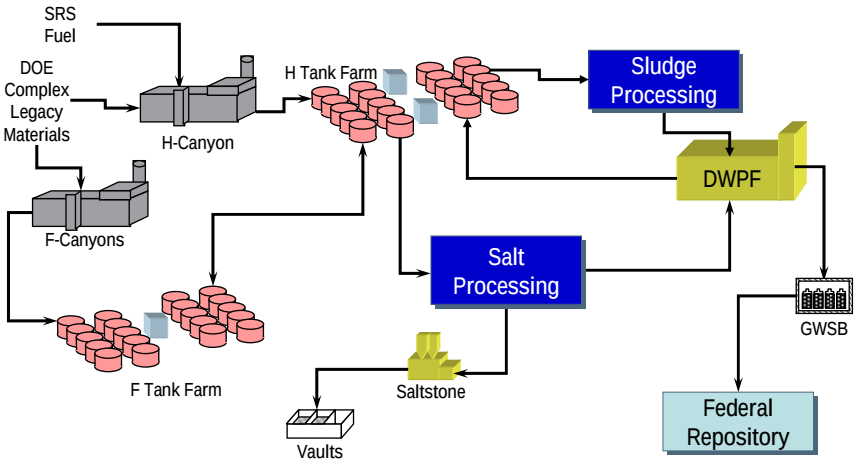
Draft 3116 Waste Determination for Closure of Tank 19 and Tank 18

Presentation to the Nuclear Regulatory Commission Staff

Savannah River Site

November 30, 2005

Generation of Waste at SRS Tank Farms

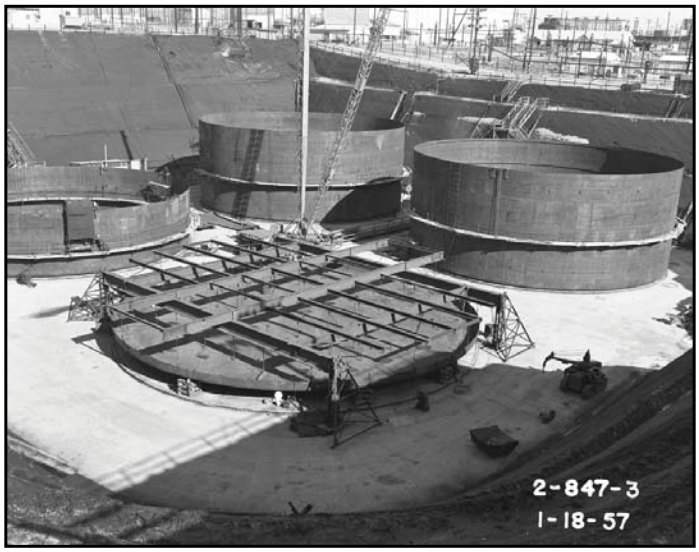


DWPF - Defense Waste Processing Facility
GWSB - Glass Waste Storage Building

2

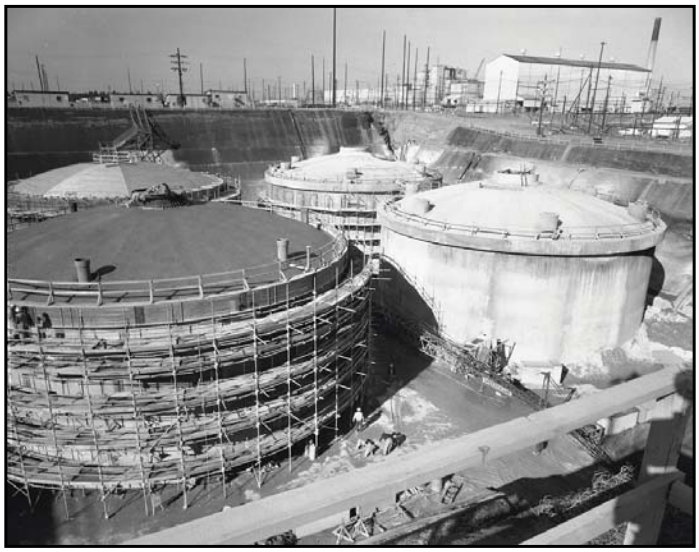
APPROVED for Release for Unlimited (Release to Public)

Tank Construction - Steel Bottom and Wall Liner



3

Tank Construction - Final Concrete Layers

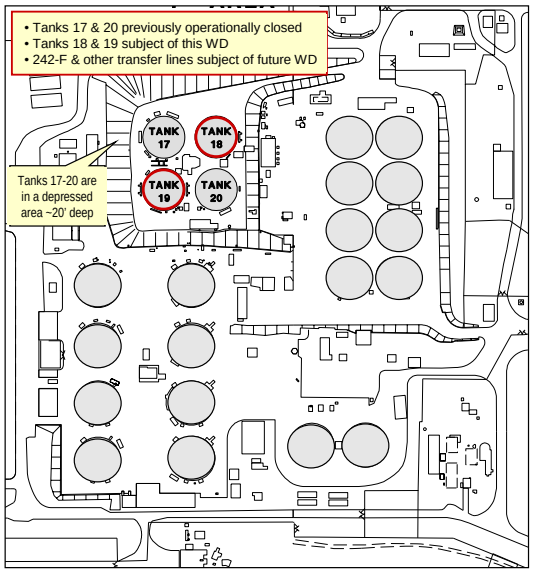


4

Tank Construction - Prior to Backfill

5

Tanks 17 - 20 Operational Grouping



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Sources of Waste for Tanks 18 and 19

- F-Canyon PUREX Process Waste Stream
  - Resulted primarily from plutonium and uranium extraction process with a nitric acid flowsheet
  - Acidic waste stream is pH adjusted in the generator facility
    - º Required for protection of carbon steel waste tanks
    - º Different chemistry requirements than INTEC
  - Waste contained two phases
    - º Solids – insoluble salts, metal oxides, radionuclides (sludge waste)
    - º Liquid – soluble nitrates, nitrites, cesium (salt waste)
- 242-F Evaporator System Concentrate
  - Concentrated the salt waste into salt cake and concentrated supernate (salt solution)
- Zeolite Resin from Ion-Exchange Column
  - Was used in conjunction with evaporator operations
  - Used for cesium extraction

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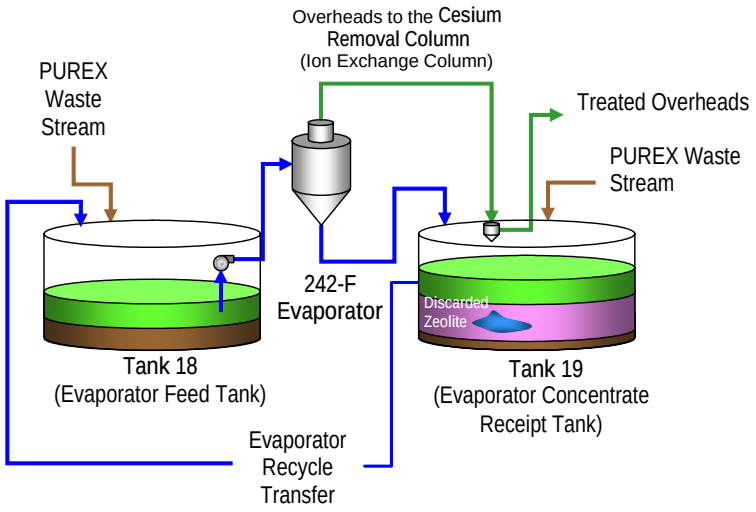
Tanks 18 and 19 Operating Configuration



Note: Figure 2-12 of Draft Waste Determination

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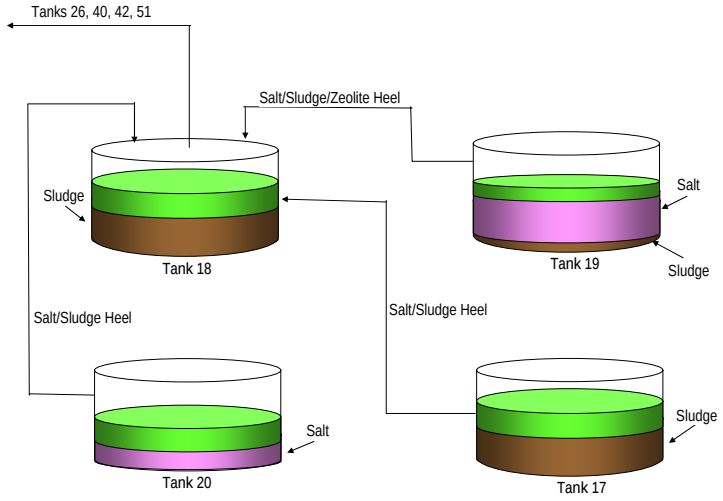
Tanks 17 – 20 Waste Removal Configuration



Note: Figure 2-15 of Draft Waste Determination

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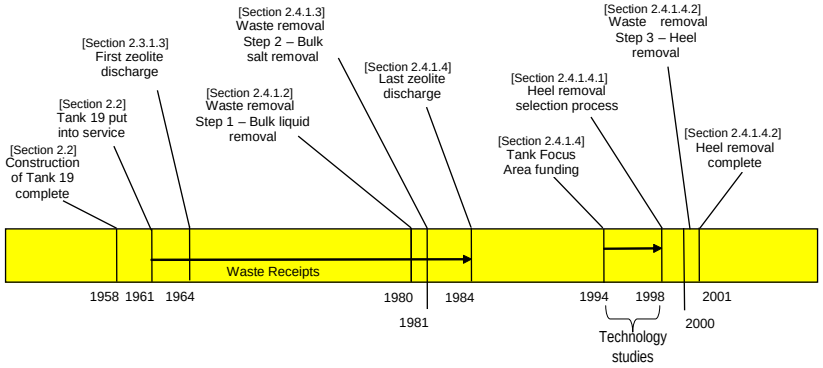
Tank 19 Time Line



Note: Figure 2-16 of Draft Waste Determination

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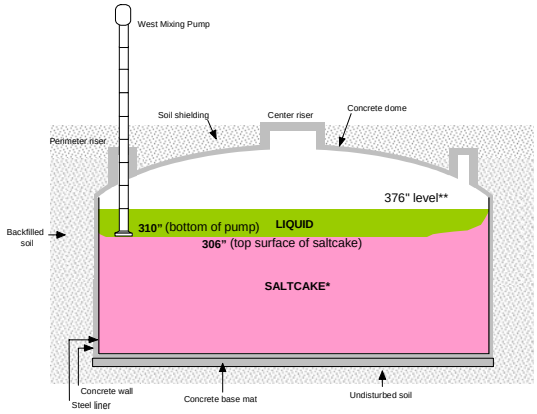
Tank 19 Waste Removal

Initial Conditions



* Saltcake includes crystallized salts, interstitial liquid, insoluble solids and zeolite solids.
**Numbers in inches indicate distance above the tank bottom.

(January 1980)

Note: Figure 2-17 of Draft Waste Determination

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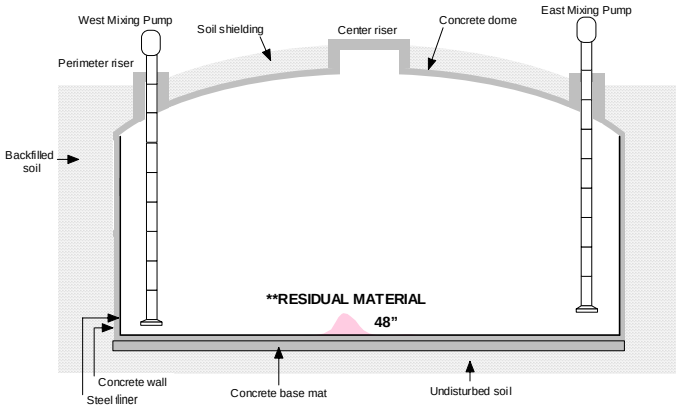
Tank 19 Waste Removal

At Completion of Bulk Waste Removal



Note: Portion of Figure 2-18 of Draft Waste Determination

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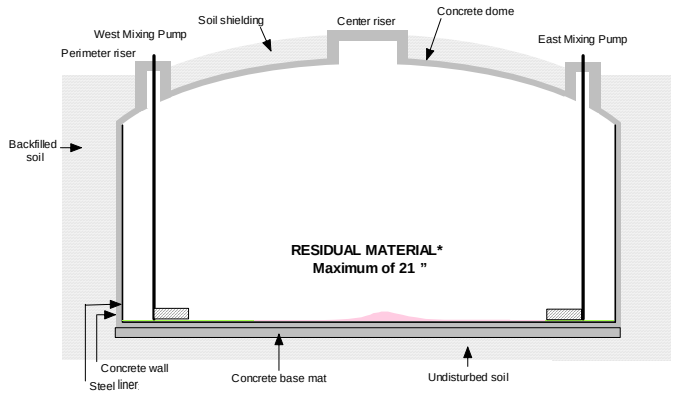
Tank 19 Waste Removal

Ready for Closure



Note: Portion of Figure 2-18 of Draft Waste Determination

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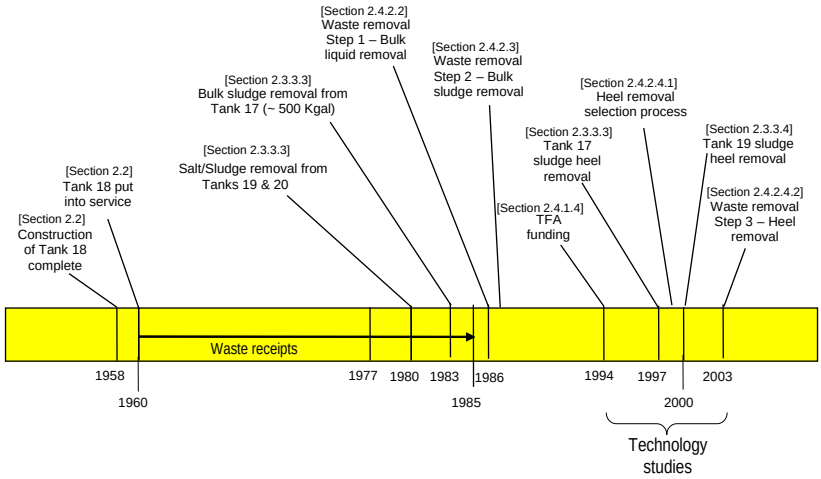
Tank 18 Time Line



Note: Figure 2-27 of Draft Waste Determination

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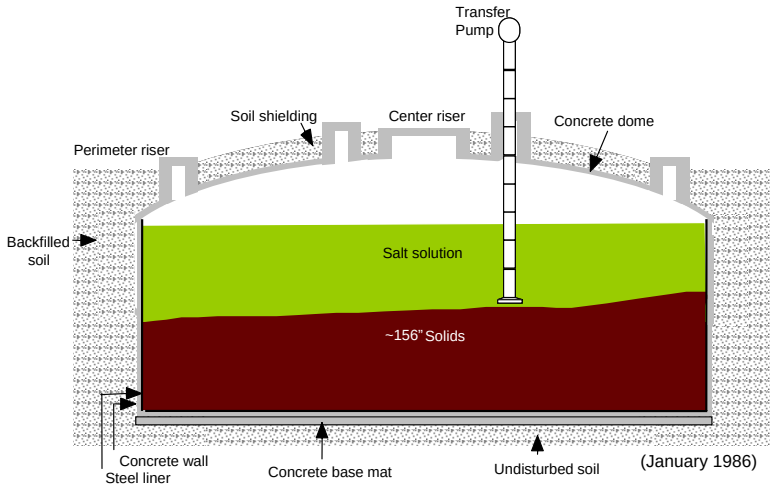
Tank 18 Waste Removal

Initial Conditions



Note: Figure 2-28 of Draft Waste Determination

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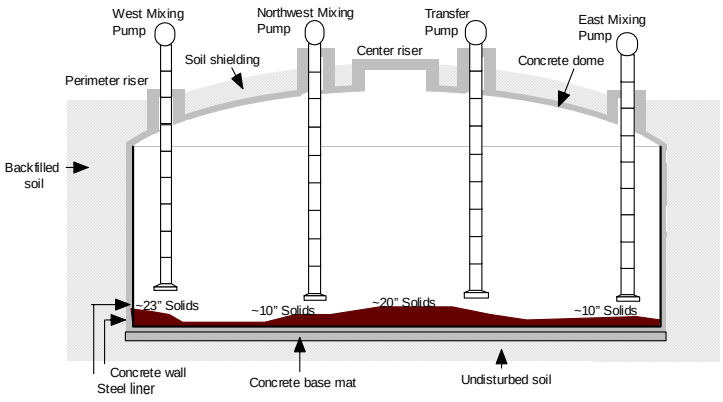
Tank 18 Waste Removal

At Completion of Bulk Waste Removal



Note: Portion of Figure 2-29 of Draft Waste Determination

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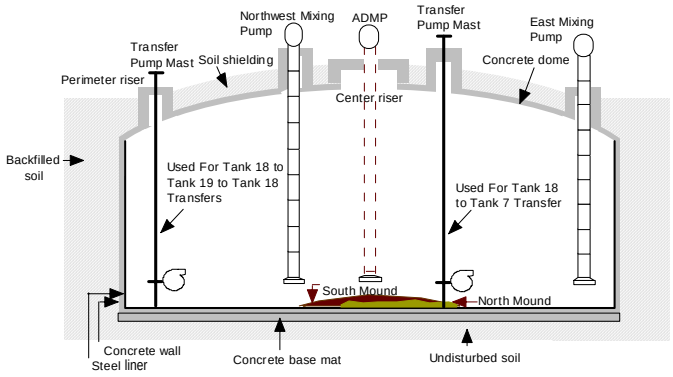
Tank 18 Waste Removal

Ready for Closure



Note: Portion of Figure 2-29 of Draft Waste Determination

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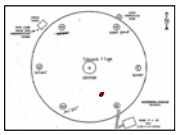
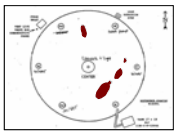
Determine the Volume of Residual Material

- Mapped exposed solids to corresponding liquid levels using detailed camera inspections
- Plotted heights of residual material on a grid to calculate the volume of solids and liquid.



Liquid Level 20.4"
(from the bottom of tank)



Liquid Level 12.4"

Liquid Level 8.4"

Liquid Level 3.3"

Tank 19 Exposed Solids Maps

Note: Portion of Figure 2-41 of Draft Waste Determination

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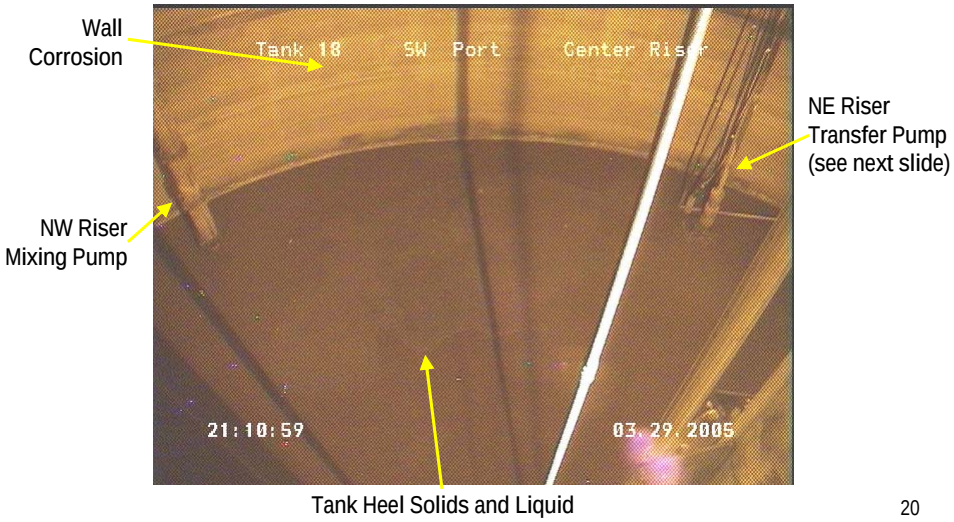
Residual Radioactive Material in Tanks 19 and 18

Residual radioactive material includes:

- Tank heel
- Material on stiffener bands
- Wall corrosion products
- Abandoned equipment
- Contaminated concrete dome
- Airborne particulates

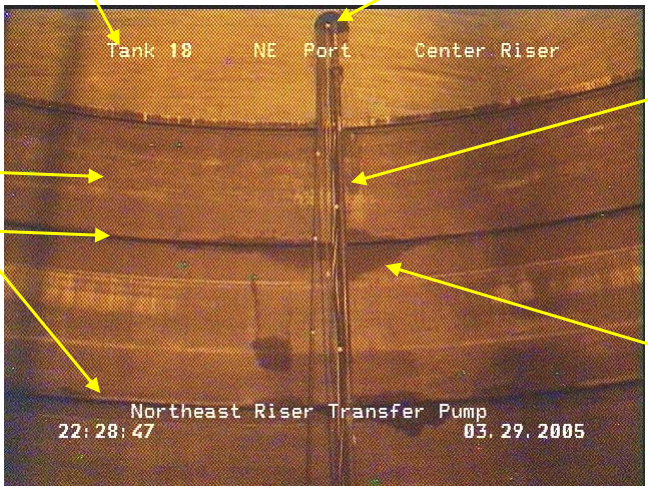
19

Tank 18 Interior



20

Tank 18 Interior



Concrete Tank Dome

Riser Opening in Tank Dome

NE Riser Transfer Pump Mast

Steel Liner

Stiffener Bands

Wall Contamination

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Residual Material Sampling

- SRNL statistical study used to develop a sample plan
- Tank 19
  - Residual material was well-mixed
  - 3 solids samples and 1 liquid sample
  - Total whole body dose to workers was ~200 mrem
- Tank 18
  - Residual material was well-mixed except for south mound
  - 6 solids samples and 1 liquid sample
  - Total whole body dose to workers was ~120 mrem

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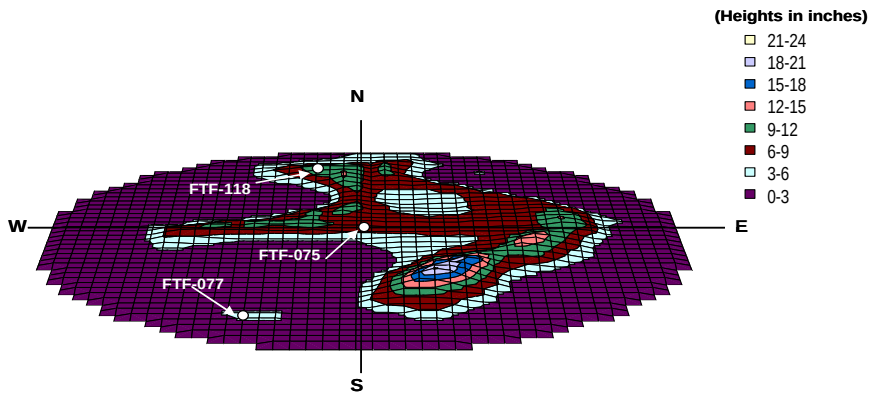
Tank 19 Sampling Locations



Note: Figure 2-42 of Draft Waste Determination

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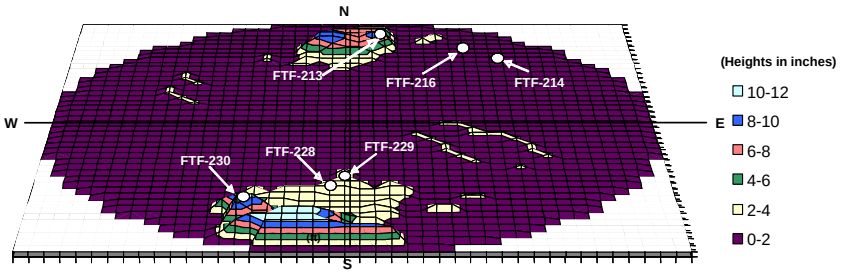
Tank 18 Sampling Locations



Note: Figure 2-47 of Draft Waste Determination

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Tank 19 Waste Removal

- Bulk waste removal
  - Four campaigns removed approximately 1,100 kgal of saltcake.
  - Entrained zeolite was washed, stripping out soluble Cs-137, leaving Cs-137 that was chemically bound to the zeolite.
- SRS used a systematic engineering evaluation to select the heel removal technology.
  - Three 50-hp rotating submersible jet mixer pumps
  - Recycle system to reuse liquid waste stream for mixing/transfers

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Tank 19 Heel Removal

- Each cleaning cycle was comprised of
  - Mixing the contents with submersible mixers (~3000 total hours),
  - Transferring the slurry to Tank 18,
  - Allowing the fast-settling solids to drop, then
  - Decanting the liquid back to Tank 19 to start the process over again (~10 Mgal were transferred)
- 46 cleaning cycles were performed during Tank 19 heel removal
- Reduced wet solids volume from ~33 kgal to ~15 kgal
- Factors preventing further heel removal
  - Fast-settling zeolite
  - FFA closure requirements
  - Tank farm storage space constraints

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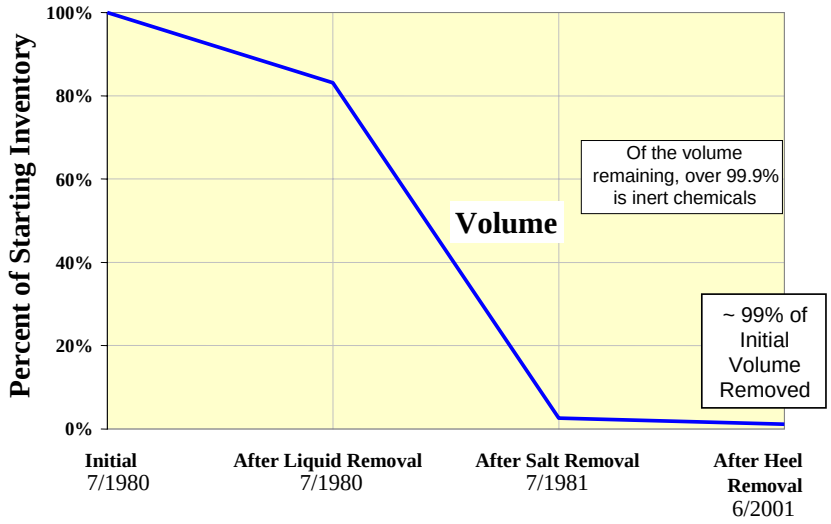
Tank 19 Waste Removal



Note: Figure 2-26 of Draft Waste Determination

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Tank 18 Waste Removal

- Bulk Waste Removal
  - Four sludge slurry removal campaigns removed approximately 515 kgal of sludge
- A systematic engineering evaluation concluded that the Advanced Design Mixer Pump (ADMP) was the best technology for Tank 18 heel removal.

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Tank 18 Heel Removal

- Each cleaning cycle was comprised of
  - Adding well water (total of 800 Kgal),
  - Mixing with the ADMP (1000 hours)
  - Transferring the sludge slurry to Tank 7
- Six cleaning cycles were performed during Tank 18 heel removal
- Reduced wet solids volume from ~49 kgal to ~4.3 kgal
- Factors preventing further heel removal included
  - Fast-settling zeolite
  - Hardened mound
  - FFA closure requirements
  - Tank farm storage space constraints

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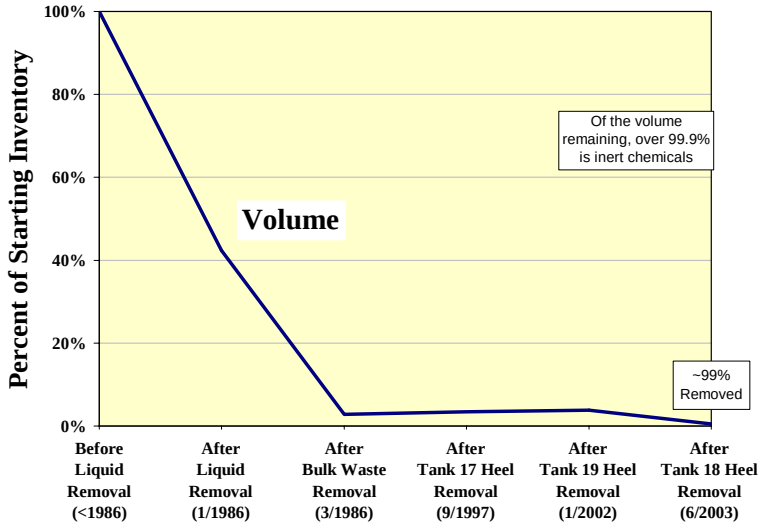
Tank 18 Waste Removal



Note: Figure 2-37 of Draft Waste Determination

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Risk Benefit Analysis

- Assumptions for evaluation:
  - Existing equipment for both tanks requires removal and disposal
  - Purchase of new equipment and supporting infrastructure is required
- Three alternatives evaluated based on their historical success at SRS or elsewhere in the DOE Complex
  - Mechanical
  - Robotic
  - Chemical

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Risk Benefit Analysis Results

Residual Waste Removal Method	Financial Cost ($)[1]	Cumulative Worker Risk (mrem)[2]	Potential 50 Year Dose Savings to an Individual[3] (mrem)		Financial Cost – to – Potential Benefit Ratio ($ / mrem)[4]		Worker Risk – to – Potential Benefit Ratio (present mrem / future mrem)[5]	
			Tank 18	Tank 19	Tank 18	Tank 19	Tank 18	Tank 19
Mechanical	10,200,000	~ 7,500	2	0.45	5,100,000	22,700,000	3,750	16,700
Robotic	14,600,000	~ 7,500	2	0.45	7,300,000	32,400,000	3,750	16,700
Chemical	11,100,000	~ 4,500	2	0.45	5,550,000	24,700,000	2,250	10,000

1 Project cost in dollars, rounded to $100,000.
2 Risk from waste removal part of the cleaning operations only. Does not include radiological exposure associated with disposal.
3 Future hypothetical member of public.
4 Dollars spent for one future potential mrem exposure saved.
5 Present day radiological exposure received by workers for one future potential mrem exposure saved.

Note: Table 5-4 of Draft Waste Determination

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Compliance with 10 CFR 61 Subpart C

- Compliance is documented in Section 7 which has as a basis the Tank 19 and Tank 18 Performance Objective Demonstration Document (PODD)
- PODD incorporated classical performance assessment elements in a document tailored to demonstrate compliance with 10 CFR 61 Subpart C performance objectives as required by Section 3116 of the NDAA

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PODD Contents

- Section 2 - Site / Facility Characteristics
- Section 3 - Radionuclide Inventories for Tanks 19/18 & FTF
- Section 4 - Analysis of Performance Objectives
- Section 5 – Uncertainty / Sensitivity Analyses
- Appendix A - Quality Assurance Process
- Appendix B - Dose Conversion Factors (DCFs)
- Appendix C - MEPAS Input / Output Data (All-Pathways)
- Appendix D - Inadvertent Intruder Input / Output Data
- Appendix E - Inadvertent Intruder Sensitivity Analysis

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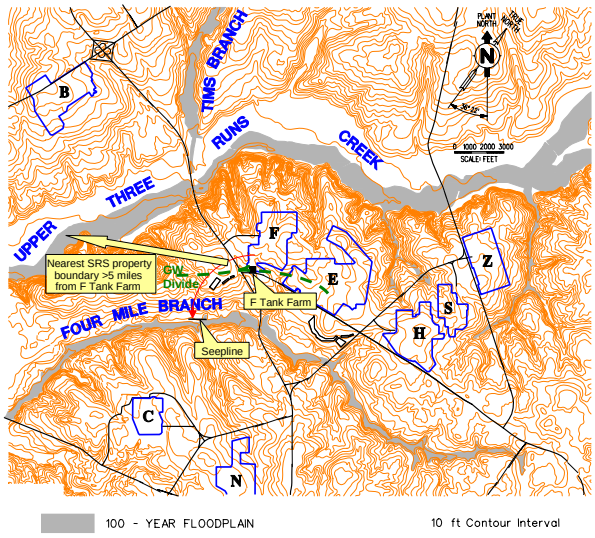
Site/Facility Characteristics



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Analysis of 10 CFR 61.41 Performance Objective

- Multimedia Environmental Pollutant Assessment System (MEPAS) computer code used
- Pessimistic assumptions used in several areas
  - Tanks all fail simultaneously
  - Grout infiltration rates and hydraulic conductivity
  - No closure cap modeled for infiltration reduction
  - All groundwater flow modeled towards Fourmile Branch

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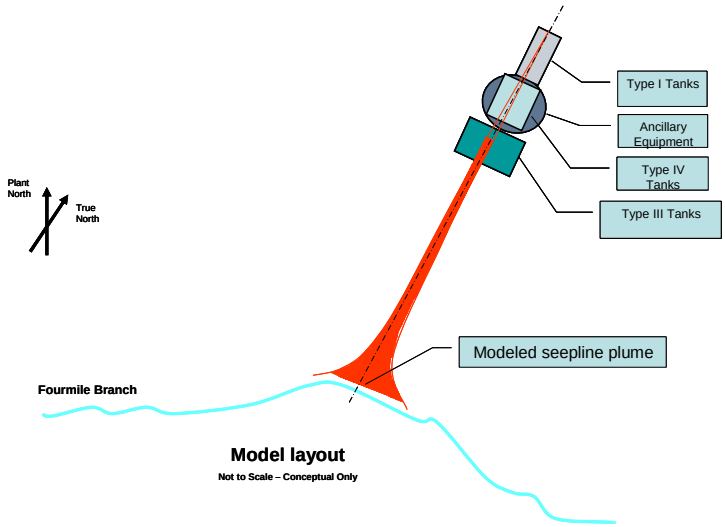
Modeled F-Tank Farm (FTF) Configuration



Note: Figure 7-12 of Draft Waste Determination

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Peak Annual Detail Dose Summary Table

Source	Year of Peak Dose	Peak Year Dose (mrem)	Tc-99 Contribution (%)	I-129 Contribution (%)	Np-237 Contribution (%)
Tank 19	735	0.009	99.79	0.2	0
Tank 18	6405	0.04	0	0	99.74
FTF	595	0.08	87.1	12.87	0

Note: Table 4-10 of PODD

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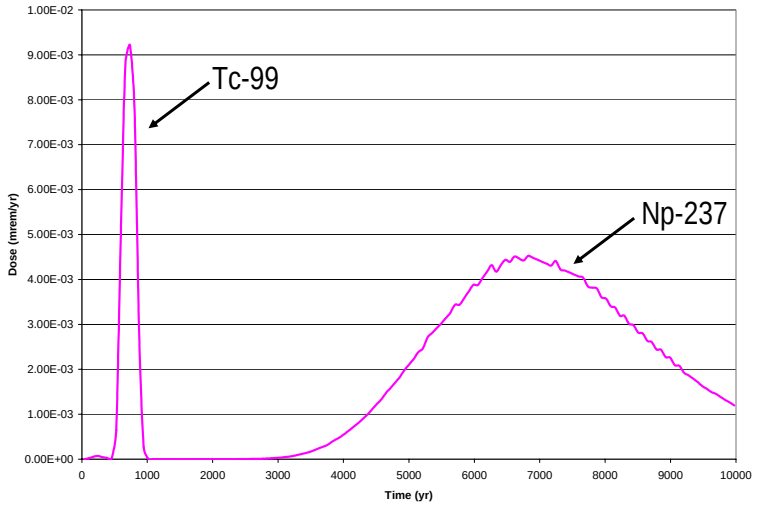
Tank 19 All-Pathways Dose



Note: Figure 4-10 of PODD

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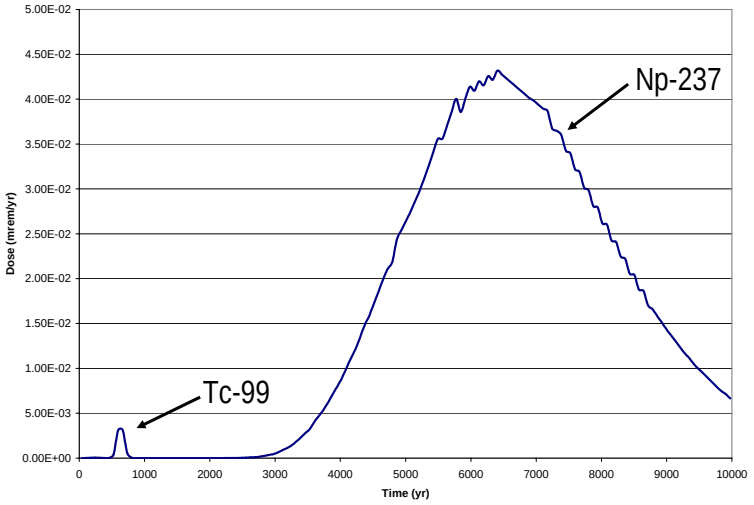
Tank 18 All-Pathways Dose



Note: Figure 4-13 of PODD

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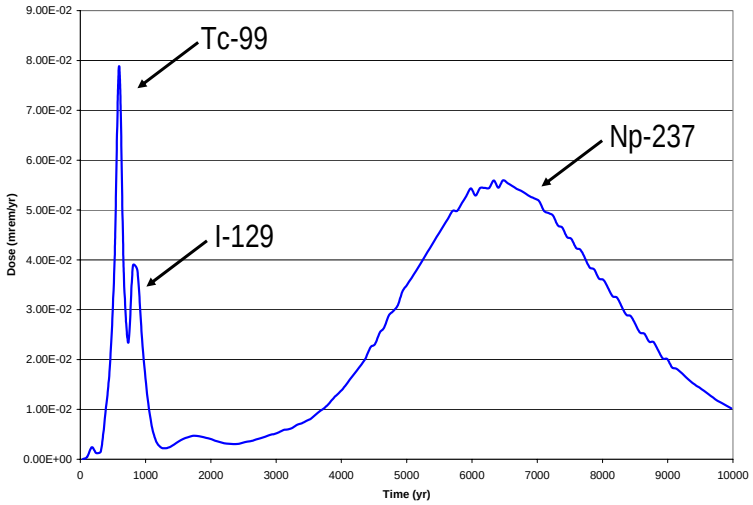
FTF All-Pathways Dose



Note: Figure 4-16 of PODD

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Analysis of 10 CFR 61.42 Performance Objective

- SRNL Automated Intruder Analysis Application used
- Intruder-Agricultural Scenario evaluated

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Pathway Contributions for Intruder-Agricultural Scenario

Nuclide	Inventory (Curies)	Vegetable Ingestion (mrem/yr)	Soil Ingestion (mrem/yr)	Garden Exposure (mrem/yr)	Garden Inhalation (mrem/yr)	Total Dose (mrem/yr)
Sr-90	2.54E-01	107	0	0	0	107
Cs-137	3.18E-01	6	0	3	0	9
Pu-238	9.95E-03	0	2	0	0	2
Total	5.82E-01	113	3	3	0	119

Note: Table 4-38 of PODD

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Sensitivity Analyses

- Incorporated lessons learned from Salt Waste Disposal RAI process
- Numerous sensitivity analyses run for both 10 CFR 61.41 and 10 CFR 61.42
- Analyses and conclusions detailed in Section 5 of PODD

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Conclusion

- The stabilized Tank 18 and 19 residuals are not HLW based on the considerations set forth in Section 3116(a) of the NDAA and may be disposed of as LLW at the SRS in accordance with Section 3116 of the NDAA.
- This draft 3116 Determination will be finalized after the DOE has completed consultation with the NRC, and although not required by Section 3116, after public review and comment.

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