TANK 29 SALT REMOVAL METHOD USING SLURRY PUMP AGITATION

by

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INTRODUCTION

Salt in Tank 29 will be dissolved to form a nearly saturated salt solution. The goal of Waste Removal is to remove the salt from the tank and deliver it to In-Tank Precipitation (ITP) at a concentration greater than 6.7 molar Na^+ (including dilution from transfer steam) to meet ITP requirements. (The amount of wash water used in ITP will be enough to dilute 6.7 molar Na^+ salt solution to 5 molar Na^+ required for the precipitation step.) The solution will be sent to In-Tank Precipitation (ITP) for precipitation of soluble cesium and strontium (radioactive elements). The precipitate will be transferred to the Defense Waste Processing Facility (DWPF) for final disposal. A USQD (Unreviewed Safety Question Determination) for criticality safety issue resolution will be completed prior to salt removal.

SUMMARY

This report outlines a plan for removing salt from Tank 29. The plan is based, in part, upon the experience gained in the removal of salt from Tank 19 and sludge from Tank 16. Tank 19 was the first tank in which slurry pumps were used during salt dissolution.

DISCUSSION

History of Tank 29

Tank 29 was constructed under project 981232 in a period from 1967 to 1970.¹ The first liquid fed to Tank 29 was 242-1H evaporator concentrate on September 20, 1971. Since then, only concentrate from evaporator 242-1H has been fed to Tank 29 except for a period in May and June of 1980 in which concentrated supernate was fed from Tank 10 to Tank 29. A list of all transfers to and from Tank 29 is printed in Appendix III. No sludge has been added to Tank 29.

Comparison with Past Salt Removal Projects

A demonstration of the use of slurry pumps for agitation during salt removal from Tank 19 took place in 1980 and 1981.² A comparison of factors relating to salt removal from Tank 19 and Tank 29 is given in Appendix I. Tank 16, containing sludge, is also included in the comparison, mainly because Tank 16 has cooling coils in connection with the use of slurry pumps.

To summarize the comparison, the rate of salt dissolution should be faster in Tank 29 than experienced in Tank 19 because Tank 19 used only one slurry pump (for the first three batches) and Tank 29 will use three slurry pumps for agitation. Also, there will be less dilution of the solution during agitation since leakage of bearing seal water into Tank 29 should be about 0.08 gpm per pump instead of 1.7 gpm. The reduction of in-leakage is due to improved seals on the pumps to be used on Tank 29.

EQUIPMENT

The following equipment description assumes that all modifications planned for Tank 29 have been completed. If the thermowells cannot be removed and replaced, then the equipment may revert to that described in references 3 and 4. Appendix IV shows a sketch of the risers on Tank 29 and list modifications to Tank 29 in progress in preparation for salt removal.

The equipment needed for removal of salt from Tank 29 is currently being installed, modified or checked for operability. This includes three standard Slurry Pumps, a Transfer Jet (TJ) in riser C1 which will be replaced by a Telescoping Transfer Jet (TTJ) after some salt has been removed from the tank, the inhibited water makeup system, the tank ventilation system, and instruments to measure liquid temperature and liquid level.

Three Standard Slurry Pumps (Figure I), Bingham model # VRP 2x15, will be installed in Risers E1, B6 and H. Each pump is 45 feet long. The pump drives are 150 horsepower motors without variable speed capability. The pumps discharge 1200 gallons per minute on a horizontal plane through two 1.5 inch discharge nozzles located on the impeller casing. The pumps are elevated by support spacers and located on turntables which can be rotated to aid in mixing fresh solution with salt crystals for faster salt dissolution. The pump shafts are supported by water lubricated bearings at intervals down the shaft. Burgmann mechanical seals are installed on the pump shafts to reduce seal water leakage into the tank. During pump operation, a positive pressure is maintained on the bearing seal water to prevent contaminated water from entering the bearing seal water system. Leaks through the bottom seal enter the HLW in the tank. A vent system forces any leakage out the top seal to enter the tank.

Instruments are available to record liquid level (by tape or conductivity), temperature at three different elevations, pressure in the tank, hydrogen concentration, radiation, and pressure drop through the exhaust gas filter systems.

Salt and supernate samples will be taken as required.

DATA COLLECTION

Appendix II lists some of the sample analyses required during salt dissolution from Tank 19. Many of the actinide analyses may be required to determine the potential for criticality during salt removal. For supernate fed to ITP, a Nuclear Criticality Safety Evaluation (NCSE) of the supernate will be required.⁵ The NCSE will determine the weight percent of equivalent U-235 that will be adsorbed on the sodium titanate particles from the supernate and will compare it to safe values. ITP⁶ and DWPF requirements must be checked at the time of sampling to make sure all the analytical requirements of these two groups are met.

The true value of data cannot be realized until it is put into a usable form. The report on Tank 19 salt dissolution was extremely valuable in preparation for salt removal from Tank 29. The following data are important from the standpoint of development of plans for future salt removal from waste tanks.

Bingham Slurry Pump

Provides agitation in F and H areas waste storage tanks to dissolve salt cake, slurry sludge and prepare feed for the DWPF. Three to four pumps per tank.

FIGURE I

- The temperature of the supernate should be recorded and plotted versus time during use of the slurry pumps. Data should be included such as volume of supernate, how many slurry pumps were used, what amperage was used, and any problems or downtime on one or more pumps during slurring operations. These data are needed because of the concern that the temperature of the supernate will rise too high and cause corrosion problems during salt dissolution. Given data of time versus temperature, future schedules can better estimate the time of agitation versus the temperature rise of the supernate when using three slurry pumps that have almost no leakage of bearing seal water into the tank.
- The density or specific gravity of the supernate versus time should be plotted. The primary purpose of the plot is to determine when to stop agitation. As the solution becomes saturated the specific gravity will level out to a horizontal line and further agitation will not increase the salt concentration. Given a plot of this data, the time to reach saturation can be estimated more accurately than using previous data when the slurry pump seals leaked. This data will be valuable in estimating schedules for future salt dissolution projects. The supernate in Tank 19 had lower specific gravities in each of four succeeding batches. The reason for the lower specific gravity in each batch is not known. Analytical data should be plotted against specific gravity for each sample. The specific gravity should be measured at the same temperature (preferably 77°F or 25°C) for each sample.
- The time to fill Tank 29 with the required inhibited solution should be recorded. This should include the time required to make up the solution as well as the time to add the solution to the tank.
- The transfer rate of solution from Tank 29 to Tank 48, at a specific steam pressure, from Tank 29 should be plotted against pressure head requirements as the tank level decreases. Record which pump (TJ or TTJ) was used for each transfer. Record the depth, from the bottom of the tank, of the inlet of the TJ or TTJ.
- An estimate of the amount of salt dissolved by the batch of inhibited water added per batch would be useful. The data should indicate the volume of salt removed, the volume of dissolving solution added, and the average specific gravity of each batch. If caustic solution (about one molar Na+) is added as the inhibited dissolving solution, the ratio of inhibited solution/salt dissolved should be higher than experienced in Tank 19 because the common ion lowers the solubility of salt.
- When the tank is nearly empty, a sample of the residual solids should be taken and analyzed. The solubility of the solids in water and oxalic acid should be determined. The actinide content of the solids should also be determined. Because Tank 29 will not be retired from service, the plans at this time are to empty the tank as much as possible without oxalic acid dissolution, unless a problem is associated with leaving the solids in the tank. A final decision must be made when data is available.
- Each sample of supernate should be recorded by chronological time of mixing and the molarity of nitrate, nitrite, hydroxide, carbonate and sulfate should be plotted versus time.

Given the supernate analysis and composition, an estimate of the salt dissolution rate can be made.

- The average rate of salt removal in gallons of salt removed per minute should be recorded. In Tank 19, the overall average, not counting downtime for repairs, analyses, etc., was about 7.5 gpm. In Tank 29, this rate should be improved by use of three slurry pumps that do not leak inhibited water through the bearing seals.
- A measurement of bearing water usage versus time should be recorded. The purpose of this data is to determine if the amount of in leakage into the tank through the bearings is increasing with time. The data will also point out a sudden failure of bearing seals if a rate of bearing water input is suddenly increased. The time should be noted when the slurry pumps are operating and also when they are not operating. This will help determine if there is any change in the rate of bearing water in-leakage when the pumps are operating versus not operating. Bearing water useage must be a continuous effort when the pumps are on.
- Any event that impacts the data requested above should be noted with the data.

METHOD OF SALT REMOVAL FROM TANK 29

General Methodology

Prior to initiating any tasks outlined in this plan, all prerequisites for operation of equipment in Tank 29 must be implemented. Health Protection must be notified of all plans.

The following discussion of the method for salt removal is based on conditions in Tank 29 in October 1993. Until salt removal actually begins in a couple of years, modifications to Tank 29 are taking place to prepare the tank for salt dissolution and transfer (see Appendix IV). Liquid levels, temperatures, salt levels, etc., will change between now and when salt removal actually begins. Water will be added to the tank when equipment is removed from the risers and sprayed during decontamination and removal (D & R) activities. Since the tank is nearly full of liquid at this time, some supernate may have to be transferred from Tank 29 before salt removal is done. This document should be viewed as a living document and used for a guide to prepare the step by step activity list for salt removal from Tank 29.

The tank level on 5/5/93 was 354.2 inches.⁷ There are 69 inches of supernate above the salt level. The waste tank fill limit is 372 inches.⁸ The maximum operating limit is 362 inches. (ref. Procedure 241-H-140) Tank temperatures are taken at 78 inches from the bottom of the tank in riser D4, 222 inches in riser D4, the knuckle in riser A4 and also at the bottom of the tank. (ref. Sketch 138-9-H-55A) A new thermowell is scheduled to be installed into riser D4.

The first 62 inches of supernate transferred from Tank 29 to Tank 48 will have to be diluted about 1/1 vol/vol to reduce the Na⁺ concentration before precipitation of radioactive isotopes.⁹ (62 inches represents the present liquid level, 354 inches, minus the level at the bottom of the TJ, 292 inches.) The supernate from a sample taken November 23, 1992, contained 14 molar Na⁺ (see

Appendix VI). Some dilution will take place during transfer when using the steam driven transfer jet. Sixty-nine (62) inches in Tank 29 equals about 217,000 gallons of supernate. Diluted 1/1, the volume in Tank 48 will be about 434,000 gallons. Tank 48 may already contain liquid depending upon the solution left in the tank after Tank 41 has been emptied. If so, then ITP will have to mix the liquid in Tank 48 and sample the liquid before a decision can be made on how much the solution in Tank 48 has to be diluted to meet the Na^+ specification. This will cause some delay in ITP processing during which salt can be dissolved in Tank 29. More supernate from salt dissolution in Tank 29 will probably be needed to make 600,000 gallons (which nominally represents one batch in Tank 48) of liquid within the specifications for ITP production.

The following steps for salt removal assume that the technical basis for criticality safety has been completed and documented in a Unreviewed Safety Question Determination (USQD).

The most likely scenario is that it will be acceptable to remove the supernate, but salt samples may be required when the supernate presently on top of the salt bed has been removed. Sampling and analysis of the results of the salt sample will interpose a delay in the resolution of the next step in the salt dissolution process. If criticality does pose a problem, water addition rates that limit the salt dissolution to a few inches per batch may be required. Other measures such as addition of neutron absorbers may even be required.

The steps in salt dissolution (assuming no criticality problems) are:

1. Transfer supernate from Tank 29 to Tank 48. Do not agitate the supernate with the slurry pumps before this first supernate transfer. The inlet to the Transfer Jet is presently located at the 292 inch level in Tank 29. Then 354 - 292 or 62 inches of liquid (about 217,000 gallons) is the maximum amount of supernate that can be removed initially. This solution, when diluted (1 vol/1 vol) in Tank 48 to lower the Na^+ concentration will make about 434,000 gallons of the initial batch for ITP to process.

From this point, about 166,000 gallons of five molar Na^+ solution will be needed in Tank 48 to finish making 600,000 gallons of salt solution for a batch. The suggested method for making the remaining solution is to add inhibited water into Tank 29 to the maximum operating level of 362 inches, agitate the supernate with the slurry pumps to obtain nearly saturated solution, sample the supernate to obtain the Na^+ content, and then calculate how much of this liquid to transfer to Tank 48 to make the remaining 166,000 gallons of five molar sodium solution after dilution. For example, if the supernate contained 10 molar Na^+ after salt dissolution, then 83,000 gallons ($166,000/2$) of supernate could be transferred to Tank 48 and 83,000 gallons of wash water from Tank 22 could be added to Tank 48 to lower the sodium concentration.

(Note: The amount of OH^- in the dissolution water should be calculated, based on the salt analysis and an estimate of the amount of salt dissolved by the dissolution water. The correct amount of caustic (OH^-) in the dissolution liquor should be the amount that will meet the Technical Standard in the salt solution formed. If the amount of caustic in the supernate is not enough to meet the Technical Standard 50% caustic will have to be added

to the tank. Since the salt is mostly sodium nitrate, a dissolving solution containing as high as 1.5 molar caustic could be needed to meet the Technical Standard. Two studies are being made which may affect this plan. SRTC is studying the Technical Standard to see if the amount of caustic needed to prevent corrosion can be reduced and whether or not caustic will be required in addition to dissolution water when dissolving salt. Systems Engineering will study the best way to add dissolution water to the waste tanks based on the SRTC recommendation, i.e. add caustic after the dissolution water has dissolved the salt or add caustic at the same time as the dissolution water using an in-line mixer. These studies will be done in 1994.)

A salt sample may be required by the HLW Engineering Support group before adding any inhibited water for salt dissolution. If so, the HLW Engineering Support group will require at least two weeks to study the results of the analyses for criticality concerns. This will cause a delay before inhibited water can be added.

[At issue is the time it takes to obtain the required analyses. Management should determine which laboratory will be responsible for the analytical work on the salt and supernate samples once the waste removal effort has begun. Experience to date has shown that several months were required to analyze a single salt sample from Tank 41. If the samples are not given top priority once waste removal has begun, the cost of waste removal will be enormous due to the delay.]

The following steps assume there is no criticality problem.

2. Add inhibited water to the 362 inch level to dissolve salt. (see note in 1 above about the inhibited water make-up.)
3. Ensure the reel tape has been raised to at least 10 inches above the liquid level and placed in "PARK". This will prevent alarms caused by agitation when the slurry pumps are turned on. Turn on the slurry pumps and rotate them to prevent damage to the cooling coils.¹⁰ The slurry pumps do not have a variable speed drive. Make sure the liquid level covers the slurry pumps enough to prevent high level alarms caused by mist formation and splashing.

While the slurry pumps are operating, check the supernate temperature and shut off the pumps if the temperature exceeds the operating limit.

4. Operate the slurry pumps for about 48 hours. Then shut off the slurry pumps and sample the supernate. If the Na^+ concentration is 6.7 M or greater, prepare to transfer the supernate to Tank 48.

[Note: There is no need to agitate the solution until it is completely saturated. The supernate will have to be diluted to about 5 molar Na^+ in Tank 48 before treating the solution to remove soluble isotopes. Some dilution of the salt solution (about 5 to 10 %) is experienced during transfer using the steam driven transfer jets. Make sure the steam

pressure is near 150 psig so that the salt solution is not diluted too much during transfer from Tank 29 to Tank 48.]

If the solution does not contain at least 6 molar Na⁺, then agitate the supernate another 48 hours using the slurry pumps and then take another sample.

5. Using the TJ, transfer the required amount of solution out of Tank 29 into Tank 48. Follow the logic in step 1 when removing the supernate.

Note: Step 6 will not be necessary until the TTJ is installed. There is no way to lower the liquid level to the salt level until the presently installed TJ is replaced by the TTJ.

6. Visually check the salt level and salt distribution in the tank after each supernate transfer out of Tank 29 except the first transfer. Check for undissolved salt hanging on the cooling coils or any other equipment above the liquid level. If a substantial amount of salt is left hanging on the equipment, then an action plan should be established to remove the salt before proceeding to a lower level in the tank.
7. Determine the salt level. If the salt level is above 215 inches in the tank, then add inhibited water to the 362 inch level and dissolve more salt. Continue the cyclic process (adding inhibited water to the 362 inch level and removing salt solution) until the salt level is below the 215 inch level. When the salt is below the 215 inch level, replace the TJ with the TTJ. The maximum level the TTJ can be retracted to is 215 inches¹¹.
8. Based on Tank 19 results, 2.4 gallons of water dissolved 1 gallon of salt, on the average. Using this ratio of dissolution water to salt dissolved, the dissolution water should be added to the full (362 inch) level for four times. The estimated salt dissolved for each batch will be:

<u>BATCH</u>	<u>ADD</u>	<u>DISSOLVE</u>	<u>NEW SALT LEVEL</u>
First	5.8 ft water	2.4 ft salt	265 in.
Second	8 ft water	3.3 ft salt	226 in.
Third	11.2 ft water	4.7 ft salt	169 in.
Fourth	15.9 ft water	6.6 ft salt	90 in.
Fifth	7.5 x 2.4=18 ft	7.5 ft salt	0

After four batches, the salt level should be near the 90 inch level. When the salt level is below the 106 inch level, then add 2.4 times the salt level to the tank for the last batch.

Note: The ratio of 2.4 is based on Tank 19 results. Some slight adjustment may be needed for Tank 29. The adjustment should be based on experience from the amount of salt dissolved in the first four batches.

9. Lower the slurry pumps each time the salt level is reduced. It was shown in tank 19 that salt dissolved much faster when the bottom of the slurry pump was close as possible to the salt. The pumps in Tank 29 can be lowered in increments of 2.5 feet.
10. After the fifth batch, there may be some insoluble solids left in the bottom of the tank. Since Tank 29 will not be retired from service, there should be no need for chemical cleaning to completely empty the tank, unless a criticality problem exists. A sample of the solids left on the bottom of the tank should be taken and analyzed for solids incompatible with future use of the tank. The HLWE Waste Characterization Manager should be consulted to evaluate the sample results.

Environmental Impacts

All conditions of the applicable permits shall be met. A list of applicable permits is given in Appendix V.

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APPENDIX I

Differences Between Tank 16 & Tank 19 Experience And The Present Situation In Tank 29

Differences Between Tank 16 & Tank 19 Experience And The Present Situation In Tank 29

Concern	Tank 16	Tank 19	Tank 29
Damage to cooling coils.	Had cooling coils, but sludge was only about 24 inches deep. Sludge does not stick to cooling coils like salt does. No comparison in this area with Tank 29.	No cooling coils.	Salt is attached to cooling coils. If salt is not dissolved from the top down, then the weight of the salt could damage the coils when the liquid is removed from the salt. A maximum of five feet of unsupported salt is allowed on the coils. ¹² The cooling coils in Tank 29 are suspended from the top of the tank, thereby causing more concern for damage.
Agitation Pattern	Single slurry pump test showed 30 foot radius agitation pattern instead of 20 foot radius pattern predicted by TNX. ¹³ Use of three slurry pumps was sufficient to slurry almost all of the sludge from the bottom of the tank.	Use of two slurry pumps left some undissolved solids in the tank bottom even with no coils in the tank. Indicates that at least three slurry pumps are needed.	Will use three slurry pumps to promote salt dissolution. The pump will be basically the same design as used in Tank 19, except for better seals.
Use of slurry pumps	No experience here for salt removal.	One slurry pump until last batch where two slurry pumps were used. Plenty of liquid above the salt level at the start of salt dissolution.	Three slurry pumps. Liquid level above pump suction will be almost identical to the Tank 19 experience.
Criticality	Sludge had excess Fe and Mn.	Depleted U only. No sample of residual material.	Will be documented in USQD prior to salt dissolution.

<p>Dilution from slurry pump seal in leakage.</p>	<p>No experience comparable with Tank 29 situation.</p>	<p>Average dilution from slurry pump seal leaks was 1.7 gallons per minute. The second batch took over 600 hours to reach saturation, partly because of dilution.</p>	<p>New pump seals should leak very little, i.e. only a few cubic centimeters per minute. Saturation should be reached faster than Tank 19 experienced. Seal leakage to be monitored.</p>
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APPENDIX II

Sample Requirements

Sample Requirements

Salt Sample (Following outline of reference 14)

^{233}U , ^{234}U , ^{235}U , ^{236}U , ^{238}U , TOTAL U
 ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{242}Pu , TOTAL Pu

Determine the water soluble and water insoluble Plutonium and Uranium.

Ag, As, Se, Ca, Cd, Co, Cu, Mg, Mn, Pb, Zn, Zr, Al, Ba, Fe, La, Li, Mo, Na, Ni, Sn, Sr, Tc, Ti, V, B, Cr, P, Si, K, Hg, U, Pu (both soluble and insoluble of all in this list)

Dissolution tests as indicated in reference 14 may also be required. Check with High Level Waste Engineering Support Manager.

Supernate Liquid Sample

The supernate sample is of interest to ITP, Engineering, and HLWE Engineering Support. Check with each group for completeness of the analytical requirements before sampling. The following analyses are required at the present time.

sp. gr., NO_3 , NO_2 , OH, CO_3 , SO_4 , pH, soluble U and soluble Pu in the isotopes listed in the salt sample.

APPENDIX III

Transfers to and from Tank 29

**Compiled from WSRC-TR-93-425, Waste Transfers and
Miscellaneous Additions (U), August 9, 1993**

Transfers to and from Tank 29

Reported Date	Actual Date	Receipt Tank	Sending Tank	Sending (gal)	Receipt (gal)	Sludge %	Type Waste	Description/Comments
Sep-71	9/20/71	29	242-1H	299000	299000	0	EVAPCONC	
Sep-71	9/20/71	32	29	21000	21000	0	CONC	Start-up Heel for Tank 32
Oct-71	10/20/71	29	242-1H	225000	225000	0	EVAPCONC	
Nov-71	11/20/71	29	242-1H	304000	304000	0	EVAPCONC	
Dec-71	12/20/71	29	242-1H	394000	394000	0	EVAPCONC	
Jan-72	12/29/71	21	29	20000	21000	0	CONCSN	
Jan-72	1/1/72	21	29	57000	60000	0	CONCSN	
Jan-72	1/9/72	21	29	625000	648000	0	CONCSN	
Jan-72	1/20/72	29	242-1H	240000	240000	0	EVAPCONC	
Feb-72	2/20/72	10	29	90000	90000	0	EDT	
Feb-72	2/20/72	29	242-1H	319000	319000	0	EVAPCONC	
Mar-72	3/20/72	29	242-1H	250000	250000	0	EVAPCONC	
Apr-72	4/6/72	21	29	80000	82000	0	CONCSN	
Apr-72	4/20/72	29	242-1H	88000	88000	0	EVAPCONC	
May-72	5/20/72	29	242-1H	32000	32000	0	EVAPCONC	
Jun-72	6/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Jun-72	6/20/72	29	242-1H	21000	21000	0	EVAPCONC	
Jul-72	7/4/72	21	29	635000	651000	0	CONCSN	
Jul-72	7/17/72	21	29	329000	336000	0	CONCSN	
Jul-72	7/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Aug-72	8/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Aug-72	8/20/72	29	242-1H	376000	376000	0	EVAPCONC	
Sep-72	9/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Sep-72	9/20/72	29	242-1H	177000	177000	0	EVAPCONC	
Oct-72	10/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Oct-72	10/20/72	29	242-1H	280000	280000	0	EVAPCONC	
Nov-72	11/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Nov-72	11/20/72	29	242-1H	165000	165000	0	EVAPCONC	
Dec-72	12/19/72	21	29	8000	9000	0	CONCSN	
Dec-72	12/20/72	29		0	4000	0	MISCADD/TRAN	Cond. H2O from CTS System
Jan-73	1/4/73	21	29	86000	89000	0	CONCSN	
Jan-73	1/13/73	21	29	520000	536000	0	CONCSN	
Jan-73	1/20/73	29		0	4000	0	MISCADD/TRAN	Cond. Water from CTS
Feb-73	2/17/73	21	29	468000	486000	0	HHWCONCSN	
Feb-73	2/20/73	29		0	4000	0	MISCADD/TRAN	Cond. Water from CTS
Mar-73	3/20/73	29		0	3000	0	MISCADD/TRAN	Cond. Water from CTS
Mar-73	3/20/73	29	242-1H	306000	306000	0	EVAPCONC	
Apr-73	4/20/73	29		0	5000	0	MISCADD/TRAN	Cond. Water from CTS
Apr-73	4/20/73	29	242-1H	297000	297000	0	EVAPCONC	
May-73	5/20/73	29		0	5000	0	MISCADD/TRAN	Cond. Water from CTS
May-73	5/20/73	29	242-1H	268000	268000	0	EVAPCONC	
Jun-73	6/20/73	29		0	4000	0	MISCADD/TRAN	Cond. Water from CTS
Jun-73	6/20/73	29	242-1H	69000	69000	0	EVAPCONC	
Jul-73	7/13/73	21	29	131000	135000	0	CONCSN	
Jul-73	7/20/73	29		0	5000	0	MISCADD/TRAN	Cond. Water from CTS
Jul-73	7/20/73	29	242-1H	30000	30000	0	EVAPCONC	
Aug-73	7/26/73	21	29	84000	88000	0	CONCSN	

Aug-73	7/30/73	21	29	319000	335000	0	CONCSN	
Aug-73	8/12/73	21	29	161000	169000	0	CONCSN	
Aug-73	8/20/73	29		0	5000	0	MISCADD/TRAN	Cond. Water from CTS
Aug-73	8/20/73	29	242-1H	299000	299000	0	EVAPCONC	
Sep-73	9/6/73	21	29	534000	561000	0	CONCSN	
Sep-73	9/20/73	29		0	4000	0	MISCADD/TRAN	Cond. Water from CTS
Sep-73	9/20/73	29		0	3000	0	MISCADD/TRAN	CRC Flushes
Sep-73	9/20/73	29	242-1H	524000	524000	0	EVAPCONC	
Oct-73	10/8/73	21	29	400000	419000	0	CONCSN	
Oct-73	10/20/73	29		0	4000	0	MISCADD/TRAN	Cond. Water from CTS
Oct-73	10/20/73	29	242-1H	590000	590000	0	EVAPCONC	
Nov-73	11/4/73	21	29	287000	301000	0	CONCSN	
Nov-73	11/20/73	29		0	5000	0	MISCADD/TRAN	Conde. Water from CTS
Nov-73	11/20/73	29	242-1H	191000	191000	0	EVAPCONC	
Dec-73	12/20/73	29		0	2000	0	MISCADD/TRAN	Cond. Water from CTS
Dec-73	12/20/73	29	242-1H	261000	261000	0	EVAPCONC	
Jan-74	12/28/73	21	29	196000	206000	0	CONCSN	
Jan-74	1/4/74	21	29	353000	370000	0	CONCSN	
Jan-74	1/20/74	29		0	5000	0	MISCADD/TRAN	CTS Condensation
Jan-74	1/20/74	29	242-1H	176000	176000	0	EVAPCONC	
Feb-74	2/20/74	29	242-1H	353000	353000	0		
Mar-74	3/10/74	21	29	406000	422000	0	CONCSN	
Apr-74	4/5/74	21	29	333000	349000	0	CONCSN	
Apr-74	4/20/74	29	242-1H	363000	393000	0	EVAPCONC	
May-74	4/27/74	21	29	258000	271000	0	CONCSN	
May-74	5/20/74	21	29	289000	304000	0	CONCSN	
May-74	5/20/74	29	242-1H	674000	695000	0	EVAPCONC	
Jun-74	5/29/74	21	29	431000	453000	0	CONCSN	
Jun-74	6/18/74	21	29	201000	211000	0	CONCSN	
Jun-74	6/20/74	29	242-1H	677000	713000	0	EVAPCONC	
Jul-74	7/20/74	29	242-1H	188000	188000	0	EVAPCONC	
Aug-74	8/1/74	21	29	662000	695000	0	CONCSN	
Aug-74	8/20/74	21	29	267000	280000	0	CONCSN	
Aug-74	8/20/74	29	242-1H	502000	555000	0	EVAPCONC	
Sep-74	8/25/74	21	29	221000	232000	0	CONCSN	
Sep-74	9/11/74	21	29	294000	309000	0	CONCSN	
Sep-74	9/16/74	21	29	140000	147000	0	CONCSN	
Sep-74	9/20/74	29	242-1H	765000	810000	0	EVAPCONC	
Oct-74	9/24/74	21	29	222000	233000	0	CONCSN	
Oct-74	10/20/74	29	242-1H	228000	244000	0	EVAPCONC	
Nov-74	11/9/74	21	29	578000	607000	0	CONC	
Nov-74	11/20/74	29	242-1H	246000	264000	0	EVAPCONC	
Dec-74	12/20/74	29	242-1H	433000	467000	0	EVAPCONC	
Jun-75	6/8/75	21	29	123000	129000	0	HHW	
Jul-75	7/10/75	21	29	76000	800000	0	CONCSN	
Jul-75	7/14/75	21	29	325000	341000	0	CONCSN	
Nov-75	11/20/75	29	242-1H	493000	493000	0	EVAPCONC	
Dec-75	12/20/75	29	242-1H	17000	17000	0	EVAPCONC	
Mar-76	3/20/76	29	242-1H	278000	295000	0	EVAPCONC	
Mar-76	2/25/76	13	29	225000	237000	0	HHWCONCSN	
Mar-76	3/6/76	13	29	147000	154000	0	HHWCONCSN	
Apr-76	4/20/76	29	242-1H	205000	205000	0	EVAPCONC	

Apr-76	4/12/76	13	29	265000	278000	0	HHWCONCSN	
May-76	5/20/76	29	242-1H	68000	68000	0	EVAPCONC	
Jun-76	6/20/76	13	29	186000	195000	0	HHWCONC	
Jul-76	7/20/76	29	242-1H	151000	151000	0	EVAPCONC	
Jul-76	6/24/76	13	29	117000	122000	0	HHWCONCSN	
Aug-76	8/20/76	29	242-1H	171000	181000	0	EVAPCONC	
Sep-76	9/4/76	13	29	143000	149000	0	HHWCONCSN	
Oct-76	10/20/76	29	242-1H	137000	137000	0	EVAPCONC	
Feb-77	2/5/77	13	29	205000	212000	0	CONCSN	
Mar-77	3/20/77	29	242-1H	229000	239000	0	EVAPCONC	
May-77	5/13/77	13	29	111000	116000	0	SNATE	
May-77	5/20/77	29	242-1H	46000	47000	0	EVAPCONC	
Jun-77	6/6/77	13	29	49000	51000	0	CONCSN	
Jun-77	6/20/77	29	242-1H	84000	84000	0	EVAPCONC	
Sep-77	9/10/77	13	29	284000	295000	0	CONCSN	
Sep-77	9/20/77	29	242-1H	24000	24000	0	EVAPCONC	
Oct-77	10/4/77	13	29	39000	42000	0	CONCSN	
Oct-77	10/20/77	29	242-1H	298000	307000	0	EVAPCONC	
Jan-78	12/31/77	36	29	241000	250000	0	CONCSN	
Jan-78	1/20/78	29	242-1H	15000	32000	0	EVAPCONC	
Feb-78	2/20/78	29	242-1H	207000	214000	0	EVAPCONC	
Mar-78	3/13/78	37	29	238000	250000	0	CONCSN	
Apr-78	4/20/78	29	242-1H	3000	3000	0	EVAPCONC	
May-78	5/20/78	29	242-1H	30000	30000	0	EVAPCONC	
Jun-78	6/20/78	37	29	49000	51000	0	CONCSN	
Jun-78	6/20/78	29	242-1H	201000	201000	0	EVAPCONC	
Jul-78	6/22/78	37	29	186000	194000	0	CONCSN	
Jul-78	7/19/78	36	29	9000	9000	0	CONCSN	
Jul-78	7/20/78	29	242-1H	234000	247000	0	EVAPCONC	
Aug-78	7/24/78	36	29	229000	238000	0	CONCSN	
Aug-78	8/20/78	29	242-1H	138000	138000	0	EVAPCONC	
Sep-78	9/6/78	36	29	212000	221000	0	HHWCONCSN	
Sep-78	9/20/78	29	242-1H	113000	113000	0	EVAPCONC	
Nov-78	11/20/78	29	242-1H	179000	179000	0	EVAPCONC	
Dec-78	11/23/78	37	29	242000	252000	0	CONCSN	
Dec-78	12/20/78	29	242-1H	211000	211000	0	EVAPCONC	
Jan-79	1/19/79	37	29	247000	261000	0	CONCSN	
Jan-79	1/19/79	35	29	2000	2000	0	CONCSN	
Jan-79	1/20/79	29	242-1H	62000	62000	0	EVAPCONC	
Feb-79	2/19/79	36	29	247000	256000	0	CONCSN	
Feb-79	2/19/79	35	29	2000	2000	0	CONCSN	
Feb-79	2/20/79	29	242-1H	237000	237000	0	EVAPCONC	
Mar-79	3/20/79	36	29	36000	37000	0	CONCSN	
Mar-79	3/20/79	35	29	2000	2000	0	CONCSN	
Mar-79	3/20/79	29	242-1H	234000	243000	0	EVAPCONC	
Apr-79	3/22/79	36	29	144000	148000	0	CONCSN	
Apr-79	3/23/79	37	29	42000	43000	0	CONCSN	
Apr-79	4/20/79	37	29	121000	125000	0	CONCSN	
Apr-79	4/20/79	35	29	2000	2000	0	CONCSN	
Apr-79	4/20/79	29	242-1H	225000	225000	0	EVAPCONC	
May-79	4/22/79	37	29	119000	123000	0	CONCSN	
May-79	5/17/79	36	29	126000	129000	0	CONCSN	

May-79	5/17/79	13	29	8000	9000	0	CONCSN	
May-79	5/18/79	13	29	52000	6000	0	CONCSN	
May-79	5/18/79	37	29	6000	54000	0	CONCSN	
May-79	5/20/79	29	242-1H	214000	226000	0	EVAPCONC	
May-80	5/2/80	29	10	15176	52345	0	CONCSN	
May-80	5/13/80	29	10	3523	8387	0	CONCSN	
May-80	5/14/80	29	10	4607	16195	0	CONCSN	
May-80	5/15/80	29	10	4336	15328	0	CONCSN	
May-80	5/20/80	29	10	5420	53962	0	CONCSN	
Jun-80	5/24/80	29	10	16100	16100	0	CONCSN	
Jun-80	5/25/80	29	10	15100	16300	0	CONCSN	
Jun-80	5/27/80	29	10	14600	14700	0	CONCSN	
Jun-80	6/1/80	37	29	26000	27000	0	CONCSN	
Jun-80	6/6/80	29	10	4600	3000	0	CONCSN	
Jun-80	6/9/80	29	10	5400	6900	0	CONCSN	
Jun-80	6/10/80	29	10	7600	7700	0	CONCSN	
Jun-80	6/11/80	29	10	7300	5600	0	CONCSN	
Jun-80	6/12/80	29	10	7300	7400	0	CONCSN	
Nov-80	10/31/80	37	29	156000	164000	0	CONSN	
Nov-80	11/20/80	29	242-1H	218000	241000	0	EVAPCONC	
Dec-80	11/28/80	36	29	218000	230000	0	CONCSN	
Dec-80	12/18/80	36	29	157000	174000	0	CONCSN	
Dec-80	12/20/80	29	242-1H	215000	215000	0	EVAPCONC	
Jan-81	12/24/80	37	29	92000	92000	0	CONCSN	
Jan-81	1/20/81	29	242-1H	185000	210000	0	EVAPCONC	
Feb-81	1/22/81	37	29	186000	190000	0	CONCSN	
Feb-81	1/25/81	37	29	82000	86000	0	CONCSN	
Feb-81	2/20/81	29	242-1H	190000	231000	0	EVAPCONC	
Mar-81	3/5/81	37	29	179000	187000	0	CONCSN	
Mar-81	3/20/81	36	29	158000	168000	0	CONCSN	
Mar-81	3/20/81	29	242-1H	106000	130000	0	EVAPCONC	
Apr-81	4/20/81	29	242-1H	201000	221000	0	EVAPCONC	
May-81	4/22/81	37	29	22000	24000	0	CONCSN	
May-81	5/1/81	37	29	184000	198000	0	CONCSN	
May-81	5/20/81	29	242-1H	144000	169000	0	EVAPCONC	
Nov-81	11/15/81	37	29	192000	196000	0	CONCSN	
Mar-82	3/11/82	36	29	203000	211000	0	CONCSN	
Mar-82	3/20/82	29	242-1H	290000	290000	0	EVAPCONC	
Apr-82	3/29/82	36	29	179000	186000	0	SNATE	
Apr-82	4/20/82	29	242-1H	82000	94000	0	EVAPCONC	
Jul-82	7/16/82	36	29	190000	223000	0	CONCSN	
Jul-82	7/20/82	29	242-1H	222000	237000	0	EVAPCONC	
Aug-82	8/4/82	36	29	184000	195000	0	CONCSN	
Aug-82	8/20/82	36	29	180000	189000	0	CONCSN	
Aug-82	8/20/82	29	242-1H	271000	289000	0	EVAPCONC	
Sep-82	9/8/82	36	29	127000	134000	0	CONCSN	
Sep-82	9/9/82	37	29	72000	78000	0	CONCSN	
Sep-82	9/20/82	29	242-1H	117000	116000	0	EVAPCONC	
Oct-82	9/24/82	13	29	182000	192000	0	CONCSN	
Oct-82	10/15/82	37	29	176000	184000	0	CONCSN	
Nov-82	10/27/82	36	29	184000	192000	0	CONCSN	
Nov-82	11/20/82	29	242-1H	136000	140000	0	EVAPCONC	

Dec-82	12/2/82	36	29	167000	180000	0	CONCSN	
Dec-82	12/18/82	37	29	93000	102000	0	CONCSN	
Dec-82	12/20/82	29	242-1H	266000	240000	0	EVAPCONC	
Jan-83	12/22/82	13	29	78000	84000	0	CONCSN	
Jan-83	1/12/83	36	29	137000	143000	0	CONCSN	
Jan-83	1/20/83	29	242-1H	279000	294000	0	EVAPCONC	
Apr-83	4/7/83	36	29	166000	178000	0	CONCSN	
May-83	5/18/83	36	29	167000	174000	0	CONCSN	
May-83	5/20/83	29	242-1H	157000	175000	0	EVAPCONC	
Jun-83	6/3/83	36	29	182000	189000	0	CONCSN	
Jun-83	6/16/83	36	29	190000	209000	0	CONCSN	
Jun-83	6/20/83	29	242-1H	381000	385000	0	EVAPCONC	
Jul-83	7/9/83	37	29	175000	201000	0	CONCSN	
Jul-83	7/20/83	29	242-1H	160000	168000	0	EVAPCONC	
Aug-83	8/6/83	37	29	179000	199000	0	CONCSN	
Aug-83	8/20/83	29	242-1H	331000	335000	0	EVAPCONC	
Aug-83	8/21/83	37	29	161000	177000	0	CONCSN	
Aug-83	8/21/83	24	29	11000	11000	0	CONCSN	
Sep-83	9/2/83	37	29	12000	14000	0	CONCSN	
Sep-83	9/2/83	24	29	7000	8000	0	CONCSN	
Sep-83	9/3/83	37	29	43000	44000	0	CONCSN	
Sep-83	9/5/83	37	29	117000	121000	0	CONCSN	
Sep-83	9/20/83	29	242-1H	220000	228000	0	EVAPCONC	
Oct-83	10/20/83	29	242-1H	45000	56000	0	EVAPCONC	
Nov-83	10/29/83	36	29	161000	167000	0	CONCSN	
Nov-83	11/20/83	29	242-1H	269000	283000	0	EVAPCONC	
Dec-83	11/25/83	37	29	184000	191000	0	CONCSN	
Dec-83	12/20/83	29	242-1H	120000	127000	0	EVAPCONC	
Jan-84	1/20/84	29	242-1H	49000	49000	0	EVAPCONC	
Aug-84	8/20/84	29		0	4000	0	MISCADD/TRAN	Concentrate Transfer System
Apr-86	4/18/86	30	29	74000	77000	0	SNATE	
Jul-87	7/31/87	29	242-1H	2000	2000	0	EVAPCONC	
Jun-88	6/30/88	29	242-1H	3000	3000	0	EVAPCONC	
Jul-88	7/31/88	29	242-1H	1000	8000	0	EVAPCONC	

APPENDIX IV

**Sketch of Risers on Tank 29
and
Modifications in Progress**

Sketch of Risers on Tank 29

138-8-H-174A

TANK 29 RISER ARRANGEMENT (U)

Revision 0
 Approval Date 10/24/91
 Category 3
 Manual SW1.10
 WMO
 Page 1 of 1

* This Is A New Procedure

NOTE

() Items to be installed

RISER DESCRIPTION

A1 CONDUCTIVITY PROBE, ACCESS PLATE, ANNULUS JET
 A2 DIP TUBES, LIQUID LEVEL TRANSMITTER, ACCESS PORT
 A3 CONDUCTIVITY PROBE, ACCESS PORT
 A4 CONDUCTIVITY PROBE, ACCESS PORT
 B1-5 COOLING WATER BUNDLES
 B6 SPARE
 B7-10 COOLING WATER BUNDLES
 C1 TRANSFER JET (WASTE OUTLET), DOWNCOMER (WASTE INLET)
 C2 CTS DRAFF VALVE
 D1 THERMOCOUPLE WELL (FAILED & CONTAMINATED), H2 MONITOR
 D2 THERMOCOUPLE WELL (FAILED & CONTAMINATED), SPARE PIPE
 ADI ANNULUS DEHELMETER INLET

RISER DESCRIPTION

D3 THERMOCOUPLE WELL, SPARE PIPE
 D4 THERMOCOUPLE WELL, SPARE PIPE
 E1 DIP TUBES, ANNULUS JET OUTLET
 E2 REEL TAPE
 H STEEL TAPE, HIGH LIQUID LEVEL
 CONDUCTIVITY PROBE
 J DEMISTER (PURGE AIR OUT)
 K ANNULUS AIR INLET
 L ANNULUS AIR OUTLET
 P1-14
 AO ANNULUS OUTLET

REFERENCE DRAWING

W 236519
 W 236812
 W 237072
 W 236830
 W 447835
 W 236569
 W 832031

Modifications To Tank 29

Riser B6	Convert spare riser to contain new slurry pump and spray chamber
Riser C1	After the existing Transfer Jet (TJ) is used to remove some salt, a new Telescoping Transfer Jet (TTJ) with Spray Chamber will be added.
Riser D1	Remove failed thermocouple and H ₂ monitor. Then install a new riser plug and inlet for annulus jet outlet (for pumping liquid from annulus back into Tank 29)
Riser D2	Remove existing failed thermocouple well and install a new riser plug.
Riser D3	Change existing thermowell to mining thermowell, replace existing riser plug with a new riser plug with a caustic addition facility, an inhibited water addition pipe, and an inspection port with steel tape for measuring liquid level.
Riser D4	Replace riser plug and thermocouple well with a new riser plug. A variable depth sampler and mining of a thermocouple well to near the bottom of tank will be in this riser.
Riser E1	Remove dip tubes and annulus jet outlet. Add slurry pump with spray chamber.
Riser H	Remove steel tape and high liquid level conductivity probe and add a slurry pump with a spray chamber.

APPENDIX V

Active Permits Relating To Waste Removal

Active Permits Relating To Waste Removal

National Environmental Policy Act:

1. ERDA-1537 "Final Environmental Impact Statement - Waste Management Operations - Savannah River Plant - Aiken, South Carolina."
2. DOE-EIS-0062 "Final Environmental Impact Statement - Supplement to ERDA-1537 - Waste Management Operations, Savannah River Plant, Aiken, South Carolina - Double Shelled Tanks for Defense High Level Radioactive Waste Storage."

Federal Facility Agreement:

3. Savannah River Site Federal Facility Agreement, Administrative Docket Number: 89-05-FF

Land Disposal Restriction-Federal Facility Compliance Agreement:

4. Federal Facility Compliance Agreement; Savannah River Site, EPA Docket #91-01-FFR, EPA ID #SCI 890 008 989

South Carolina Department of Health and Environmental Control Industrial Wastewater Permit

5. Construction Permit No. 17, 424-IW, "F & H Area High Level Radioactive Waste Tank Farms", 3 March, 1993.

South Carolina Department of Health and Environmental Control Air Quality Control Permit

6. Permit to Operate Seven (7) Diesel Generators at Waste Management Facilities in H-Area - Permit #0080-0041.

National Pollution Discharge and Elimination System:

7. NPDES Permit for Savannah River Site; Permit # SC000175.

South Carolina Department of Health and Environmental control Domestic Water Permit:

8. Permit SC#405556: H-Area Facilities

South Carolina Department of Health and Environmental Control Sanitary Water Permit:

9. Permit #12910 and Addendum: H-Area Facilities.

APPENDIX VI

Analytical Data From Tank 29

Analytical Results from Supernate Sample taken from Tank 29 on 11/23/92

Density	(g/ml)	1.47
Na	(molar)	14
K	(molar)	0.086
Al	(molar)	0.93
Mn	(ppm)	0.3
Fe	(ppm)	2.3
Si	(ppm)	25
As	(ppm)	<19
Ba	(ppm)	1.4
Cd	(ppm)	0.75
Cr	(ppm)	407
Pb	(ppm)	<51
Se	(ppm)	<235
Ag	(ppm)	0.21
NO ³	(molar)	1.66
NO ²	(molar)	2.38
SO ⁴	(molar)	0.012
PO ⁴	(molar)	<0.01
Cl	(molar)	0.017
F	(ppm)	<8
Oxalate	(molar)	<0.01
Total OH	(molar)	6.5
AlO ²	(molar)	0.93
Cs-137	(d/m/ml)	6.5E09
Cs-134	(d/m/ml)	2.0E07
Ru-106	(d/m/ml)	2.0E05
Sb-125	(d/m/ml)	4.9E04
Co-60	(d/m/ml)	4/7E03
Eu-154	(d/m/ml)	<900
Sn-126	(d/m/ml)	1/0E04
Sr-89/90	(d/m/ml)	8.5E05
Sr error		±14%
Tc-99	(d/m/ml)	1.15E06
U-238	(ppm)	2.2
U-235	(ppm)	0.44
Total Alpha		1.0E07
Total B/G		5.4E09

Supernate Sample History Of Tank 29

Date	Sp. Gr.	pH	NO2 (M)	NO3 (M)	OH (M)
11/28/92	1.4300		2.3800	1.6600	6.5000
12/26/91	1.4530	> 14	1.6100	1.9800	5.7500
06/23/91	1.4525	14.00	2.3200	2.1300	5.1700
01/03/90					
12/15/89	1.4430	13.95	2.1900	2.0500	6.2900
05/22/89	1.4139	13.57	2.3200	1.8000	4.8800
08/22/88	1.3657	13.78	1.9200	1.7100	5.0200
07/17/87	1.1354	13.58	1.4200	1.1200	4.1700
07/17/87	1.1354	13.58	1.4200	1.1200	4.1700
02/26/85	1.4000		1.3000	1.3000	6.3000
01/11/85					
10/12/84	1.4600	14.48	2.1400	1.5900	3.6300
09/17/84					
08/16/83	1.5600	14.95	2.0100	1.7200	10.8200
09/10/82	1.4800	14.70	1.9000	1.5000	7.0000
02/15/82	1.3500		2.2000	2.5000	4.7000
09/09/81	1.2400	13.20	0.2000	0.2000	1.2000
11/10/80	1.5000	15.00	3.0000	2.8000	1.6000
06/20/80	1.4000		0.3800	4.7000	0.8800
06/17/80	1.4000	13.80	0.3000	4.8000	1.1000
06/10/80	1.3000	13.80	0.3000	4.8000	1.1000
05/28/80	1.3800	13.20	0.3000	5.3000	1.1000
05/19/80	1.5700	12.70	0.7000	6.0000	1.1900
02/20/80	1.4300	11.80	2.8600	1.7000	7.4900
01/18/80	1.4900		2.1500	3.4900	8.6100
07/14/76		13.20	2.2000	2.4000	4.9000
08/01/71					

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