	9.06E-04									
86	Nb-94	5.62E-11									
87	Tc-99	2.19E-04									
88	Sb-125	5.53E-05									
89	Sn-126	2.98E-06									
90	I-129	1.10E-07									
91	Cs-134	1.21E-03									
92	Cs-135	2.38E-06									
93	Pm-147	6.35E-05									
94	Eu-154	1.95E-05									
95	Th-232	4.61E-13									
96	U-232	4.91E-10									
97	U-233	1.22E-08									
98	U-234	1.51E-07									
99	U-235	2.27E-09									
100	U-236	2.87E-08									
101	U-238	1.71E-07									
102	Np-237	5.89E-08									
103	Pu-238	5.41E-04									
104	Pu-239	2.16E-05									
105	Pu-240	4.83E-06									
106	Pu-241	4.44E-04									
107	Pu-242	2.52E-08									

	A	B	C	D	E	F	G	H	I	J	K
108	**MCU Feed Radiological**										
109	**Taken from X-CLC-H-00575, R4**										
110		Ci/gal									
111	Am-241	1.92E-06									
112	Am-242m	2.27E-09									
113	Cm-244	5.50E-07									
114	Cm-245	2.88E-10									
115	Na-22	7.50E-05									
116	Al-26	3.01E-07									
117	Sb-126	4.18E-07									
118	Sb-126m	2.98E-06									
119	Sm-151	5.29E-05									
120	Eu-152	2.56E-07									
121	Eu-155	2.99E-06									
122	Ra-226	2.12E-09									
123	Ra-228	4.61E-13									
124	Ac-227	6.15E-13									
125	Th-229	4.13E-11									
126	Th-230	2.47E-10									
127	Pa-231	1.71E-12									
128	Pu-244	1.15E-10									
129	Am-243	7.63E-10									
130	Cm-242	1.04E-09									
131	Cm-243	6.15E-10									
132	Cm-247	2.02E-10									
133	Cm-248	8.84E-20									
134	Bk-249	7.34E-27									
135	Cf-249	3.85E-10									
136	Cf-251	4.56E-10									
137	Cf-252	6.18E-22									
138											
139											

	A	B	C	D	E	F	G	H	I	J	K
140	**X-CLC-S-00113 Appendix L - Str11**										
141	MW (g/gmol)	Additional Soluble chemicals	lb/hr	mol/L	New lb/hr		MW (g/gmol)	Component	lb/hr	mol/L	New lb/hr
142	118.01	NaAl(OH)4	1.24E+02	2.82E-01	1.42E+02		18.02	water	3.09E+03	4.61E+01	3.53E+03
143	105.99	Na2CO3	7.26E+01	1.84E-01	8.31E+01		101.11	KNO3	2.37E+00	6.30E-03	2.71E+00
144	163.94	Na3PO4	1.47E+00	2.41E-03	1.68E+00		40	NaOH	1.43E+02	9.63E-01	1.64E+02
145	142.06	Na2SO4	1.40E+02	2.66E-01	1.61E+02		85	NaNO3	9.97E+02	3.15E+00	1.14E+03
146	169.88	AgNO3	7.44E-05	1.18E-07	8.51E-05		28.02	N2	0.00E+00	0.00E+00	0.00E+00
147	165.95	NaAs(OH)4	3.03E-02	4.91E-05	3.47E-02		69	NaNO2	4.26E+01	1.66E-01	4.88E+01
148	261.36	Ba(NO3)2	3.74E-06	3.85E-09	4.28E-06		211.63	Sr(NO3)2	3.54E-06	4.49E-09	4.05E-06
149	164.1	Ca(NO3)2	2.53E-02	4.15E-05	2.90E-02		274	alpha (PuO2)	0.00E+00	0.00E+00	0.00E+00
150	236.42	Cd(NO3)2	1.27E-03	1.45E-06	1.46E-03		634.04	Na2U2O7	0.00E+00	0.00E+00	0.00E+00
151	58.44	NaCl	7.83E+00	3.60E-02	8.96E+00			sludge	0.00E+00		0.00E+00
152	244.96	Co(NO3)3	3.16E-04	3.47E-07	3.61E-04			MST	0.00E+00		0.00E+00
153	161.98	Na2CrO4	7.12E-02	1.18E-04	8.14E-02		256.59	NaHgOOH	6.53E-03	6.84E-06	7.47E-03
154	187.57	Cu(NO3)2	8.05E-02	1.15E-04	9.21E-02		32.04	CH3OH	2.26E-03	1.90E-05	2.58E-03
155	241.88	Fe(NO3)3	3.72E-03	4.13E-06	4.25E-03		60.08	(CH3)2CHO	1.99E-03	8.91E-06	2.28E-03
156	41.99	NaF	9.06E+00	5.80E-02	1.04E+01		90.04	H2C2O4	0.00E+00	0.00E+00	0.00E+00
157	148.33	Mg(NO3)2	1.51E-05	2.73E-08	1.72E-05		134.02	Na2C2O4	9.17E+00	1.84E-02	1.05E+01
158	302.98	Mn(NO3)4	2.19E-04	1.95E-07	2.51E-04						
159	330.27	Nd(NO3)3	7.57E-04	6.16E-07	8.66E-04				Filtrate to LWHT		
160	182.73	Ni(NO3)2	5.56E-04	8.17E-07	6.36E-04				vol flow	7.43	gpm
161	331.21	Pb(NO3)2	7.31E-04	5.93E-07	8.36E-04				[Na+]	5.60	M
162	349.11	Ru(NO3)4	1.61E-02	1.24E-05	1.84E-02				density	10.40	lb/gal
163	188.94	Na2SeO4	7.60E-02	1.08E-04	8.70E-02				New vol flow	8.5	gpm
164	122.07	Na2SiO3	2.25E-02	4.96E-05	2.58E-02						
165	139.39	NaZn(OH)3	7.44E-02	1.43E-04	8.51E-02						
166	231.23	Zr(O)(NO3)2	3.19E-03	3.71E-06	3.65E-03						

	A	B	C	D	E	F	G	H	I	J	K
1	Aqueous Feed Flow From MCU										
2											
3		**MW (g/mol)**	**mg/L**	**mol/L**	**lb/gal**	**lb/hr**	8 5	gpm			
4	water	18 02				=K149					
5	NaOH	40	=D11*B11*1000	=E5/3 7854*453 6/B5	=F5/60/$G$3	=K151					
6	NaNO2	69	=D12*B12*1000	=E6/3 7854*453 6/B6	=F6/60/$G$3	=K154					
7	NaNO3	85	=D13*B13*1000	=E7/3 7854*453 6/B7	=F7/60/$G$3	=K152					
8	KOH	56 11	=D14*B14*1000	=E8/3 7854*453 6/B8	=F8/60/$G$3	0					
9	KNO3	101 11	=D15*B15*1000	=E9/3 7854*453 6/B9	=F9/60/$G$3	=K150					
10	CsOH	149 91	=B28/3 7854/87/0 225*1000*(149 91/132 91)	=C10/1000/149 91	=C10*3 7854/1000/453 6	=E10*G3*60					
11	H3BO3	61 83	=D17*B17*1000	=E11/3 7854*453 6/B11	=F11/60/$G$3	0					
12	BCs3O3	457 53	=D18*B18*1000	=E12/3 7854*453 6/B12	=F12/60/$G$3	0					
13	Na2C2O4	134 02	=D19*B19*1000	=E13/3 7854*453 6/B13	=F13/60/$G$3	=K164					
14	Na2SO4	142 05	=D20*B20*1000	=E14/3 7854*453 6/B14	=F14/60/$G$3	=E152					
15	NaAl(OH)4	118 01	=D21*B21*1000	=E15/3 7854*453 6/B15	=F15/60/$G$3	=E149					
16	misc Na Salts		=(C156+C157+C160+C164+C166+C169+C176+C177+C178)*453 6*1000/60/G9/3 7854	=D150*2+D151*3+D154+D158+D160*2+D163+D170*2+D171*2+D172+J160	=F16/60/$G$3	=(E150+E151+E154+E158+E160+E163+E170+E171+E172+K160)					
17			**Na (M) =**	**=D5+D6+D7+D13*2+D14*2+D15+D16**	**Density (lb/gal) =**	**=J169**					
18			Target	5 6	=IF(D17>=Target,Target,D17)		new Density		=J169	lb/gal	
19				=SUM(D5:D16,J160)*3 7854*G3*60/453 6				0 00	delta Ci/gal		
20											

	A	B	C	D	E	F	G	H	I	J	K
21	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
22	Maximum Cs-137 in Feed Stream	1 1	Ci/gal								
23	CF	15	unitless	CF							
24	DF	100	unitless	CsDF							
25	Solvent DF	100	unitless	solvDF							
26	Solvent Density	0 8386	g/ml								
27	Solvent Density	=B32*8 34	lb/gal	solvSG							
28	Extract Organic to Aqueous (V-10)	0 25	unitless	EOA							
29	Scrub/Strip/Wash Organic to Aqueous (V-05)	3 75	unitless	SOA							
30	Contactor Solvent Carryover	1000	ppm								
31	DSS Decanter Solvent Entrainment	70	ppm	EXTentrainmentPPM							
32	SE Decanter Solvent Entrainment	70	ppm	SEentrainmentPPM							
33	Maximum Salt Solution Feed Flow Rate	8 5	gpm								

	A	B	C	D	E	F	G	H	I	J	K
34	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
35	Ratio of Scrub to Salt Solution Feed Flow Rate	=1/15									
36	Scrub Flow Rate	=B35*B37	gpm								
37	Solvent Flow Rate	=B35*EOA	gpm								
38	Extraction (V-10) Carryover	=I61	gal/hr	EXTCarryover							
39	DSS [Extraction (V-10)] Entrainment Post Decanter	=J61	lb/hr	EXTentrainment							
40	V-05 Carryover (Strip, Scrub, Wash)	=I68	gal/hr	SSWcarryover							
41	SE V-05 Entrainment Strip Effluent - Post Decanter	=K68	lb/hr	SSWentrainment							
42	**Solvent Composition**										
43	Cs-7SB	0 5	M	Modifier							
44	MaxCalix	0 05	M	Max							
45	TiDG	0 003	M	TiDG							
46	**Solvent Weight %**										
47	Isopar L	=E73	wt	Isopar_wtper							
48	Cs-7SB	=E74	wt	Modifier_wtper							
49	MaxCalix	=E75	wt	Max_wtper							
50	TiDG	=E76	wt	TiDG_wtper							
51											
52											
53											
54											

	A	B	C	D	E	F	G	H	I	J	K
55	**Extraction Carryover**										
56		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	DSS Solvent Carryover Post-Decanter gal/hr	
57	Maximum Salt Solution Feed	8 5	=B59*60	=F17	=B59*D59*60	=E59	=F57*1000/ 1000000	=G57/solvSG	=H57*70/100 0000	=I57/solvSG	
58	Scrub	=B59/15	=B61*60	=1 005*8 34	=B61*D61*60						
59	Total V-10	=SUM(B59:B61)	=SUM(C59 C61)		=SUM(E59 E61)						
60											
61	**Strip Effluent Carryover**										
62		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	SE Solvent Carryover Post-Decanter gal/hr	
63	Strip	0 57	=B66*60	=8 34*1 002	=B66*D66*60	=E64	=F64*1000/ 1000000	=G64/solvSG	=H64*70/100 0000	=I64/solvSG	
64											
65	**Solvent Weight % Calculation (Assumes 1 L control Volume)**										
66		1	L								
67		**MW (g/gmol)**	**g**	**lbs**	**wt%**						
68	Isopar L	163	=B71*0 8386*1000-SUM(	=C73/453 6	=C73/$C$77						
69	Cs-7SB	338 35	=Modifier*B71*B74	=C74/453 6	=C74/$C$77						
70	MaxCalix	955 31	=Max*B71*B75	=C75/453 6	=C75/$C$77						
71	TiDG	516 3	=TiDG*B71*B76	=C76/453 6	=C76/$C$77						
72			=SUM(C73:C76)								

	A	B	C	D	E	F	G	H	I	J	K
73	**MCU Feed Radiological Makeup**										
74	**Taken from X-CLC-H-00575, R4**										
75		Ci/gal									
76	Cs-137										
77	Ba-137m										
78	H-3	3 96E-04									
79	C-14	1 03E-05									
80	Co-60	1 02E-05									
81	Ni-59	3 11E-08									
82	Ni-63	1 20E-05									
83	Se-79	5 94E-07									
84	Sr-90	8 13E-04									
85	Y-90	9 06E-04									
86	Nb-94	5 62E-11									
87	Tc-99	2 19E-04									
88	Sb-125	5 53E-05									
89	Sn-126	2 98E-06									
90	I-129	1 10E-07									
91	Cs-134	1 21E-03									
92	Cs-135	2 38E-06									
93	Pm-147	6 35E-05									
94	Eu-154	1 95E-05									
95	Th-232	4 61E-13									
96	U-232	4 91E-10									
97	U-233	1 22E-08									
98	U-234	1 51E-07									
99	U-235	2 27E-09									
100	U-236	2 87E-08									
101	U-238	1 71E-07									
102	Np-237	5 89E-08									
103	Pu-238	5 41E-04									
104	Pu-239	2 16E-05									
105	Pu-240	4 83E-06									
106	Pu-241	4 44E-04									
107	Pu-242	2 52E-08									
108	Am-241	1 92E-06									

	A	B	C	D	E	F	G	H	I	J	K
109	**MCU Feed Radiological Makeup**										
110	**Taken from X-CLC-H-00575, R4**										
111		Ci/gal									
112	Am-242m	2 27E-09									
113	Cm-244	5 50E-07									
114	Cm-245	2 88E-10									
115	Na-22	7 50E-05									
116	Al-26	3 01E-07									
117	Sb-126	4 18E-07									
118	Sb-126m	2 98E-06									
119	Sm-151	5 29E-05									
120	Eu-152	2 56E-07									
121	Eu-155	2 99E-06									
122	Ra-226	2 12E-09									
123	Ra-228	4 61E-13									
124	Ac-227	6 15E-13									
125	Th-229	4 13E-11									
126	Th-230	2 47E-10									
127	Pa-231	1 71E-12									
128	Pu-244	1 15E-10									
129	Am-243	7 63E-10									
130	Cm-242	1 04E-09									
131	Cm-243	6 15E-10									
132	Cm-247	2 02E-10									
133	Cm-248	8 84E-20									
134	Bk-249	7 34E-27									
135	Cf-249	3 85E-10									
136	Cf-251	4 56E-10									
137	Cf-252	6 18E-22									
138											
139											

	A	B	C	D	E	F	G	H	I	J	K
140	**X-CLC-S-00113 Appendix L - Str11**										
141	MW (g/gmol)	Additional Soluble chemicals	lb/hr	mol/L	New lb/hr		MW (g/gmol)	Component	lb/hr	mol/L	New lb/hr
142	118 01	NaAl(OH)4	1 24E+02	=C147*453 6/A147/60/$J$165/3 7854	=D147/453 6*A147*60*$J$168*3 7854		18 02	water	3 09E+03	=I147*453 6/G147/60/$J$165/3 7854	=J147/453 6*G147*60*$J$168*3 7854
143	105 99	Na2CO3	7 26E+01	=C148*453 6/A148/60/$J$165/3 7854	=D148/453 6*A148*60*$J$168*3 7854		101 11	KNO3	2 37E+00	=I148*453 6/G148/60/$J$165/3 7854	=J148/453 6*G148*60*$J$168*3 7854
144	163 94	Na3PO4	1 47E+00	=C149*453 6/A149/60/$J$165/3 7854	=D149/453 6*A149*60*$J$168*3 7854		40	NaOH	1 43E+02	=I149*453 6/G149/60/$J$165/3 7854	=J149/453 6*G149*60*$J$168*3 7854
145	142 06	Na2SO4	1 40E+02	=C150*453 6/A150/60/$J$165/3 7854	=D150/453 6*A150*60*$J$168*3 7854		85	NaNO3	9 97E+02	=I150*453 6/G150/60/$J$165/3 7854	=J150/453 6*G150*60*$J$168*3 7854
146	169 88	AgNO3	7 44E-05	=C151*453 6/A151/60/$J$165/3 7854	=D151/453 6*A151*60*$J$168*3 7854		28 02	N2	0 00E+00	=I151*453 6/G151/60/$J$165/3 7854	=J151/453 6*G151*60*$J$168*3 7854
147	165 95	NaAs(OH)4	3 03E-02	=C152*453 6/A152/60/$J$165/3 7854	=D152/453 6*A152*60*$J$168*3 7854		69	NaNO2	4 26E+01	=I152*453 6/G152/60/$J$165/3 7854	=J152/453 6*G152*60*$J$168*3 7854
148	261 36	Ba(NO3)2	3 74E-06	=C153*453 6/A153/60/$J$165/3 7854	=D153/453 6*A153*60*$J$168*3 7854		211 63	Sr(NO3)2	3 54E-06	=I153*453 6/G153/60/$J$165/3 7854	=J153/453 6*G153*60*$J$168*3 7854
149	164 1	Ca(NO3)2	2 53E-02	=C154*453 6/A154/60/$J$165/3 7854	=D154/453 6*A154*60*$J$168*3 7854		274	alpha (PuO2)	0 00E+00	=I154*453 6/G154/60/$J$165/3 7854	=J154/453 6*G154*60*$J$168*3 7854
150	236 42	Cd(NO3)2	1 27E-03	=C155*453 6/A155/60/$J$165/3 7854	=D155/453 6*A155*60*$J$168*3 7854		634 04	Na2U2O7	0 00E+00	=I155*453 6/G155/60/$J$165/3 7854	=J155/453 6*G155*60*$J$168*3 7854
151	58 44	NaCl	7 83E+00	=C156*453 6/A156/60/$J$165/3 7854	=D156/453 6*A156*60*$J$168*3 7854			sludge	0 00E+00		=J156/453 6*G156*60*$J$168*3 7854
152	244 96	Co(NO3)3	3 16E-04	=C157*453 6/A157/60/$J$165/3 7854	=D157/453 6*A157*60*$J$168*3 7854			MST	0 00E+00		=J157/453 6*G157*60*$J$168*3 7854
153	161 98	Na2CrO4	7 12E-02	=C158*453 6/A158/60/$J$165/3 7854	=D158/453 6*A158*60*$J$168*3 7854		256 59	NaHgOOH	6 53E-03	=I158*453 6/G158/60/$J$165/3 7854	=J158/453 6*G158*60*$J$168*3 7854
154	187 57	Cu(NO3)2	8 05E-02	=C159*453 6/A159/60/$J$165/3 7854	=D159/453 6*A159*60*$J$168*3 7854		32 04	CH3OH	2 26E-03	=I159*453 6/G159/60/$J$165/3 7854	=J159/453 6*G159*60*$J$168*3 7854
155	241 88	Fe(NO3)3	3 72E-03	=C160*453 6/A160/60/$J$165/3 7854	=D160/453 6*A160*60*$J$168*3 7854		60 08	(CH3)2CHOH	1 99E-03	=I160*453 6/G160/60/$J$165/3 7854	=J160/453 6*G160*60*$J$168*3 7854
156	41 99	NaF	9 06E+00	=C161*453 6/A161/60/$J$165/3 7854	=D161/453 6*A161*60*$J$168*3 7854		90 04	H2C2O4	0 00E+00	=I161*453 6/G161/60/$J$165/3 7854	=J161/453 6*G161*60*$J$168*3 7854
157	148 33	Mg(NO3)2	1 51E-05	=C162*453 6/A162/60/$J$165/3 7854	=D162/453 6*A162*60*$J$168*3 7854		134 02	Na2C2O4	9 17E+00	=I162*453 6/G162/60/$J$165/3 7854	=J162/453 6*G162*60*$J$168*3 7854
158	302 98	Mn(NO3)4	2 19E-04	=C163*453 6/A163/60/$J$165/3 7854	=D163/453 6*A163*60*$J$168*3 7854						
159	330 27	Nd(NO3)3	7 57E-04	=C164*453 6/A164/60/$J$165/3 7854	=D164/453 6*A164*60*$J$168*3 7854				Filtrate to LWHT		
160	182 73	Ni(NO3)2	5 56E-04	=C165*453 6/A165/60/$J$165/3 7854	=D165/453 6*A165*60*$J$168*3 7854				vol flow	7 431192661	gpm
161	331 21	Pb(NO3)2	7 31E-04	=C166*453 6/A166/60/$J$165/3 7854	=D166/453 6*A166*60*$J$168*3 7854				[Na+]	5 603185048	M
162	349 11	Ru(NO3)4	1 61E-02	=C167*453 6/A167/60/$J$165/3 7854	=D167/453 6*A167*60*$J$168*3 7854				density	10 40437116	lb/gal
163	188 94	Na2SeO4	7 60E-02	=C168*453 6/A168/60/$J$165/3 7854	=D168/453 6*A168*60*$J$168*3 7854				New vol flow	8 5	gpm
164	122 07	Na2SiO3	2 25E-02	=C169*453 6/A169/60/$J$165/3 7854	=D169/453 6*A169*60*$J$168*3 7854						
165	139 39	NaZn(OH)3	7 44E-02	=C170*453 6/A170/60/$J$165/3 7854	=D170/453 6*A170*60*$J$168*3 7854						
166	231 23	Zr(O)(NO3)2	3 19E-03	=C171*453 6/A171/60/$J$165/3 7854	=D171/453 6*A171*60*$J$168*3 7854						

	A	B	C	D	E	F	G	H	I	J	K
1	Aqueous Feed Flow From MCU										
2	All Molecular Weights taken from Reference R-32 CRC Handbook of Chemistry and Physics. 94th Ed. 2013-2014.										
3		**MW (g/mol**	**mg/L**	**mol/L**	**lb/gal**	**lb/hr**	8.50	gpm			
4	water	18.02				3532.60					
5	NaOH	40	3.85E+04	0.96	0.32	163.95					
6	NaNO2	69	1.15E+04	0.17	0.10	48.78					
7	NaNO3	85	2.68E+05	3.15	2.24	1140.71					
8	KOH	56.11	0.00E+00	0.00	0.00	0.00					
9	KNO3	101.11	6.37E+02	0.01	0.01	2.71					
10	CsOH	149.91	1.67E+01	0.0001	0.0001	0.071					
11	H3BO3	61.83	0.00E+00	0.00	0.00	0.00					
12	BCs3O3	457.53	0.00E+00	0.00	0.00	0.00					
13	Na2C2O4	134.02	2.46E+03	0.02	0.02	10.48					
14	Na2SO4	142.05	3.77E+04	0.27	0.31	160.62					
15	NaAl(OH)4	118.01	3.33E+04	0.28	0.28	141.79					
16	misc Na Salts		2.14E+04	0.47	0.20	104.42					
17			**Na (M) =**	**5.60**	**Density (lb/gal) =**	**10.40**					
18			Target	5.60	5.60		new Density		10.40	lb/gal	
19				22.66573335				0.00	delta Ci/gal		
20											

	A	B	C	D	E	F	G	H	I	J	K
21	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
22	Maximum Cs-137 in Feed Stream	1.10E+00	Ci/gal								
23	CF	15	unitless	CF							
24	DF	100	unitless	CsDF							
25	Solvent DF	100	unitless	solvDF							
26	Solvent Density	0.8384	g/ml								
27	Solvent Density	6.99	lb/gal	solvSG							
28	Extract Organic to Aqueous (V-10)	0.25	unitless	EOA							
29	Scrub/Strip/Wash Organic to Aqueous (V-05)	3.75	unitless	SOA							
30	Contactor Solvent Carryover	1000	ppm								
31	DSS Decanter Solvent Entrainment	70	ppm	EXTentrainmentPPM							
32	SE Decanter Solvent Entrainment	70	ppm	SEentrainmentPPM							
33	Maximum Salt Solution Feed Flow Rate	8.5	gpm								

	A	B	C	D	E	F	G	H	I	J	K
34	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
35	Ratio of Scrub to Salt Solution Feed Flow Rate	1/15									
36	Scrub Flow Rate	0.57	gpm								
37	Solvent Flow Rate	2.13	gpm								
38	Extraction (V-10) Carryover	0.80	gal/hr	EXTCarryover							
39	DSS [Extraction (V-10)] Entrainment Post	0.39	lb/hr	EXTentrainment							
40	V-05 Carryover (Strip, Scrub, Wash)	0.041	gal/hr	SSWcarryover							
41	SE V-05 Entrainment Strip Effluent - Post Decanter	0.003	lb/hr	SSWentrainment							
42	Solvent Composition										
43	Cs-7SB	0.5	M	Modifier							
44	MaxCalix	0.0465	M	Max							
45	TiDG	0.003	M	TiDG							
46	BOBCalix	0.0035	M	BOB							
47	TOA	0.0015	M	TOA							
48	**Solvent Weight %**										
49	Isopar L	73.80%	wt	Isopar_wtper							
50	Cs-7SB	20.18%	wt	Modifier_wtper							
51	MaxCalix	5.30%	wt	Max_wtper							
52	TiDG	0.18%	wt	TiDG_wtper							
53	BOBCalix	0.48%	wt	BOB_wtper							
54	TOA	0.06%	wt	TOA_wtper							
55											
56											

	A	B	C	D	E	F	G	H	I	J	K
57	**Extraction Carryover**										
58		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate	Solvent Carryover	Solvent Carryover	Solvent Carryover	DSS Solvent Carryover	
59	Maximum Salt Solution Feed	8.50	510	10.40	5.31E+03	5.59E+03	5.59E+00	8.00E-01	3.91E-01	5.60E-02	
60	Scrub	0.57	34	8.38	2.85E+02						
61	Total V-10	9.07	544		5.59E+03						
62											
63	**Strip Effluent Carryover**										
64		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	SE Solvent Carryover Post-Decanter gal/hr	
65	Strip	0.57	34.2	8.36	2.86E+02	2.86E+02	2.86E-01	4.09E-02	2.00E-02	2.86E-03	
66											
67	**Solvent Weight % Calculation (Assumes 1 L control Volume)**										
68		1	L								
69		**MW (g/gm**	**g**	**lbs**	**wt%**						
70	Isopar L	163	618.7	1.3640	0.7379531						
71	Cs-7SB	338.35	169.2	0.3730	0.2017832						
72	MaxCalix	955.31	44.4	0.0979	0.0529842						
73	TiDG	516.3	1.5	0.0034	0.0018474						
74	BOBCalix	1149.64	4.0	0.0089	0.0047993						
75	TOA	353.7	0.5	0.0012	0.0006328						
76			838.4								

	A	B	C	D	E	F	G	H	I	J	K
77	**MCU Feed Radiological**										
78	**Taken from X-CLC-H-00575,**										
79		Ci/gal									
80	Cs-137										
81	Ba-137m										
82	H-3	3.96E-04									
83	C-14	1.03E-05									
84	Co-60	1.02E-05									
85	Ni-59	3.11E-08									
86	Ni-63	1.20E-05									
87	Se-79	5.94E-07									
88	Sr-90	8.13E-04									
89	Y-90	9.06E-04									
90	Nb-94	5.62E-11									
91	Tc-99	2.19E-04									
92	Sb-125	5.53E-05									
93	Sn-126	2.98E-06									
94	I-129	1.10E-07									
95	Cs-134	1.21E-03									
96	Cs-135	2.38E-06									
97	Pm-147	6.35E-05									
98	Eu-154	1.95E-05									
99	Th-232	4.61E-13									
100	U-232	4.91E-10									
101	U-233	1.22E-08									
102	U-234	1.51E-07									
103	U-235	2.27E-09									
104	U-236	2.87E-08									
105	U-238	1.71E-07									
106	Np-237	5.89E-08									
107	Pu-238	5.41E-04									
108	Pu-239	2.16E-05									
109	Pu-240	4.83E-06									
110	Pu-241	4.44E-04									
111	Pu-242	2.52E-08									

	A	B	C	D	E	F	G	H	I	J	K
112	**MCU Feed Radiological**										
113	**Taken from X-CLC-H-00575,**										
114		Ci/gal									
115	Am-241	1.92E-06									
116	Am-242m	2.27E-09									
117	Cm-244	5.50E-07									
118	Cm-245	2.88E-10									
119	Na-22	7.50E-05									
120	Al-26	3.01E-07									
121	Sb-126	4.18E-07									
122	Sb-126m	2.98E-06									
123	Sm-151	5.29E-05									
124	Eu-152	2.56E-07									
125	Eu-155	2.99E-06									
126	Ra-226	2.12E-09									
127	Ra-228	4.61E-13									
128	Ac-227	6.15E-13									
129	Th-229	4.13E-11									
130	Th-230	2.47E-10									
131	Pa-231	1.71E-12									
132	Pu-244	1.15E-10									
133	Am-243	7.63E-10									
134	Cm-242	1.04E-09									
135	Cm-243	6.15E-10									
136	Cm-247	2.02E-10									
137	Cm-248	8.84E-20									
138	Bk-249	7.34E-27									
139	Cf-249	3.85E-10									
140	Cf-251	4.56E-10									
141	Cf-252	6.18E-22									

	A	B	C	D	E	F	G	H	I	J	K
142											
143											
144	**X-CLC-S-00113 Appendix L - Str11**										
145	MW (g/gmol)	Additional Soluble chemicals	lb/hr	mol/L	New lb/hr		MW (g/gmol)	Component	lb/hr	mol/L	New lb/hr
146	118.01	NaAl(OH)4	1.24E+02	2.82E-01	1.42E+02		18.02	water	3.09E+03	4.61E+01	3.53E+03
147	105.99	Na2CO3	7.26E+01	1.84E-01	8.31E+01		101.11	KNO3	2.37E+00	6.30E-03	2.71E+00
148	163.94	Na3PO4	1.47E+00	2.41E-03	1.68E+00		40	NaOH	1.43E+02	9.63E-01	1.64E+02
149	142.06	Na2SO4	1.40E+02	2.66E-01	1.61E+02		85	NaNO3	9.97E+02	3.15E+00	1.14E+03
150	169.88	AgNO3	7.44E-05	1.18E-07	8.51E-05		28.02	N2	0.00E+00	0.00E+00	0.00E+00
151	165.95	NaAs(OH)4	3.03E-02	4.91E-05	3.47E-02		69	NaNO2	4.26E+01	1.66E-01	4.88E+01
152	261.36	Ba(NO3)2	3.74E-06	3.85E-09	4.28E-06		211.63	Sr(NO3)2	3.54E-06	4.49E-09	4.05E-06
153	164.1	Ca(NO3)2	2.53E-02	4.15E-05	2.90E-02		274	alpha (PuO2)	0.00E+00	0.00E+00	0.00E+00
154	236.42	Cd(NO3)2	1.27E-03	1.45E-06	1.46E-03		634.04	Na2U2O7	0.00E+00	0.00E+00	0.00E+00
155	58.44	NaCl	7.83E+00	3.60E-02	8.96E+00			sludge	0.00E+00		0.00E+00
156	244.96	Co(NO3)3	3.16E-04	3.47E-07	3.61E-04			MST	0.00E+00		0.00E+00
157	161.98	Na2CrO4	7.12E-02	1.18E-04	8.14E-02		256.59	NaHgOOH	6.53E-03	6.84E-06	7.47E-03
158	187.57	Cu(NO3)2	8.05E-02	1.15E-04	9.21E-02		32.04	CH3OH	2.26E-03	1.90E-05	2.58E-03
159	241.88	Fe(NO3)3	3.72E-03	4.13E-06	4.25E-03		60.08	(CH3)2CHO	1.99E-03	8.91E-06	2.28E-03
160	41.99	NaF	9.06E+00	5.80E-02	1.04E+01		90.04	H2C2O4	0.00E+00	0.00E+00	0.00E+00
161	148.33	Mg(NO3)2	1.51E-05	2.73E-08	1.72E-05		134.02	Na2C2O4	9.17E+00	1.84E-02	1.05E+01
162	302.98	Mn(NO3)4	2.19E-04	1.95E-07	2.51E-04						
163	330.27	Nd(NO3)3	7.57E-04	6.16E-07	8.66E-04				Filtrate to LWHT		
164	182.73	Ni(NO3)2	5.56E-04	8.17E-07	6.36E-04				vol flow	7.43	gpm
165	331.21	Pb(NO3)2	7.31E-04	5.93E-07	8.36E-04				[Na+]	5.60	M
166	349.11	Ru(NO3)4	1.61E-02	1.24E-05	1.84E-02				density	10.40	lb/gal
167	188.94	Na2SeO4	7.60E-02	1.08E-04	8.70E-02				New vol flow	8.5	gpm
168	122.07	Na2SiO3	2.25E-02	4.96E-05	2.58E-02						
169	139.39	NaZn(OH)3	7.44E-02	1.43E-04	8.51E-02						
170	231.23	Zr(O)(NO3)2	3.19E-03	3.71E-06	3.65E-03						

	A	B	C	D	E	F	G	H	I	J	K
1	Aqueous Feed Flow From MCU										
2											
3		**MW (g/mol)**	**mg/L**	**mol/L**	**lb/gal**	**lb/hr**	8 5	gpm			
4	water	18 02				=K149					
5	NaOH	40	=D11*B11*1000	=E5/3 7854*453 6/B5	=F5/60/$G$3	=K151					
6	NaNO2	69	=D12*B12*1000	=E6/3 7854*453 6/B6	=F6/60/$G$3	=K154					
7	NaNO3	85	=D13*B13*1000	=E7/3 7854*453 6/B7	=F7/60/$G$3	=K152					
8	KOH	56 11	=D14*B14*1000	=E8/3 7854*453 6/B8	=F8/60/$G$3	0					
9	KNO3	101 11	=D15*B15*1000	=E9/3 7854*453 6/B9	=F9/60/$G$3	=K150					
10	CsOH	149 91	=B28/3 7854/87/0 225*1000*(149 91/132 91)	=C10/1000/149 91	=C10*3 7854/1000/453 6	=E10*G3*60					
11	H3BO3	61 83	=D17*B17*1000	=E11/3 7854*453 6/B11	=F11/60/$G$3	0					
12	BCs3O3	457 53	=D18*B18*1000	=E12/3 7854*453 6/B12	=F12/60/$G$3	0					
13	Na2C2O4	134 02	=D19*B19*1000	=E13/3 7854*453 6/B13	=F13/60/$G$3	=K164					
14	Na2SO4	142 05	=D20*B20*1000	=E14/3 7854*453 6/B14	=F14/60/$G$3	=E152					
15	NaAl(OH)4	118 01	=D21*B21*1000	=E15/3 7854*453 6/B15	=F15/60/$G$3	=E149					
16	misc Na Salts		=(C156+C157+C160+C164+C166+C169+C176+C177+C178)*453 6*1000/60/G9/3 7854	=D150*2+D151*3+D154+D158+D160*2+D163+D170*2+D171*2+D172+J160	=F16/60/$G$3	=(E150+E151+E154+E158+E160+E163+E170+E171+E172+K160)					
17			**Na (M) =**	**=D5+D6+D7+D13*2+D14*2+D15+D16**	**Density (lb/gal) =**	**=J169**					
18			Target	5 6	=IF(D17>=Target,Target,D17)		new Density		=J169	lb/gal	
19				=SUM(D5:D16,J160)*3 7854*G3*60/453 6				0 00	delta Ci/gal		
20											

	A	B	C	D	E	F	G	H	I	J	K
21	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
22	Maximum Cs-137 in Feed Stream	1 1	Ci/gal								
23	CF	15	unitless	CF							
24	DF	100	unitless	CsDF							
25	Solvent DF	100	unitless	solvDF							
26	Solvent Density	0 8384	g/ml								
27	Solvent Density	=B32*8 34	lb/gal	solvSG							
28	Extract Organic to Aqueous (V-10)	0 25	unitless	EOA							
29	Scrub/Strip/Wash Organic to Aqueous (V-05)	3 75	unitless	SOA							
30	Contactor Solvent Carryover	1000	ppm								
31	DSS Decanter Solvent Entrainment	70	ppm	EXTentrainmentPPM							
32	SE Decanter Solvent Entrainment	70	ppm	SEentrainmentPPM							
33	Maximum Salt Solution Feed Flow Rate	8 5	gpm								

	A	B	C	D	E	F	G	H	I	J	K
34	**Variable**	**Value**	**Unit**	**Excel Cell Name**							
35	Ratio of Scrub to Salt Solution Feed Flow Rate	=1/15									
36	Scrub Flow Rate	=B35*B37	gpm								
37	Solvent Flow Rate	=B35*EOA	gpm								
38	Extraction (V-10) Carryover	=I61	gal/hr	EXTCarryover							
39	DSS [Extraction (V-10)] Entrainment Post Decanter	=J61	lb/hr	EXTentrainment							
40	V-05 Carryover (Strip, Scrub, Wash)	=I68	gal/hr	SSWcarryover							
41	SE V-05 Entrainment Strip Effluent - Post Decanter	=K68	lb/hr	SSWentrainment							
42	Solvent Composition										
43	Cs-7SB	0 5	M	Modifier							
44	MaxCalix	0 0465	M	Max							
45	TiDG	0 003	M	TiDG							
46	BOBCalix	0 0035	M	BOB							
47	TOA	0 0015	M	TOA							
48	**Solvent Weight %**										
49	Isopar L	=E70	wt	Isopar_wtper							
50	Cs-7SB	=E71	wt	Modifier_wtper							
51	MaxCalix	=E72	wt	Max_wtper							
52	TiDG	=E73	wt	TiDG_wtper							
53	BOBCalix	=E74	wt	BOB_wtper							
54	TOA	=E75	wt	TOA_wtper							
55											
56											

	A	B	C	D	E	F	G	H	I	J	K
57	**Extraction Carryover**										
58		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	DSS Solvent Carryover Post-Decanter gal/hr	
59	Maximum Salt Solution Feed	8 5	=B59*60	=F17	=B59*D59*60	=E59	=F57*1000/ 1000000	=G57/solvSG	=H57*70/100 0000	=I57/solvSG	
60	Scrub	=B59/15	=B61*60	=1 005*8 34	=B61*D61*60						
61	Total V-10	=SUM(B59:B61)	=SUM(C59 C61)		=SUM(E59 E61)						
62											
63	**Strip Effluent Carryover**										
64		Flow Rate (gal/min)	gal/hr	Density (lb/gal)	lb/hr	Total Mass Flow Rate (lb/hr)	Solvent Carryover lb/hr (assuming 1000 ppm carryover)	Solvent Carryover gal/hr	Solvent Carryover lb/hr (assuming 70 ppm carryover)	SE Solvent Carryover Post-Decanter gal/hr	
65	Strip	0 57	=B65*60	=8 34*1 002	=B65*D65*60	=E65	=F65*1000/ 1000000	=G65/solvSG	=H65*70/100 0000	=I65/solvSG	
66											
67	**Solvent Weight % Calculation (Assumes 1 L control Volume)**										
68		1	L								
69		**MW (g/gmol)**	**g**	**lbs**	**wt%**						
70	Isopar L	163	=B71*0 8386*1000-SUM(	=C70/453 6	=C70/$C$77						
71	Cs-7SB	338 35	=Modifier*B71*B74	=C71/453 6	=C71/$C$77						
72	MaxCalix	955 31	=Max*B71*B75	=C72/453 6	=C72/$C$77						
73	TiDG	516 3	=TiDG*B71*B76	=C73/453 6	=C73/$C$77						
74	BOBCalix	1149 64	=BOB*B68*B74	=C74/453 6	=C74/$C$78						
75	TOA	353 7	=TOA*B68*B75	=C75/453 6	=C75/$C$79						
76			=SUM(C70:C75)								

	A	B	C	D	E	F	G	H	I	J	K
77	**MCU Feed Radiological Makeup**										
78	**Taken from X-CLC-H-00575, R4**										
79		Ci/gal									
80	Cs-137										
81	Ba-137m										
82	H-3	3 96E-04									
83	C-14	1 03E-05									
84	Co-60	1 02E-05									
85	Ni-59	3 11E-08									
86	Ni-63	1 20E-05									
87	Se-79	5 94E-07									
88	Sr-90	8 13E-04									
89	Y-90	9 06E-04									
90	Nb-94	5 62E-11									
91	Tc-99	2 19E-04									
92	Sb-125	5 53E-05									
93	Sn-126	2 98E-06									
94	I-129	1 10E-07									
95	Cs-134	1 21E-03									
96	Cs-135	2 38E-06									
97	Pm-147	6 35E-05									
98	Eu-154	1 95E-05									
99	Th-232	4 61E-13									
100	U-232	4 91E-10									
101	U-233	1 22E-08									
102	U-234	1 51E-07									
103	U-235	2 27E-09									
104	U-236	2 87E-08									
105	U-238	1 71E-07									
106	Np-237	5 89E-08									
107	Pu-238	5 41E-04									
108	Pu-239	2 16E-05									
109	Pu-240	4 83E-06									
110	Pu-241	4 44E-04									
111	Pu-242	2 52E-08									
112	Am-241	1 92E-06									

	A	B	C	D	E	F	G	H	I	J	K
113	**MCU Feed Radiological Makeup**										
114	**Taken from X-CLC-H-00575, R4**										
115		Ci/gal									
116	Am-242m	2 27E-09									
117	Cm-244	5 50E-07									
118	Cm-245	2 88E-10									
119	Na-22	7 50E-05									
120	Al-26	3 01E-07									
121	Sb-126	4 18E-07									
122	Sb-126m	2 98E-06									
123	Sm-151	5 29E-05									
124	Eu-152	2 56E-07									
125	Eu-155	2 99E-06									
126	Ra-226	2 12E-09									
127	Ra-228	4 61E-13									
128	Ac-227	6 15E-13									
129	Th-229	4 13E-11									
130	Th-230	2 47E-10									
131	Pa-231	1 71E-12									
132	Pu-244	1 15E-10									
133	Am-243	7 63E-10									
134	Cm-242	1 04E-09									
135	Cm-243	6 15E-10									
136	Cm-247	2 02E-10									
137	Cm-248	8 84E-20									
138	Bk-249	7 34E-27									
139	Cf-249	3 85E-10									
140	Cf-251	4 56E-10									
141	Cf-252	6 18E-22									
142											
143											

	A	B	C	D	E	F	G	H	I	J	K
144	**X-CLC-S-00113 Appendix L - Str11**										
145	MW (g/gmol)	Additional Soluble chemicals	lb/hr	mol/L	New lb/hr		MW (g/gmol)	Component	lb/hr	mol/L	New lb/hr
146	118 01	NaAl(OH)4	1 24E+02	=C147*453 6/A147/60/$J$165/3 7854	=D147/453 6*A147*60*$J$168*3 7854		18 02	water	3 09E+03	=I147*453 6/G147/60/$J$165/3 7854	=J147/453 6*G147*60*$J$168*3 7854
147	105 99	Na2CO3	7 26E+01	=C148*453 6/A148/60/$J$165/3 7854	=D148/453 6*A148*60*$J$168*3 7854		101 11	KNO3	2 37E+00	=I148*453 6/G148/60/$J$165/3 7854	=J148/453 6*G148*60*$J$168*3 7854
148	163 94	Na3PO4	1 47E+00	=C149*453 6/A149/60/$J$165/3 7854	=D149/453 6*A149*60*$J$168*3 7854		40	NaOH	1 43E+02	=I149*453 6/G149/60/$J$165/3 7854	=J149/453 6*G149*60*$J$168*3 7854
149	142 06	Na2SO4	1 40E+02	=C150*453 6/A150/60/$J$165/3 7854	=D150/453 6*A150*60*$J$168*3 7854		85	NaNO3	9 97E+02	=I150*453 6/G150/60/$J$165/3 7854	=J150/453 6*G150*60*$J$168*3 7854
150	169 88	AgNO3	7 44E-05	=C151*453 6/A151/60/$J$165/3 7854	=D151/453 6*A151*60*$J$168*3 7854		28 02	N2	0 00E+00	=I151*453 6/G151/60/$J$165/3 7854	=J151/453 6*G151*60*$J$168*3 7854
151	165 95	NaAs(OH)4	3 03E-02	=C152*453 6/A152/60/$J$165/3 7854	=D152/453 6*A152*60*$J$168*3 7854		69	NaNO2	4 26E+01	=I152*453 6/G152/60/$J$165/3 7854	=J152/453 6*G152*60*$J$168*3 7854
152	261 36	Ba(NO3)2	3 74E-06	=C153*453 6/A153/60/$J$165/3 7854	=D153/453 6*A153*60*$J$168*3 7854		211 63	Sr(NO3)2	3 54E-06	=I153*453 6/G153/60/$J$165/3 7854	=J153/453 6*G153*60*$J$168*3 7854
153	164 1	Ca(NO3)2	2 53E-02	=C154*453 6/A154/60/$J$165/3 7854	=D154/453 6*A154*60*$J$168*3 7854		274	alpha (PuO2)	0 00E+00	=I154*453 6/G154/60/$J$165/3 7854	=J154/453 6*G154*60*$J$168*3 7854
154	236 42	Cd(NO3)2	1 27E-03	=C155*453 6/A155/60/$J$165/3 7854	=D155/453 6*A155*60*$J$168*3 7854		634 04	Na2U2O7	0 00E+00	=I155*453 6/G155/60/$J$165/3 7854	=J155/453 6*G155*60*$J$168*3 7854
155	58 44	NaCl	7 83E+00	=C156*453 6/A156/60/$J$165/3 7854	=D156/453 6*A156*60*$J$168*3 7854			sludge	0 00E+00		=J156/453 6*G156*60*$J$168*3 7854
156	244 96	Co(NO3)3	3 16E-04	=C157*453 6/A157/60/$J$165/3 7854	=D157/453 6*A157*60*$J$168*3 7854			MST	0 00E+00		=J157/453 6*G157*60*$J$168*3 7854
157	161 98	Na2CrO4	7 12E-02	=C158*453 6/A158/60/$J$165/3 7854	=D158/453 6*A158*60*$J$168*3 7854		256 59	NaHgOOH	6 53E-03	=I158*453 6/G158/60/$J$165/3 7854	=J158/453 6*G158*60*$J$168*3 7854
158	187 57	Cu(NO3)2	8 05E-02	=C159*453 6/A159/60/$J$165/3 7854	=D159/453 6*A159*60*$J$168*3 7854		32 04	CH3OH	2 26E-03	=I159*453 6/G159/60/$J$165/3 7854	=J159/453 6*G159*60*$J$168*3 7854
159	241 88	Fe(NO3)3	3 72E-03	=C160*453 6/A160/60/$J$165/3 7854	=D160/453 6*A160*60*$J$168*3 7854		60 08	(CH3)2CHOH	1 99E-03	=I160*453 6/G160/60/$J$165/3 7854	=J160/453 6*G160*60*$J$168*3 7854
160	41 99	NaF	9 06E+00	=C161*453 6/A161/60/$J$165/3 7854	=D161/453 6*A161*60*$J$168*3 7854		90 04	H2C2O4	0 00E+00	=I161*453 6/G161/60/$J$165/3 7854	=J161/453 6*G161*60*$J$168*3 7854
161	148 33	Mg(NO3)2	1 51E-05	=C162*453 6/A162/60/$J$165/3 7854	=D162/453 6*A162*60*$J$168*3 7854		134 02	Na2C2O4	9 17E+00	=I162*453 6/G162/60/$J$165/3 7854	=J162/453 6*G162*60*$J$168*3 7854
162	302 98	Mn(NO3)4	2 19E-04	=C163*453 6/A163/60/$J$165/3 7854	=D163/453 6*A163*60*$J$168*3 7854						
163	330 27	Nd(NO3)3	7 57E-04	=C164*453 6/A164/60/$J$165/3 7854	=D164/453 6*A164*60*$J$168*3 7854				Filtrate to LWHT		
164	182 73	Ni(NO3)2	5 56E-04	=C165*453 6/A165/60/$J$165/3 7854	=D165/453 6*A165*60*$J$168*3 7854				vol flow	7 431192661	gpm
165	331 21	Pb(NO3)2	7 31E-04	=C166*453 6/A166/60/$J$165/3 7854	=D166/453 6*A166*60*$J$168*3 7854				[Na+]	5 603185048	M
166	349 11	Ru(NO3)4	1 61E-02	=C167*453 6/A167/60/$J$165/3 7854	=D167/453 6*A167*60*$J$168*3 7854				density	10 40437116	lb/gal
167	188 94	Na2SeO4	7 60E-02	=C168*453 6/A168/60/$J$165/3 7854	=D168/453 6*A168*60*$J$168*3 7854				New vol flow	8 5	gpm
168	122 07	Na2SiO3	2 25E-02	=C169*453 6/A169/60/$J$165/3 7854	=D169/453 6*A169*60*$J$168*3 7854						
169	139 39	NaZn(OH)3	7 44E-02	=C170*453 6/A170/60/$J$165/3 7854	=D170/453 6*A170*60*$J$168*3 7854						
170	231 23	Zr(O)(NO3)2	3 19E-03	=C171*453 6/A171/60/$J$165/3 7854	=D171/453 6*A171*60*$J$168*3 7854						

Summary of Design Flow Rates

Stream	Description	Design Flow Rate (gpm)	Basis
1	CSS from ARP to MCU	158	Process History for SSRT 1 accumulation
2	CSS from ARP to MCU to SSRT 1	158	Process History for SSRT 1 accumulation
3	CSS from ARP to MCU to SSRT 2	156	Process History for SSRT 2 accumulation
4	SSRT 1 to SSFT	75	Process History for SSRT 1 depletion
5	SSRT 2 to SSFT	73	Process History for SSRT 2 depletion
10	DSS Decanter Aqueous flow to DSS Hold Tank	16	Process History for DSSHT accumulation
12	DSS Hold Tank transfer to Tank 50	93	Process History for DSSHT depletion
26	SE Decanter Aqueous flow to SE Hold Tank	10	Process History for SEHT accumulation
27	SE Hold Tank transfer to DWPF	14	Process History for SEHT depletion
31	CDT Transfer for Reprocessing	20	Process History for CDT depletion/DSSHT accumulation
32	DSS Decanter Organic flow to SHT	0.5	MCU Process Systems Hydraulic Calculation
46	SE Decanter Organic flow to Extraction Contactor 7	0.5	MCU Process Systems Hydraulic Calculation
47	Cleaning Agent (15 wt% Nitric Acid) flow to Extraction Contactors	27.75	MCU Process Systems Hydraulic Calculation
48	Cleaning Agent (15 wt% Nitric Acid) flow to Strip/Scrub/Wash Contactors	17	MCU Process Systems Hydraulic Calculation
48A	Cleaning Agent (30 wt% NaOH) flow to the DSS Hydraulic Accumulator (for DSS Coalescer Cleaning)	9	Process History for Accumulator/ CDT accumulation
49	Cleaning Agent (15 wt% Nitric Acid) flow to Contactor Spray Header	28.5	MCU Process Systems Hydraulic Calculation
52	Solvent Drum addition to SHT	5	MCU Process Systems Hydraulic Calculation

Streams 1 and 2: Clarified Salt Solution from ARP to SSRT 1

Process history taken from PI is based on accumulation in SSRT 1:

ARP to SSRT 1 - 2/2/2013 Transfer

blue cells indicate an input

	start	End	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 10:07:41 AM	2/2/13 10:32:11 AM	0:24:30	24.50	157.6
gallons	2255.5	6116.8	3861.3		

ARP to SSRT 1 -2/4/2013 Transfer

	start	End	Delta	Fill In Minute	Gallons Per Minute
date	2/4/13 5:00:29 AM	2/4/13 5:27:03 AM	0:26:34	26.57	156.9
gallons	2306.1	6475.6	4169.5		

ARP to SSRT 1 -2/9/2013 Transfer

	start	End	Delta	Fill In Minute	Gallons Per Minute
date	2/9/13 6:14:37 PM	2/9/13 6:40:40 PM	0:26:03	26.05	158.5
gallons	1546.8	5676.5	4129.7		

Average Gallons per Minute
157.7

Streams 1 and 3: Clarified Salt Solution from ARP to SSRT 2

Process history taken from PI is based on accumulation in SSRT 2:

ARP to SSRT 2 - 2/3/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/3/13 12:07:19 PM	2/3/13 12:33:35 PM	0:26:16	26.27	154.7
gallons	2471.7	6533.9	4062.2		

ARP to SSRT 2 -2/6/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/6/13 1:03:39 AM	2/6/13 1:28:26 AM	0:24:47	24.78	155.5
gallons	2013.8	5867.7	3853.9		

ARP to SSRT 2 -2/10/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/10/13 5:53:05 AM	2/10/13 6:18:47 AM	0:25:42	25.70	157.4
gallons	1159	5203.2	4044.2		

Average Gallons per Minute
155.8

Stream 4: SSRT 1 to SSFT

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 63 gpm (R-20).

Process history taken from PI is based on depletion in SSRT 1:

SSRT 1 to SSFT - 2/2/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 8:51:09 AM	2/2/13 9:49:05 AM	0:57:56	57.93	74.6
gallons	6542.4	2223.3	4319.1		

SSRT 1 to SSFT - 2/4/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/4/13 3:01:30 AM	2/4/13 4:01:08 AM	0:59:38	59.63	75.0
gallons	6785.8	2311.2	4474.6		

SSRT 1 to SSFT - 2/5/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/5/13 4:12:46 AM	2/5/13 4:59:24 AM	0:46:38	46.63	75.0
gallons	6431.8	2934	3497.8		

Average Gallons per Minute
74.9

Stream 5: SSRT 2 to SSFT

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 64 gpm (R-20).

Process history taken from PI is based on depletion in SSRT 2:

SSRT 2 to SSFT - 1/31/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	1/31/13 8:50:32 AM	1/31/13 9:19:25 AM	0:28:53	28.88	72.0
gallons	5093	3012.9	2080.1		

SSRT 2 to SSFT - 2/3/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/3/13 2:30:39 AM	2/3/13 3:41:44 AM	1:11:05	71.08	72.8
gallons	6958.6	1782.5	5176.1		

SSRT 2 to SSFT - 2/4/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/4/13 12:30:01 PM	2/4/13 1:25:58 PM	0:55:57	55.95	72.7
gallons	6436.9	2367.7	4069.2		

Average Gallons per Minute
72.5

Stream 10: DSS Aqueous Decanter to DSSHT

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 13 gpm (R-20).

Process History taken from PI is based on accumulation in the DSSHT:

Stream 10 flow rates are determined from DSSHT accumulation during the time the DSS Decanter Aqueous Pump is On.

DSS Aqueous Decanter to DSSHT - 2/1/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/1/13 10:34:30 PM	2/1/13 10:42:36 PM	0:08:06	8.10	14.4
gallons	1172.1	1288.4	116.3		

DSS Aqueous Decanter to DSSHT - 2/1/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/1/13 11:03:34 PM	2/1/13 11:12:22 PM	0:08:48	8.80	16.3
gallons	1314.8	1458.1	143.3		

DSS Aqueous Decanter to DSSHT - 2/1/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/1/13 11:24:17 PM	2/1/13 11:37:39 PM	0:13:22	13.37	16.8
gallons	1481.5	1705.7	224.2		

Average Gallons per Minute
15.8

Stream 12: DSSHT to Tank 50

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 100 gpm (R-20).

Process History taken from PI is based on depletion of DSSHT:

DSSHT to Tank 50 - 2/2/2013
Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 5:21:31 AM	2/2/13 6:06:59 AM	0:45:28	45.47	90.9
gallons	4741.5	607.66	4133.84		

DSSHT to Tank 50 - 2/2/2013
Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 4:00:52 PM	2/2/13 4:59:07 PM	0:58:15	58.25	93.2
gallons	6010.4	578.75	5431.65		

DSSHT to Tank 50 - 2/3/2013
Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/3/13 3:13:36 AM	2/3/13 4:13:59 AM	1:00:23	60.38	95.2
gallons	6300.2	549.17	5751.03		

Average Gallons per Minute
93.1

Stream 26: Strip Effluent Aqueous Decanter to SEHT

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 7.5 gpm (R-20).

Process History taken from PI:

Stream 26 flow rates are determined from SEHT accumulation during the time the SE Decanter Aqueous Pump is On.

SE Aqueous Decanter to SEHT - 2/1/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/1/13 10:18:29 PM	2/1/13 10:26:14 PM	0:07:45	7.75	9.4
gallons	182.67	255.33	72.66		

SE Aqueous Decanter to SEHT - 2/2/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 12:58:28 AM	2/3/13 1:06:13 AM	0:07:45	7.75	9.5
gallons	260.96	334.9	73.94		

SE Aqueous Decanter to SEHT - 2/2/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 3:11:20 AM	2/2/13 3:18:46 AM	0:07:26	7.43	9.7
gallons	341.88	414.25	72.37		

Average Gallons per Minute
9.6

Stream 27: SEHT to DWPF

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 15.5 gpm (R-20).

Process History taken from PI is based on depletion of the SEHT:

SEHT to DWPF - 2/2/2013 Transfer

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/2/13 11:19:41 AM	2/2/13 11:49:55 AM	0:30:14	30.23	15.1
gallons	642.7	184.72	457.98		

SEHT to DWPF - 2/2/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/3/13 2:16:33 AM	2/3/13 2:48:13 AM	0:31:40	31.67	13.3
gallons	605.48	184.53	420.95		

SEHT to DWPF - 2/3/2013 Transfer

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/3/13 1:48:59 PM	2/3/13 2:12:01 PM	0:23:02	23.03	13.0
gallons	485.45	186.31	299.14		

Average Gallons per Minute
13.8

Stream 31: CDT to DSSHT

The MCU Process Contactor Drain Tank Pump Hydraulic Calculation predicts a nominal flow rate of 15 gpm (R-21).

The flow path from the CDT to the DSSHT was chosen as the design flow rate for stream 31. The flow rate of stream 31 is varied to meet the needs of the receiving process stream or vessel.

Process History taken from PI:

Flow Rates indicated by accumulation in the DSSHT while the CDT transfer pump is on.

CDT to DSSHT - 2/12/2013

blue cells indicate an input

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/12/13 7:12:52 PM	2/12/13 7:35:23 PM	0:22:31	22.52	19.6
gallons	1561.7	2002.4	440.7		

CDT to DSSHT - 2/19/2013

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/19/13 3:11:06 PM	2/19/13 3:39:36 PM	0:28:30	28.5	19.6
gallons	764.83	1323.9	559.07		

CDT to DSSHT - 2/26/2013

	start	end	Delta	Fill In Minute	Gallons Per Minute
date	2/26/13 10:52:34 AM	2/26/13 11:19:50 AM	0:27:16	27.27	19.6
gallons	2290	2825	535		

Average Gallons per Minute
19.6

Stream 32: DSS Decanter Organic Boot to SHT

The MCU Process Systems Hydraulic Calculation predicts a flow rate of 0.5 gpm (R-20).

Process History for the DSS Decanter Organic Boot is not available. The DSS Decanter Organic Boot does not impact the SHT volume in any significant matter; the SHT outlet flow rate to the extraction contactors does fluctuate to compensate for the solvent addition from the DSS Decanter. However, because the SHT levels do not reflect the stream 32 organic addition the flow rate for stream 32 cannot be determined.

Based on the capabilities of the pump, the design flow rate should be 0.5 gpm (R-20).

Stream 46: SE Decanter Organic Boot to Extraction

Process History for the SE Decanter Organic Boot is not available. Based on the capabilities of the pump, the design flow rate should be 0.5 gpm (R-20).

Stream 47, 48, 49: Nitric Acid Cleaning Agent to Process.

Streams 47, 48, 48A and 49 share the same pump. Historical process flow rates were not available for streams 47, 48, and 49. The MCU Process Contactor Drain Tank Pump Hydraulic Calculation predicts a flow rate of 27.75, 17, and 28.5 gpm, respectively (R-21).

Stream 52: Solvent Drum to SHT

Process History for the Solvent Drum additions to the SHT is not available. Based on the capabilities of the pump, the design flow rate should be 5.0 gpm (R-20).

Stream 48A: Sodium Hydroxide Cleaning Agent to DSS Coalescer

Historical process flow rates for stream 48A (30wt% NaOH Cleaning Solution) are not available from the tote to the DSS Hydraulic Accumulator. The DSS Hydraulic Accumulator is filled until a certain level (inWC) is reached in the DSS Hydraulic Accumulator. The chemical cleaning pump is then shut off and the cleaning solution is transferred to the DSS Coalescer. This volume is then sent to the CDT. The design flow rate for stream 48A is calculated by dividing the volume sent to the CDT by the time it takes to increase level in the DSS Accumulator.

Process History taken from PI:

Cleaning Agent to DSS Coalescer - 1/24/2013

blue cells indicate an input

	start	end	Delta	Fill In Minute	**Gallons Per Minute**
date	1/24/13 7:43:29 PM	1/24/13 7:51:32 PM	0:08:03	8.05	**9.1**
gallons	90.669	163.99	73.321		