Regulatory Basis for Incidental Waste Classification at the Savannah River Site High-Level Waste Tank Farms

Savannah River Site

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EXECUTIVE SUMMARY

Since the Savannah River Site (SRS) began operating in the early 1950s, its processes for the recovery of uranium and plutonium have generated liquid high-level radioactive waste. At present, the U.S. Department of Energy (DOE) stores approximately 34 million gallons of this waste on the SRS in large underground tanks in facilities known as the F- and H-Area Tank Farms.

There are 51 of these high-level waste (HLW) storage tanks. DOE intends to remove these tanks and their associated systems from service as they complete their missions. Because all but one of the tank systems are permitted as industrial wastewater treatment facilities under the South Carolina Pollution Control Act, DOE will close them in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities."

DOE has established a process for tank closure that will include a combination of waste removal, tank cleaning, and stabilization of the tank configuration. The waste that is the subject of this report consists of residual contaminated material that DOE could not clean from the tank bottom or that is embedded in small pits in the steel tank wall. The characteristics of this waste do not fit the prescriptive classification schemes contained in the regulations of DOE or the U.S. Nuclear Regulatory Commission (NRC). The NRC has published criteria on the classification of certain material as "incidental" waste. In this context, incidental waste activities would be exempt from NRC licensing at a DOE facility.

The NRC incidental waste classification is based on meeting the performance objectives in Title 10 of the Code of Federal Regulations, Chapter 61 (10 CFR 61). A Denial of Petition letter dated March 2, 1993 (Bernero 1993), states that certain waste generated at the DOE Hanford site could be incidental if it met the following criteria:

1. The HLW has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical.

2. The waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level radioactive waste, as established in 10 CFR 61.

3. The waste will be managed, pursuant to the Atomic Energy Act, in a manner that satisfies safety requirements comparable to the performance objectives established in 10 CFR 61.

These criteria apply to certain wastes to be removed from the Hanford double-shell tanks and processed for radionuclide separation. The residual from that separation had been proposed to be stabilized with grout for disposal as low-level waste. Criteria 1 and 3 are directly applicable to the planned tank closure activities at the SRS. The criterion 2 requirement to have the waste in a solid physical form is also applicable, however, meeting the Class C concentration limits in 10 CFR 61.55 may not be appropriate because those values were based on an intruder exposure scenario for disposal of waste rather than *in situ* stabilization. DOE requests NRC's consideration of an alternative to the Class C limits of 10 CFR 61.55 for the SRS tank system closures. This approach will not affect compliance of the SRS tank closures with the performance objectives of 10 CFR 61.

The closure activities for SRS HLW tanks will meet the NRC requirement in 10 CFR 61.41 for protection of the public. To demonstrate conformance to the applicable NRC criteria, DOE has described the process by which it will choose tank closure activities. The process requires the development of performance objectives for each tank closure and adherence to applicable laws for the protection of the public for the cumulative tank closure. DOE has examined a range of tank cleaning techniques and stabilization procedures. As described in Section 4.1, the DOE closure process will ensure the removal of key radionuclides to the extent technically and economically practical. The South Carolina Department of Health and Environmental Control will approve each tank closure and provide oversight to ensure the performance objectives are satisfied.

DOE has developed a computer model to predict the concentration values of radionuclides in the groundwater resulting from eventual leaching of the residual waste in each closed tank. This model determines the size and shape of a zone around closed tanks in which no drinking water wells can exist. DOE will rely on concentration values in the groundwater rather than on concentrations in the residual waste, thus providing assurance of protection of the public. DOE has determined the solid physical form of the residual waste by using the closure process to select the most appropriate stabilization activity for each tank. Providing greater public protection and meeting the 10 CFR 61 performance objectives for stability and structural integrity of the closed tank will meet the intent of the second criterion for incidental waste classification.

The third criterion stipulates management of the waste to meet performance objectives comparable to those in 10 CFR 61. Part 61.41 states that the annual dose to a member of the public resulting from releases of radioactive material shall not exceed an equivalent of 25 mrem to the whole body. Any configuration will release radioactive material into the groundwater after hundreds of years and the disintegration of the concrete and steel tank. Water flowing through the area will leach the radioactive material from the soil into the groundwater. DOE will establish a zone around the tank farms that will extend to a point at which a member of the public would receive a dose no greater than the U.S. Environmental Protection Agency (EPA) annual lim... of 4 mrem for drinking water contaminated by beta-gamma emitters. (Alpha particle-emitting radionuclides would not reach the point of exposure within the 10,000-year period of analysis.) The public would be excluded from this zone through a combination of active and passive institutional controls. This zone would fully encompass any zone designed to meet the 25-mrem limit cited in 10 CFR 61.41 and, therefore, would be more restrictive than the NRC performance objectives.

DOE has established a process to ensure that any residual material in the SRS HLW tanks after the completion of planned closure activities will meet the definition of incidental waste and that the Department can manage such material to protect the public by meeting performance objectives more stringent than those in 10 CFR 61. DOE believes, therefore, that specific closure activities should proceed under its auspices as well as those of the EPA and the South Carolina Department of Hea'... and Environmental Control.

Reference

Bernero, R. M. (Director, Office of Nuclear Material Safety and Safeguards), 1993, letter to J. Lytle (Deputy Assistant Secretary for Waste Operations, Office of Waste Management, U.S. Department of Energy), U.S. Nuclear Regulatory Commission, Washington, D.C.

ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
CLSM	controlled low-strength material
DOE	U.S Department of Energy
DWPF	Defense Waste Processing Facility
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration.
FFA	Federal Facility Agreement
g	gram
GTCC	greater-than-class-C
HLW	high-level waste
ITP	In-Tank Precipitation Facility
LLW	low-level waste
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
RCRA	Resource Conservation and Recovery Act
SMDF	Saltstone Manufacturing and Disposal Facility
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
WSRC	Westinghouse Savannah River Company

CHAPTER 1. INTRODUCTION

Since the Savannah River Site (SRS) began operating in the early 1950s, its processes for the recovery of uranium and plutonium have generated liquid high-level radioactive waste. At present, the U.S. Department of Energy (DOE) stores approximately 34 million gallons of this waste on the SRS in large underground tanks in facilities known as the F- and H-Area Tank Farms.

There are 51 of these high-level waste (HLW) storage tanks. DOE intends to remove these tanks and their associated systems from service as they complete their missions. Because all but one of the tank systems are permitted as industrial wastewater treatment facilities under the South Carolina Pollution Control Act, DOE will close them in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities."

DOE has prepared a general plan (DOE 1996) for the closure of the tank systems. The plan describes the proposed waste removal techniques and stabilization options. It also describes the analytical methods used to predict impacts on the environment resulting from closed tank systems and presents the performance objectives for tank closure.

1.1 Purpose

Before closing the tanks, DOE will remove waste and stabilize any residual contamination (see Section 2.2). The purpose of this report is to provide a basis for the DOE position that the residual contamination in the HLW tanks is incidental waste. The NRC has established noncodified guidance for classifying waste that is incidental to but that is not regulated as HLW (Bernero 1993). During the preparation of this report, DOE performed a regulatory analysis that used the NRC guidance along with precedents and dose modeling to demonstrate that the residual contamination in the HLW tanks meets the NRC incidental waste definition and that the planned closure of the tanks is consistent with the performance objectives of NRC regulations for low-level waste disposal (10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste").

1.2 NRC Incidental Waste Classification

The NRC incidental waste classification is based on meeting the performance objectives in 10 CFR 61 and other criteria. A Denial of Petition letter dated March 2, 1993 (Bernero 1993), states that certain waste generated at the Hanford site could be considered incidental if it met the following criteria:

1. The HLW has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical.

2. The waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level radioactive waste, as established in 10 CFR 61.

3. The waste will be managed, pursuant to the Atomic Energy Act, in a manner that satisfies safety requirements comparable to the performance objectives established in 10 CFR 61.

DOE used both the performance objectives in 10 CFR 61 and Hanford criteria to determine the classification of the SRS tank residual waste.

1.3 Document Organization

The remainder of this report provides the background and reasons for the DOE position to classify the tank residual waste as incidental waste. Chapter 2 contains background information on the SRS HLW tanks and provides a regulatory history on the classification of HLW and incidental waste. Chapter 3 discusses the 10 CFR 61 performance objectives in the context of the three incidental waste criteria (above) in relation to the planned tank closures. Chapter 4 provides additional regulatory, environmental, and economic arguments for an incidental waste classification. Appendix A describes the baseline closure activities and the options available to DOE to perform tank closure; Appendix B describes the modeling performed to determine the doses associated with the closed tank systems.

1.4 References

Bernero, R. M. (Director, Office of Nuclear Material Safety and Safeguards), 1993, letter to J. Lytle (Deputy Assistant Secretary for Waste Operations, Office of Waste Management, U.S. Department of Energy), U.S. Nuclear Regulatory Commission, Washington, D.C.

DOE (U.S. Department of E ergy), 1996, *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Site, Construction Permit Numbers 14,338*, 14,520, 17,424-IW, Revision 1, Savannah River Operations Office, Aiken, South Carolina, July 10.

CHAPTER 2. BACKGROUND

This chapter provides background information on the Savannah River Site (SRS) tank farms, the contamination in the tanks, and the regulatory history and framework to support the positions of the U.S. Department of Energy (DOE) that are presented in Chapters 3 and 4. This information is essential for an understanding of DOE justifications for classifying residual contamination in the SRS high-level waste (HLW) tanks as incidental waste.

2.1 F- and H-Area Tank Farms

The SRS occupies approximately 300 square miles adjacent to the Savannah River, principally in Aiken, Barnwell, and Allendale Counties, South Carolina. DOE owns the Site, and Westinghouse Savannah River Company (WSRC) is the contractor responsible for SRS operations.

From the early 1950s until 1991, the mission of the SRS was to produce nuclear materials for national defense. As a result of that mission, the processes used to recover uranium and plutonium from reactor fuel and target assemblies in the separations areas (F and H Areas) have generated the current inventory of approximately 34 million gallons of liquid high-level radioactive waste. DOE has developed an integrated management system to process that waste. The "High Level Waste System" includes the F- and H-Area Tank Farms, in which DOE isolates these wastes from the environment, SRS workers, and the public. The use of the two tank farms enables radioactive decay by aging the waste, clarification of the waste by gravity settling, and removal of soluble salts from the waste by evaporation. The tank farms also pretreat accumulated sludge and salt solutions (supernate) to enable their management at SRS High-Level Waste System treatment facilities including the Defense Waste Processing Facility (DWPF) and the Z-Area Saltstone Manufacturing and Disposal Facility, which convert the sludge and supernate to more stable forms suitable for permanent disposal.

The F- and H-Area Tank Farms are in the central portion of the SRS, as shown on Figure 2-1. DOE chose the sites for the tank farms because of their favorable terrain, their proximity to the F- and H-Area Separations Facilities (the major waste generating sources), and their isolation from the SRS boundaries (the minimum distance is approximately 5.5 miles). Figure 2-2 shows the F- and H-Areas and the tank farms.

The 22-acre F-Area Tank Farm consists of 22 waste tanks, 2 evaporator systems, transfer pipelines, 6 diversion boxes, and 3 pump pits. The 45-acre H-Area Tank Farm consists of 29 waste tanks, 2 evaporator systems and the Replacement High-Level Waste Evaporator (under construction), the

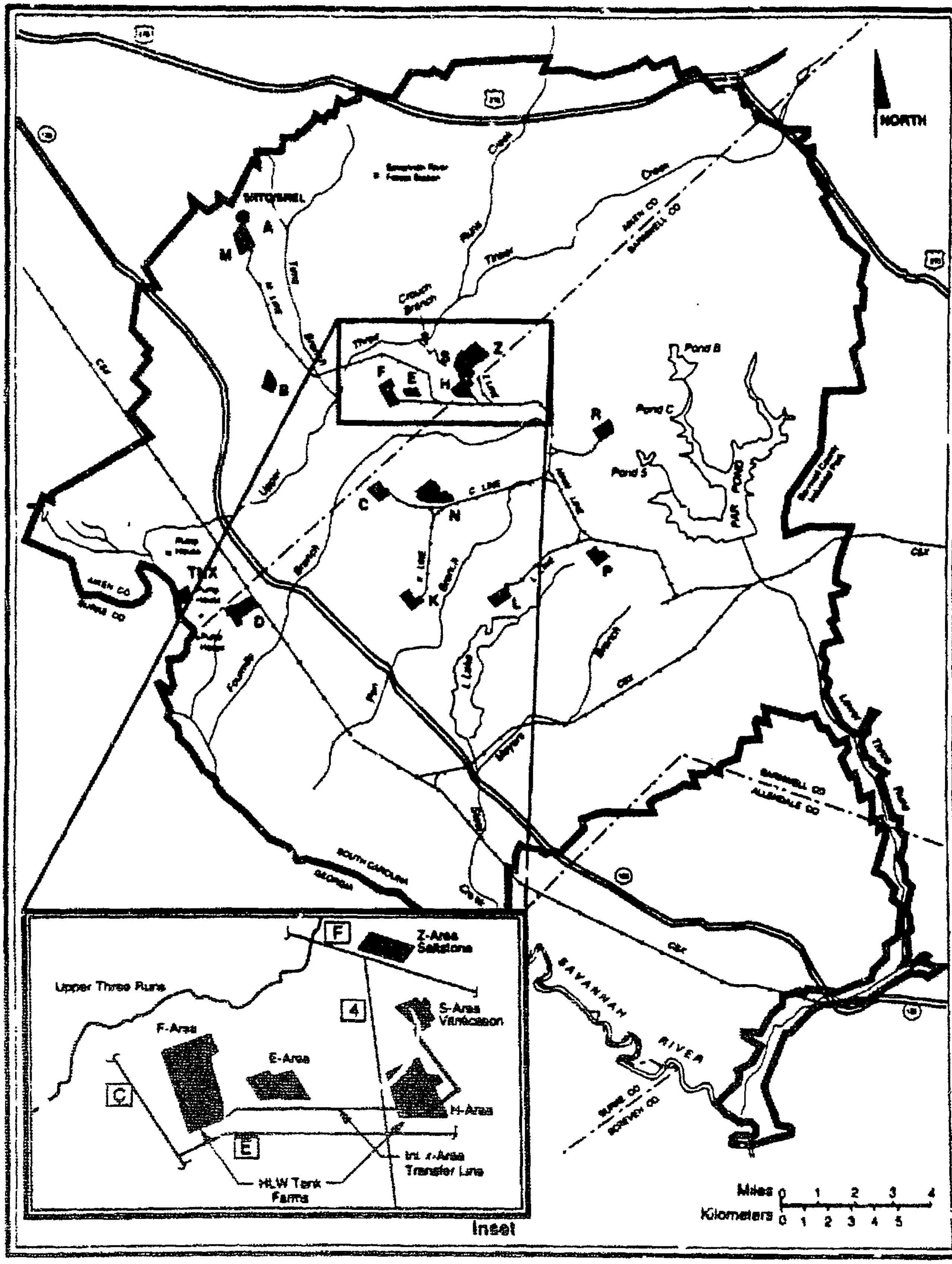

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Figure 2-1. SRS site map with F- and H-Areas highlighted.

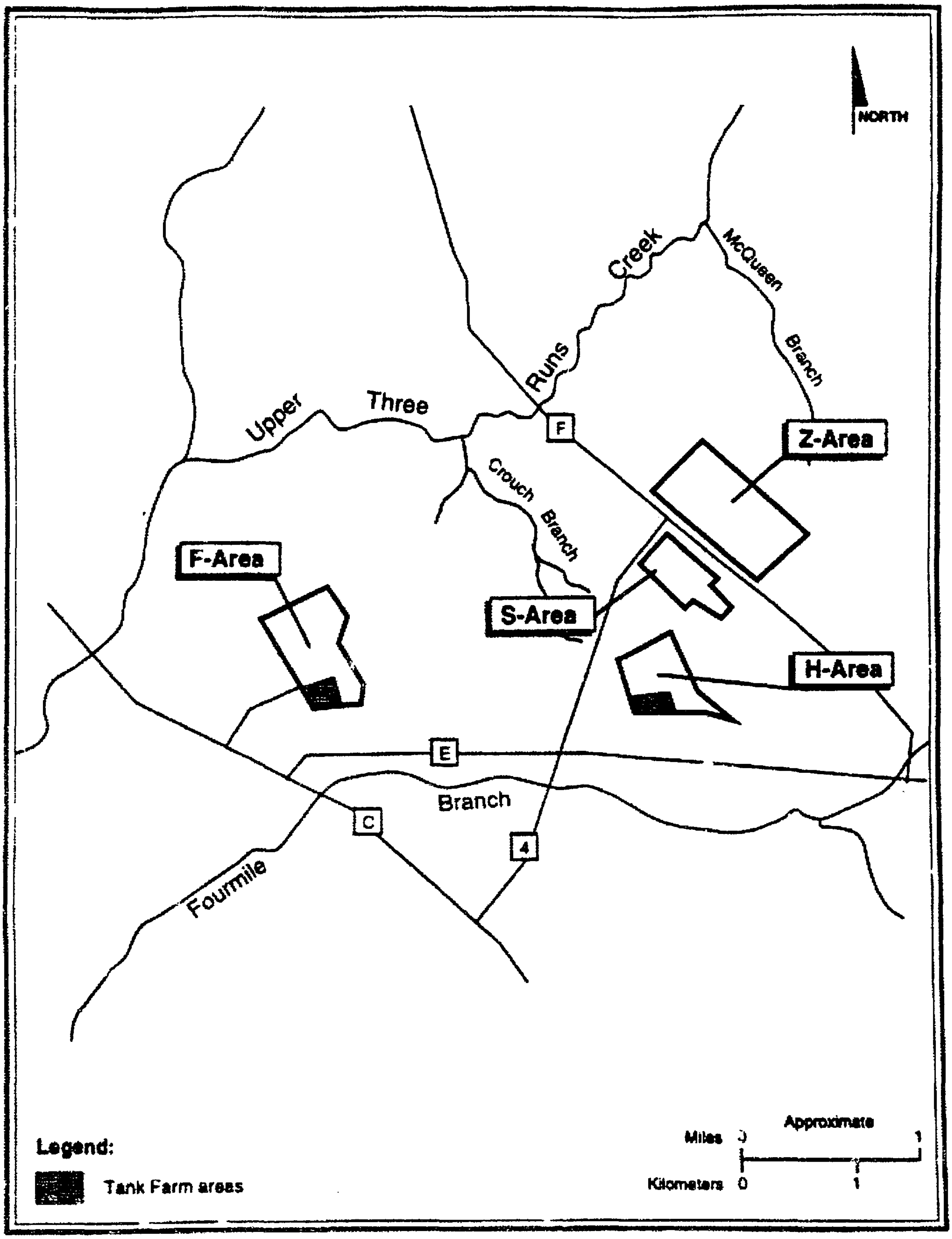

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Figure 2-2. F- and H-Tank Farm areas.

In-Tank Precipitation Process building and associated equipment, transfer pipelines, 8 diversion boxes, and 10 pump pits.

To accomplish the operational objectives of the HLW System, DOE installed the following units in the tank farms:

- Fifty-one large underground waste tanks to receive and age liquid HLW and to allow it to settle
- Four evaporator systems (and one under construction) to concentrate soluble salts and reduce waste volume
- A transfer system (transfer lines, diversion boxes, and pump pits) to transfer supernate, sludge, and other waste (e.g., evaporator condensate) between tanks and treatment facilities
- A precipitation/filtration system (the In-Tank Precipitation Facility) to separate the salt solution into high- and low-activity fractions for immobilization at the DWPF Vitrification Facility and the Z-Area Saltstone Manufacturing and Disposal Facility, respectively
- A sludge washing system (Extended Sludge Processing) to pretreat accumulated sludge before its vitrification at the DWPF

Chapter 2 of the general closure plan (DOE 1996a) contains a more detailed discussion of the tank farm equipment.

2.2 High-Level Waste Tank Closure

DOE plans to begin closing the HLW tanks at the SRS in 1996. The general closure plan (DOE 1996a) establishes the protocol DOE will use in closing the tank systems. DOE will remove the waste from all tanks using the following techniques or similar techniques of comparable effectiveness:

- Bulk waste removal - Use slurry pumps, transfer pumps, and transfer jets to remove as much HLW as practical from the tank system.
- Spray washing - Spray the interior of the tank with jets of hot water to dislodge contamination that bulk waste removal did not remove.
- Annulus cleaning - On tanks that have leaked waste from the primary to secondary containment, remove as much waste as practical from the annulus.

If it is determined that additional cleaning (beyond the baseline established for all tanks) of a particular tank is necessary to meet the performance objectives, acid washing or other techniques of comparable effectiveness will be performed. DOE anticipates that acid washing will not be required for salt tanks. However, acid wash is likely to be necessary to meet performance objectives for sludge tanks. In acid washing, the interior of the tank is sprayed with oxalic acid to remove contamination that remains after spray washing. After each water or acid wash, the liquid with dissolved contaminants will be pumped out of the tank.

DOE has identified [in coordination with the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Environmental Protection Agency (EPA)] requirements with which it will comply and guidance it will consider to ensure that the closure of the tank systems will be protective of human health and the environment, and has used these requirements and guidance to develop closure performance objectives that provide a basis for determining the tank-specific closure activities. As described in the Program Plan, DOE will evaluate the collective impacts at the point of exposure and compare those impacts to the performance objectives applicable to specific environmental media (e.g., groundwater). The collective contribution of contamination from the closed tank systems cannot exceed the performance objective. The specific actions for cleaning tanks will be developed on a case-by-case basis. These actions will be set forth in tank-specific closure modules that will be developed and submitted for SCDHEC approval as the individual tank systems are prepared for closure.

DOE will evaluate each tank system or group of tank systems to determine the inventory of contaminants (radiological and nonradiological) that will remain in the system after waste removal, and will use this information to conduct a performance evaluation. The performance evaluation will include the modeling of projected contamination pathways for the planned closure configuration and a comparison of modeling results with performance objectives. If the comparison indicates that the modeling results would meet the performance objectives, closure will continue as planned. If the results could not meet performance objectives, DOE would take additional waste removal steps or revise the stabilization method to ensure compliance with the performance objectives. This process would be conducted in close coordination with SCDHEC and EPA, which have regulatory authority for final remediation of the tank farms area. Closure of individual tank systems requires formal approval by SCDHEC under South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities."

Appendix A contains more information on the SRS HLW tank closure strategy.

2.3 Regulatory Framework for High-Level Waste and Incidental Waste

The definition of HLW is based on the origin of the waste rather than its characteristics. For example, Title 10 of the Code of Federal Regulations Part 50, Appendix F, defines HLW as "those aqueous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuels." The Nuclear Waste Policy Act (NWPA), as amended, (1) designates the U.S. Nuclear Regulatory Commission (NRC) as the Government agency responsible for licensing the disposal of HLW, and (2) identifies the proposed geologic repository at Yucca Mountain, Nevada, as the only such facility currently under consideration.

In addition, the NWPA provides a new definition of HLW that introduces the concentration of radioactive materials as an important factor. The NWPA definition classifies solidified reprocessing waste as HLW only if it "contains fission products in sufficient concentrations," suggesting that liquid reprocessing wastes would not be HLW if they were partitioned or otherwise treated such that some of the solidified products contained substantially reduced concentrations of radionuclides.

The NRC has considered modifications to the definition of HLW in a series of *Federal Register* notices. In 1987, the NRC issued an Advanced Notice of Proposed Rulemaking (ANPRM, 52 FR 5992) that made a distinction between HLW and "incidental wastes" that result from reprocessing plant operations; examples of incidental wastes included ion exchange beds, sludges, contaminated laboratory items, clothing, tools, and equipment as well as radioactive hulls and other irradiated and contaminated fuel structural hardware. The proposed rulemaking included incidental wastes generated from the treatment of HLW, such as decontaminated salt.

In 1990 the States of Washington and Oregon petitioned the NRC to revise its definition of HLW to establish a procedural framework and substantive standards for determining if reprocessing wastes, including in particular wastes stored at the DOE Hanford Reservation, are HLW and therefore subject to NRC licensing authority (55 FR 51732). The Hanford wastes in question consisted of the low-activity fraction that resulted from pretreatment of double-shell tank wastes, which at that time were scheduled for treatment via grout stabilization and disposal in vaults on the Hanford site. The NRC denied the petition for rulemaking (Bernero 1993; 58 FR 12342, March 4, 1993) and expanded on the types of incidental waste that would fall outside the HLW definition in 10 CFR 50, Appendix F (e.g., waste generated from the further treatment of HLW, such as salt residues or miscellaneous trash from waste glass processing). The NRC concluded that DOE could classify the Hanford tank wastes as incidental if they:

1. Have been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical

2. Will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste (LLW) established in 10 CFR 61

3. Are to be managed, pursuant to the Atomic Energy Act, such that they satisfy safety requirements comparable to the performance objectives established in 10 CFR 61

The NRC also noted that the proper classification of some Hanford wastes, including the single-shell tank wastes and *empty but still contaminated waste tanks DOE might dispose of in-place* (emphasis added), remains to be determined. Because the Hanford decision does not establish a clear precedent for DOE to declare the residual contamination in the SRS tanks as incidental waste, DOE has prepared this report to provide the regulatory basis to support this classification; Chapter 3 describes how the closure of the F- and H-Area tanks and the handling of the residual contamination in the waste tanks is consistent with the NRC criteria for incidental waste.

In 10 CFR 61.41, the annual whole body dose equivalent to a member of the public resulting from releases to the environment is limited to 25 mrem, including the groundwater pathway. In cases where the groundwater pathways dominate, the EPA 4 mrem per year limit for beta-gamma emitters in public drinking water supplies is more restrictive than the NRC 25 mrem per year limit. (EPA has also established limits for alpha particle emitters; however, as will be discussed later, DOE believes the beta-gamma limit will be the controlling standard for the SRS tank closures.)

In notices accompanying *Federal Register* regulations dealing with decontamination and waste disposal, the NRC notes it has attempted to strike a reasonable balance between taking protective measures and the feasibility and cost of these measures.

2.4 Status of DOE Closure Activities

As discussed above, DOE has prepared a general plan for closing the 51 HLW tanks at the SRS (DOE 1996a). The plan includes the regulatory strategy for satisfying EPA and South Carolina regulations. Although the schedule for closing the tanks depends on operational considerations, several tanks are virtually empty of waste. Tank 20 is the first tank scheduled for closure (anticipated in early 1997), and

DOE has prepared an individual closure module for Tank 20 (DOE 1997) as called for in the general plan. SCDHEC has approved the Tank 20 module. As described in that module, Tank 20 has been spray washed and will be stabilized with three layers of a grout-like substance to minimize contaminant leaching and the likelihood of inadvertent penetration in the future by drilling or excavation. SCDHEC has approved the general closure plan and EPA has concurred. Each tank's closure module must be approved by EPA and SCDHEC before DOE can complete the closure activities for a specific tank.

DOE has performed a priori fate and transport modeling for all of the HLW tank systems in F-Area (see Appendix B). The modeling analysis reveals that tank closure would satisfy applicable performance objectives (primarily the 4-mrem-per-year drinking water maximum contaminant level) at the point of exposure (the seepline), where groundwater outcrops to the surface approximately 1 mile from the tanks. DOE would ensure that institutional controls on future land use are in effect to limit access to groundwater closer than 1 mile to the tanks. The analysis indicates that the 4-mrem drinking water standard would not be satisfied at locations nearer to the F-Area Tank Farm. However, the closure strategy set forth by DOE in its general plan (DOE 1996a) will ensure that all HLW tank systems will be closed under the oversight of SCDHEC and EPA in a manner that meets performance objectives (including the NRC 25 mrem per year limit) and assures protection of human health and the environment.

2.5 References

Bernero, R. M. (Director, Office of Nuclear Material Safety and Safeguards), 1993, letter to J. Lytle (Deputy Assistant Secretary for Waste Operations, Office of Waste Management, U.S. Department of Energy), U.S. Nuclear Regulatory Commission, Washington, D.C.

DOE (U.S. Department of Energy), 1996a, *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Site, Construction Permit Numbers 14,338, 14,520, 17,424-IW*, Revision 1, Savannah River Operations Office, Aiken, South Carolina, July 10.

DOE (U.S. Department of Energy), 1997, *Industrial Wastewater Closure Module for the High-Level Waste Tank 20 System, Savannah River Site, Construction Permit Number 17,424-IW*, Revision 1, Savannah River Operations Office, Aiken, South Carolina, January 8.

NRC (U.S. Nuclear Regulatory Commission), 1981, *Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste,"* NUREG-0782, Office of Nuclear Material Safety and Safeguards, Washington, D.C.

CHAPTER 3. CONFORMANCE OF SAVANNAH RIVER SITE HIGH-LEVEL WASTE TANK CONTAMINATION WITH INCIDENTAL WASTE CRITERIA

DOE has identified criteria for incidental waste classification to be applicable to residual tank waste at SRS based on guidance from the U.S. Nuclear Regulatory Commission (NRC). The criteria are based on the treatment of the waste and the characteristics of the physical disposal form. Wastes can be classified as incidental if they:

1. Have been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical

2. Will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste (LLW), as set forth at 10 CFR 61

3. Are to be managed, pursuant to the Atomic Energy Act, in a matter that satisfies safety requirements comparable to the performance objectives established in 10 CFR 61

The U.S. Department of Energy (DOE) considers the residual contamination in the HLW tanks after it has performed the closure activities described in Chapter 2 to be incidental waste. The alternatives for decontamination of the Savannah River Site (SRS) HLW tank systems are those technically feasible cleaning and removal actions that offer reasonable assurance that the remaining material can be stabilized and managed such that it will not pose an unacceptable risk to members of the public. DOE will perform research and will examine new techniques and processes developed by other organizations to determine if those technologies extend the limits of decontamination technology and if they are technically and economically practical to employ for SRS HLW tank closures.

The following sections address the three criteria for the classification of incidental waste.

3.1 Conformance to Criterion 1 - Removal of Radionuclides

DOE believes that there are two aspects to the removal of "key radionuclides to the maximum extent that is technically and economically practical": processing the HLW that has been removed from the tanks, and processing the residual contamination that remains behind. The processing of HLW at the SRS is a well-documented, ongoing process; bulk waste will be removed from the tanks for treatment at the Defense Waste Processing Facility (DWPF) and Z-Area Saltstone Manufacturing and Disposal Facility

(SMDF). DOE will remove additional waste from the tanks by hot-water pressure-washing, which will put some of the solids into a slurry-type mix. Although the addition of water might appear contrary to the concepts of volume reduction, the removed slurry will undergo evaporation and will generate only small additional amounts of waste to be processed at DWPF or Z-Area SMDF. Appendix A summarizes the baseline waste removal activities and other options from which DOE will select an optimum combination to remove as much of the material from the tank systems as is technically and economically practical. The combined activities will remove greater than 99 percent of the original radioactivity in the tank systems.

Nine tanks have leaked detectable amounts of wastes from primary to secondary containment. On these tanks, the waste will be removed from the annulus using water or steam. Annulus cleaning has been attempted at SRS on only one tank (Tank 16), and the operation was only partially completed. Thus, annulus cleaning is not demonstrated technology. Also, there may be some cases where it is impractical and new techniques might have to be developed. The amount of waste in secondary containment is small, so the environmental risk of this waste is small in relation to the amount of waste inside the tanks.

In the general closure plan (DOE 1996), DOE presents its process for the selection of the closure configuration that will ensure that "radionuclides were removed to the extent that is technically and economically feasible." In accordance with that plan, DOE will characterize each HLW tank system or group of tank systems to determine the inventory of contaminants (radiological and nonradiological) that would remain after waste removal. The planned methodology for determining the inventory of contaminants in each tank is as follows:

1. If the tank has liquid, the liquid contents of the tank will be removed so that any remaining residual is clearly visible.

2. Photographic inspections will be performed to assess the condition of the tank interior.

3. Existing tank structures will be used as references to map the location of the residual on the tank bottom and to estimate the volume of material. Most tanks have features of known size on the floor of the tank that can be used to gauge the depth of materials, such as lifting plates, weld beads, cooling coils, or support plates for cooling coils. If no such features are apparent or they are covered by the residual, a graduated rod or other depth reference device may be inserted to gauge the depth of the residual material.

4. Protocols will be established on a tank-specific basis to characterize the residual material. Specifics of the sampling and analysis will be subject to SCDHEC approval in the context of the tank-specific closure modules.

5. Samples will be collected based on the results of the photographic inspection. The operational history and visual evidence will be used to determine a representative sampling approach (i.e., the number of samples and their locations). Sampling methods will be determined by the physical characteristics of the residual material. For example, piles of loose residue of more than an inch in depth can be sampled using a clamshell sampler. Thin films cannot be sampled with a clamshell, so another technique such as smearing would be used.

6. Analyses will be performed for a broad range of potential contaminants based on the operational history of the tank system. The analyses will include properties of the residual material that are relevant to formulating the grout to ensure effective stabilization.

DOE will then use the characterization information to determine the grout formulation and conduct a performance evaluation that will model projected contamination pathways for selected closure configurations and will compare the modeling results with performance objectives. If the performance objectives are met, DOE will continue with the planned tank closure; if they are not met, DOE will take additional waste removal steps or revise the stabilization method to comply with the performance objectives.

The performance evaluation, which is described more completely in Appendix B, will focus on exposure pathways and contaminants of most concern for a specific tank system. Based on preliminary analyses, DOE anticipates that the limiting exposure pathway for HLW tank closures will be through releases to groundwater and subsequent migration to onsite surface waters. The contaminants of greatest consequence in the exposure pathway are those subject to the most stringent standards for compliance. The general closure plan (DOE 1996) contains a detailed comparison of the various performance standards to aid in identifying the most restrictive limit that would apply at a specific point of exposure. The lowest concentration limit for a specific constituent would become the performance objective for that constituent in the specific media (i.e., air, groundwater, or surface water for nonradiological constituents) and the lowest dose limit for a specified exposure pathway (i.e., air, soil, groundwater, or multipathway) would become the performance objective for radiological constituents. DOE considers that final, tank-specific analyses will indicate that, for the members of the public, the EPA 4 mrem per year drinking water limit will be more restrictive than the N[illegible] 5 mrem per year limit from all releases to the environment.

DOE will employ waste removal techniques that are technically and economically practicable and which will remove greater than 99 percent of the radioactivity. The estimated incremental costs of performing these techniques is reasonable considering the benefits in key radioactive isotope removal and exposure reduction.

3.2 Conformance to Criterion 2 - Solidification

The second incidental waste classification criterion states that the waste "will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C LLW as set forth at 10 CFR 61."

Incidental waste must be in a "solid physical form" to ensure that it remains stable over time. The stability of disposed waste described in the regulati is t ed on three factors: (1) the ability to maintain integrity and strength of the waste container .. ficient period of time to ensure that a "cave-in" does not permit access to the disposed waste by a member of the public, (2) the ability to limit dispersion of the waste material, and (3) the potential reduction of the likelihood of an inadvertent intruder. DOE will design fill material to suit each individual tank configuration, type and amount of waste, pour, and strength requirements. For example, placing reducing grout over the waste layer, then filling the tank with self-leveling, low-strength material, then using strong grout at the top of the tank would take all the factors into account. Appendix A describes various grout-like substances and the properties of each.

DOE would pump the reducing grout directly on the residual waste in the tank, and some mixing with the residual waste could occur. This type of grout reduces the mobility of certain radionuclides by altering the chemical properties of water that leaches through the grout. There are several radionuclides present in the tanks with long half lives that could impact long-term performance of the closure configuration. Two of these are plutonium and technetium. However, in an environment of high pH and reducing conditions, these radionuclides either form very low solubility compounds or are strongly bound onto surrounding particles. In either case, the mobility of the radionuclides is greatly reduced compared to conditions in the natural environment. Reducing grout provides a high pH, reducing environment, thereby limiting the migration of some radionuclides and decreasing their impacts on groundwater. Appendix A summarizes the alternatives for solidifying and stabilizing residual contamination after waste removal.

DOE has evaluated the concentrations of radionuclides in the SRS HLW tank systems (Watkins 1996) and determined that 14 of the tank systems do not exceed the Class C LLW limits for radionuclides listed in 10 CFR 61. This evaluation used concentration averaging based on NRC guidelines in the Branch Technical Position (BTP) issued January 17, 1995 (NRC 1995). For the remaining 37 tank systems, DOE believes that additional cleaning, which could include an oxalic acid wash, and the likely use of concentration averaging, would be needed to meet criterion 2. The cost for the additional cleaning is approximately $800,000 per tank.

The NRC method for deriving the Class C concentration limits in 10 CFR 61 is based on direct contact with the disposed waste by an inadvertent intruder scenario. The overall standard for determining Class C concentration limits is an annual dose equivalent to an inadvertent intruder of 500 mrem from all pathways. DOE intends to maintain control of the site encompassing the SRS HLW Tank Farms in perpetuity. Therefore, the possibility of inadvertent intrusion into the closed HLW tank systems and the area surrounding the tanks will be remote. Reevaluation of the appropriateness of the Class C limits for HLW tank closure would result in significant costs savings as additional cleaning of 37 tank systems may not be required.

Under 10 CFR 61.58, the Commission may authorize other provisions for the classification of waste on a specific basis if, after evaluation of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in Subpart C of 10 CFR 61. Section 3.9 of the BTP (NRC 1995) states that alternatives to the determination of radionuclide concentrations for waste classification purposes, other than those defined in the BTP, may be considered acceptable. For example, the physical form of certain wastes may be such that intruder exposure scenarios other than those used to establish the waste classification limits in Tables 1 and 2 of 10 CFR 61.55 may be appropriate. DOE requests NRC's consideration of an alternative to the Class C limits of 10 CFR 61.55 for the tank system closures.

The intruder scenarios for the Class C determination may be inappropriate as the residual waste will be immobilized, the residual material is located at least 10 meters below the ground surface, and the tank system is filled with a stable medium. A site-specific intruder analysis for a hypothetical closed tank system is presented in Appendix C of this report. The analysis does not consider exposure of the intruder to groundwater near the closed tank system as a source of drinking water (DOE has committed to implement institutional controls to ensure compliance with the 4 mrem per year groundwater protection standard at the nearest location with a likelihood of exposure.). This limitation is consistent with NRC's methodology for deriving the Class C concentration limits in 10 CFR 61 (site-specific groundwater migration analyses are performed independent of the intrusion scenarios considered for waste classification).

Under the site-specific intruder analysis, the dose received by the intruder is approximately 1.2 mrem per year based on exposure to a conservative upper estimate for the waste residual remaining in the closed tank systems. The SRS-specific analysis assumes the intruder is exposed as a result of drilling a well that penetrates the waste form. For this analysis, the waste form was assumed to be the source inventory from 10 tanks contained in an area smaller than that occupied by the 10 tanks. The intruder's exposure is assumed to occur 100 years after closure of the tanks. The postulated SRS intruder would receive a dose well below the limit of 500 mrem per year imposed under 10 CFR 61 for the inadvertent intruder. This site-specific analysis demonstrates that the SRS tank closures will comply with the performance objectives of 10 CFR 61 and human health and the environment will still be protected.

3.3 Conformance to Criterion 3 - Waste Management

The third NRC stipulation for classifying tank waste as incidental requires that wastes "are to be managed, pursuant to the Atomic Energy Act, so that safety requirements comparable to the performance objectives set out in 10 CFR 61 are satisfied."

The SRS is a large Federal reservation under the control of DOE, which is empowered by Federal law to manage its waste in accordance with the Atomic Energy Act. DOE Order 5820.2A, "Radioactive Waste Management," implements the Atomic Energy Act for DOE facilities. With experience gained at several large facilities, DOE is prepared and intends to manage the residual contamination in the HLW tanks to meet safety requirements comparable to 10 CFR 61 performance objectives.

These performance objectives, listed in Subpart C of 10 CFR 61, require the following:

1. Annual dose to members of the public cannot exceed 25 mrem from releases to the environment. In accordance with the general plan (DOE 1996), DOE has committed to achieve a 4-mrem-per-year groundwater standard at the nearest location with a likelihood of exposure. At locations where it could not satisfy the 4-mrem-per-year drinking water standard, DOE would institute active and passive institutional controls (see Section 4.3). Because the groundwater pathway would dominate, combined doses from all pathways would therefore be less than 25 mrem per year.

   Appendix B, section B.1 illustrates the dose modeling DOE would perform to verify compliance with this performance objective. DOE, the U.S. Environmental Protection Agency (EPA), and the South Carolina Department of Health and Environmental Control (SCDHEC) have agreed that the point of exposure for a member of the public is at the "seepline" where groundwater outcrops to the surface about 1 mile from the HLW tanks. The 4-mrem-per-year drinking water standard would be satisfied at the seepline.

DOE will establish a control zone extending from each tank farm to the point of allowable public access. Tank-specific performance objectives will be developed considering potential contamination from the target tank system as well as the potential impacts from other tanks and nontank sources up- and downgradient from the tank system to be closed. Based on these potential sources of contamination, the control zone will encompass the area in which the predicted dose received as a result of groundwater consumption would exceed the EPA standard of 4 mrem per year for drinking water.

2. The design, operation, and closure of the facility must ensure protection of the inadvertent intruder after active institutional controls are removed. The closure configuration described in Appendix A involves grout-like fill material that will be approximately 30 feet thick. This barrier may remain effective for 1,000 years or more. Combined with the concrete and steel structure of the tank and the depth of the contamination layer, for the first 1,000 years, there is little likelihood that an intruder would be persistent enough to excavate to the contamination layer to become exposed to the radioactivity it contains.

NRC has stated that the physical form of certain wastes may be such that intruder exposure scenarios other than those used to establish the waste classification limits in Tables 1 and 2 of 10 CFR 61.55 may be appropriate (NRC 1995). The referenced BTP provides an example of disposal of a large intact component filled with a structurally stable medium (e.g., cement), or enclosed in a massive robust container capable of meeting structural stability requirements. For the SRS tank closures, reducing grout (grout formulated to bind up the specific contaminants) will be placed in the tank to immobilize any residual waste. A low-strength cement, controlled low-strength material or CLSM, forms the next layer (approximately 7,500 cubic yards) on top of the reducing grout. The final layer (approximately 1,500 cubic yards) consists of a high-strength cement filling the remaining space at the top of the tank. The long-lived radionuclides in the tank residual must also be isolated by means other than these engineered barriers since any fill material or grout will assume the physical properties of normal soil after a few hundred or a thousand years.

At SRS, there will be zones affected by the waste that extend well beyond the closed tanks. The intent of the performance objectives in Part 61.42 is fully met because any intruder into the area under control would be deliberate and no occupancy or public use of the control zone will be allowed. Appendix B contains a discussion outlining the process to be used to establish the size and orientation of the control zone. The control zone is designed to meet the NRC 25 mrem-per-year limit and the EPA 4 mrem-per year limit for drinking water and would be implemented by a combination of active and passive institutional controls to remain in perpetuity.

3. Operation of the disposal facility must comply with 10 CFR 20. This evaluation does not discuss this performance objective because its subject is closure of the tank systems, not operation of a disposal facility. DOE will comply with 10 CFR 835, "Radiation Protection for Occupational Workers," during tank closure activities. This regulation is the DOE regulatory equivalent to 10 CFR 20 for protection of workers and is functionally similar to 10 CFR 20.

4. The facility must be sited, designed, used, operated, and closed to achieve long-term stability. The 30 or more feet of grout-like material poured over the waste and the steel-and-concrete structure of the tanks will create a solid, stable configuration for more than 1,000 years [see Appendix D of the general closure plan (DOE 1996)]. Final remediation of the tank farm areas under the Comprehensive Environmental Response, Compensation, and Liability Act may include capping the area, if necessary, which would further isolate the waste from rainwater by sealing the areas above each tank grouping. Such a configuration would provide long-term assurance of stability and strength of the closure area. The actual final remediation will be customized to the specific tank or tank groupings based on such factors as the elevation of the tank(s) and the surrounding terrain.

3.4 References

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CHAPTER 4. TECHNICAL AND REGULATORY BASES FOR INCIDENTAL WASTE CLASSIFICATION

Chapter 3 explains the U.S. Department of Energy (DOE) contention that the residual contamination in the high-level waste (HLW) tanks at the Savannah River Site (SRS) is "incidental waste" in accordance w... applicable criteria established by the U.S. Nuclear Regulatory Commission (NRC; Bernero 1993). This chapter presents three related reasons for a classification of incidental waste, as fol'

1. *In situ* closure of the residual contamination in the HLW tanks is the "right thing to do" from the perspectives of worker health, the environment, and cost.

2. *In situ* disposal ...ng methods described in Appendix A will be more protective of the public and the environment than shallow land burial and thus is consistent with available means of protection from wastes that could be Greater Than Class C (GTCC).

3. The tank closures would occur on a large Federal reservation and would continue under Government control in perpetuity.

4.1 Cost/Benefit Analysis

DOE designed its *in situ* closure strategy, which it established in the general closure plan (DOE 1996) to ensure that it conducts SRS HLW tank closures in a manner that protects human health and the environment and is within reasonable bounds of economic and technical practicability. The strategy begins with a baseline of bulk waste removal, spray water washing, and removal of the resulting slurry by pumping. An optimal closure configuration (i.e., combination of waste removal and stabilization) is chosen on the basis of technical feasibility, effectiveness, cost, and other relevant factors from a range of additional closure activities. For an individual tank, the evaluation of closure options in relation to environmental performance objectives begins using the generic baseline configuration for that system and other tank systems in the vicinity that might contribute contaminants to a point of exposure. DOE evaluates system-specific adaptations of the baseline configuration (e.g., waste-specific grout formulations, additional waste removal steps) as needed to ensure the maintenance of overall cost effectiveness for individual tank system closures. Regulatory approval for each individual tank system closure by the South Carolina Department of Health and Environmental Control (SCDHEC) in close coordination with the U.S. Environmental Protection Agency (EPA) is integral to the DOE closure strategy to ensure short- and long-term effectiveness in meeting environmental performance objectives (DOE 1996).

Table 4-1 summarizes the cost/benefit comparison for the range of closure configuration options that DOE considered in determining the baseline for waste removal and fill (see DOE 1996). These options include bulk waste removal using slurry pumps followed by spray washing with hot water using rotary spray jets; these are technologies that have been demonstrated at the SRS. The alternatives are differentiated on the basis of additional waste removal steps and options for the physical-chemical stabilization of t- - system structures and residual waste remaining in these structures. Fill options examined include sand, pumpable self-leveling backfill material (grout), or saltstone [radioactively contaminated grout made from the low activity liquid waste fraction that results from the pretreatment of HLW at the In-Tank Precipitation (ITP) facility] for stabilization. Essential features of the DOE base case are bulk waste removal and spray water washing followed by stabilization using pumpable, self-leveling backfill (grout or grout combinations) formulated and placed to reduce the migration of radionuclides, provide structural stability, and discourage penetration of the waste form. Variations to the base case include the deletion of spray water washing for salt tanks only (if hydraulic removal is of comparable effectiveness), repetition o water or acid washing, and application of new waste removal techniques with comparable or greater cleaning effectiveness (DOE 1996). DOE is actively supporting advanced waste removal technologies, as exemplified by a demonstration project to remove contaminated zeolite from Tank 19 to be performed in 1996 and 1997.

Table 4-1 uses estimated cost and cumulative worker exposure on a per tank system basis, radiological impacts to groundwater determined from fate and transport modeling of a cluster of four HLW tanks (Tanks 17 through 20), and demonstrated technical feasibility as primary determinants of cost-effectiveness. As listed, DOE eliminated four options from further consideration on the basis of ineffectiveness, technical feasibility, cost, or a combination of these items. The Spray Water Wash/ No Fill alternative was eliminated because it provides no structural stability and is ineffective in immobilizing radionuclides, in particular long-lived alpha-emitters (e.g., plutonium-239). The Spray Wash/Sand Fill option provides some structural stability and radionuclide immobilization; however, DOE eliminated this alternative because, in relation to the selected base case, it is considerably less effective in immobilizing radionuclides (indicated by relatively high near-field potential doses for alpha emitters and earlier peak doses for more mobile beta-gamma emitters) at comparable cost. DOE eliminated the Spray Water Wash/Saltstone alternative primarily on the basis of relatively high cost.

Cost and dose estimates are based on various options for cleaning and filling the tanks. Worker doses were estimated based on the number of workers needed to perform the job, the number of months to complete the activities, and radiation levels at both the tank surface and equipment used to remove waste. The base case estimate is 10 person-years by radiation workers over a 6-month period per tank. The resulting dose estimate is 10.2 person-rem. If tanks were filled with saltstone, a radioactive grout-like

Table 4-1. Cost/Benefit comparison of major HLW tank closure options.[a]

Closure configuration option[b]	Estimated cost ($/tank)[c]	Estimated cumulative worker exposure (person-rem/tank)	Relative radiological [illegible] to groundwater[d] maximum annual dose (mrem/yr) [Time of occurrence (years after closure)]						Remarks and conclusion
			1-meter well		10[illegible] well		Seepline		
			Beta-gamma	Total	Beta-gamma	Total	Beta-gamma	Total	
Spray Water Wash/No Fill (No Cover)	1,356,000	2-3	150 [315]	10,000 [9,975]	73 [315]	280 [9,975]	4.7 [805]	4.7 [805]	Ineffective; eliminated from further consideration.
Spray Water Wash/Sand Fill (w/RCRA-Style Cap)	3,800,000	10.2-11.2	120 [1,085]	1,200 [9,975]	49 [1,085]	49 [1,085]	4.1 [[illegible],645]	4.1 [1,645]	Selected base case is more effective at comparable cost, eliminated from further consideration.
Spray Water Wash/Grout Fill (No Cover)	**3,800,000**	**10.2-11.2**	**100 [1,785]**	**[illegible] [1,785]**	**54 [1,995]**	**54 [1,995]**	**3.1 [2,555]**	**3.1 [2,555]**	**DOE's selected base case; most cost-effective alternative.**
Spray Water Wash/Grout Fill (w/RCRA-Style Cap)	3,800,000	10.2-[illegible].2	100 [2,275]	100 [2,275]	53 [2,485]	53 [2,485]	3.1 [3,045]	3.1 [3,045]	Minimally more effective than selected base case.
Spray Water Wash + Oxalic Acid Wash/ Grout Fill	4,600,000	10.2-12.2	< Selected base case		< Selected base case		< Selected base case		Oxalic acid wash demonstrated at SRS for sludge; more effective than the base case, but higher c[illegible] and sodium oxalate produced could require changes in ITP processing; will be used as necessary on some tanks.
Spray Water Wash + Saltstone Fill	6,300,000	10.5-11.5	> Selected base case		> Selected base case		> Selected base case		As effective as base case but higher source term because saltstone is already contaminated; higher cost; eliminated from further consideration.

Table 4-1. (continued).

Closure configuration option[b]	Estimated cost ($/tank)[c]	Estimated cumulative worker exposure (person-rem/tank)	Relative radiological impact to groundwater[d] maximum annual dose (*mrem/yr*) [Time of occurrence (years after closure)]: 1-meter well, Beta-gamma	1-meter well, Total	100-meter well, Beta-gamma	100-meter well, Total	Seepline, Beta-gamma	Seepline, Total	Remarks and conclusion
Spray Water Wash + Oxalic Acid Wash + Chemical- Mechanical Cleaning/Grout Fill	>50,000,000?	> Selected Alternative	< Selected base case		< Selected base case		< Selected base case		Technologies not demonstrated large scale. DOE will support technology research, development, and demonstration (e.g., Tank 19 Demonstration) and will consider for HLW tank closures as cost-effective technologies are demonstrated
Spray Water Wash + Oxalic Acid Wash + Chemical- Mechanical Cleaning/Tank Removal	>100,000,000?	>93	< Selected base case		< Selected base case		< Selected base case		Technologies not demonstrated large scale, much more expensive, higher cumulative worker dose than base case; radioactive waste residuals not vitrified at DWPF would be transferred to shallow land disposal (e.g., Saltstone Disposal Facility, SRS Solid Waste Disposal Facility); eliminated from further consideration

a. Source: DOE ([illegible])

b. Closure configuration includes combination of waste removal and physical-chemical stabilization technologies for residual waste and tank system structure. Final decisions on RCRA-style cap to be determined after closure of individual tank systems in context of final RCRA/CERCLA remediation of the tank farm, included for indicated options to establish equal basis for comparison of radiological impact to groundwater as determined from fate and transport modeling

c. Cost estimates are incremental costs beyond bulk waste removal, including the cost of treating the spent wash water/oxalic acid, but do not include cost for RCRA-style cap. Costs are for comparison purposes only and are not of budget quality. All costs in FY 1996 dollars.

d. Numerical dose estimates based on fate and transport modeling of the HLW Tanks 17-20 system (i.e., four tanks and associated ancillary equipment) for a 10,000-year period of analysis as reported in DOE (1996). Modeling results are for well locations 1 meter and 100 meters from the tank farm boundary and at the outcropping of groundwater to surface water (Fourmile Branch), approximately 1 mile from the tank farm. Differentials between beta-gamma dose and total dose is alpha dose from long-lived radionuclides.

material, cost per tank is increased significantly. This is primarily due to performing radiation work to generate and handle the saltstone in lieu of a non-radiation environment to generate grout in a concrete facility. Handling radioactive material requires numerous procedures, work permits, and anti-contamination measures resulting in longer times and additional workers. These factors drive the cost of using saltstone out of the range DOE believes is reasonable. Other disadvantages are discussed in Appendix A. In addition, DOE eliminated the Tank Removal alternative because it is beyond the limits of technical and economic practicability, would involve relatively high worker risks, and would result in the transfer of any remaining residual contamination on tank components to another near-surface disposal facility. The higher risk to workers results from several factors, but would be dominated by the increase in industrial-type accidents associated with heavy equipment use, excavation activities, cutting with torches, and handling the excavated concrete, steel, and internal components. The National Academy of Sciences has urged DOE to examine alternatives to excavation at the Hanford HLW tank farms and has specifically suggested "close-in-place" options may be more protective to the environment and public health (NAS 1996).

DOE has determined that the remaining two options are not cost-effective as baseline activities at this time. The Spray Water Wash + Oxalic Acid Wash/Grout Fill option, which is effective at the SRS for sludge (not salt) removal, would result in less impact to groundwater than the selected base case in proportion to the reduction in source term achieved. Since acid wash is not required to meet performance objectives for most salt tanks (i.e., those containing salts and saltcake), DOE did not include it in the baseline activities. The oxalic acid would result in an additional waste stream requiring treatment. This alternative could result in additional cost and require changes to ITP, the HLW salt pretreatment process. Nevertheless, DOE will use oxalic acid cleaning on a case-by-case basis when necessary and appropriate to achieve performance objectives. Because the Spray Wash + Oxalic Acid Wash + Chemical-Mechanical/Grout alternative would involve the use of expensive advanced technologies for waste removal that have not been demonstrated or developed, it was not selected for use because of its cost and technical practicability. In general, these technologies would involve intensive cleaning with high pressure jets or intensive mechanical scrubbing, and would require further development in such areas as chemical cleaning formulations and robotic mechanisms to either navigate the array of cooling coils in the tanks or to cut the coils. DOE supports and will continue to support the development of advanced waste removal technologies and will consider them, once they are demonstrated, for use in future tank system closures.

In conclusion, the DOE process for selecting the cleaning and *in situ* closure configuration for individual tank system closures would be technically feasible and highly cost effective in relation to available alternatives.

4.2 Technical Criteria for High-Level Waste Tank System Closure

A significant milestone in the NRC waste disposal program was the promulgation of 10 CFR 61 on December 27, 1982. The regulation establishes procedural requirements, institutional and financial requirements, and overall performance objectives for land disposal of radioactive waste, where land disposal can include a number of disposal methods such as mined cavities, engineered bunkers, or shallow land burial. This regulation also contains technical criteria (i.e., onsite suitability, design, operation, closure, and waste form) that are applicable to near-surface disposal, which is a subset of the broader range of land disposal methods. Near-surface disposal is defined as disposal in or within the upper 30 meters of the earth's surface, and can include a range of such techniques as concrete bunkers or shallow land burial. The 10 CFR 61 regulation is intended to be performance-oriented rather than prescriptive, with the res[illegible] the 10 CFR 61 technical criteria are written in relatively general terms, allowing applicants to demonstrate how their proposals meet these criteria for various specific near-surface disposal methods.

The concentration limits in 10 CFR 61 are for classification as a particular type (A, B, C, or GTCC), and were established based on the NRC understanding at the time of the rulemaking of the characteristics and volumes of low-level waste (LLW) reasonably expected to be generated through 2000, as well as potential disposal methods. These regulations primarily address facilities that dispose of wastes by the method known as shallow land burial. At the time of the NRC rulemaking, this method consisted of placement of packaged waste in excavated trenches that, once filled, are backfilled with soil, capped, and mounded to facilitate rainwater runoff. In the context of such disposal practices, the NRC identified several technical measures that can be taken to ensure compliance with the 10 CFR 61 performance objectives (NRC 1981):

- Design to ensure long-term stability of the disposal facility and the disposed waste
- Reduce the presence of liquids in the waste and the contact of the waste with water
- Provide institutional controls and other engineering and natural controls

The proposed closure configuration for the SRS HLW tank systems incorporates features to ensure conformance with each of these technical criteria.

- Long term stability – Any liquid residual in the HLW tank systems after waste removal is completed will be solidified. The remaining void space in the tanks will be filled by a combination of backfill material(s) with a formula based on the specific circumstances of each tank. The backfill will be designed to achieve the requisite compressive strength to control subsidence and to provide a deterrent to inadvertent intrusion into the closed tank system. Appendix A provides a detailed discussion of the stabilization options for closure of the HLW tank systems.

- Contact of water with waste – The closure configuration for the HLW tanks is designed to limit rainwater infiltration. Backfill material will be placed in the tanks to control the infiltration of rainwater into the contaminated zone. Infiltration rates on the order of 4 centimeters per year can be achieved using an engineered cap such as those previously designed and evaluated at SRS. The combination of such a cap and the grout backfill material would result in an infiltration rate of approximately 2 centimeters per year. This infiltration rate increases to approximately 40 centimeters per year (average infiltration for SRS soils) for closure scenarios without an engineered cap or for time periods after failure of the cap and backfill material (beyond approximately 1,500 years). The use of reducing grout ensures that the chemical properties of liquid that eventually leaches through the backfill will limit the mobility of selected radionuclides.

- Institutional controls – DOE has committed to ensuring long-term control over the closed tank systems, including a combination of active controls (site surveillance and inspection) and passive controls (engineered barriers to deter intrusion). Section 4.3 discusses the proposed institutional controls.

The Class C concentration limits are applicable to all potential near-surface disposal systems; however, the calculations performed to establish the limits are based on the postulated use of one near-surface disposal method -- shallow land burial. The Class C limits are, therefore, conservative because other near-surface disposal methods could have greater confinement capability than shallow land burial. This flexibility to provide additional protective features if the waste concentrations are GTCC values governs the DOE tank closure method. The NRC rationale is that, given the current absence of prescriptive requirements for disposal of waste exceeding Class C concentration limits, the regulation allows for evaluation of specific proposals for disposal of such waste on a case-by-case basis. The general criteria to be used in evaluating specific proposals are the 10 CFR 61 performance objectives contained in Subpart C of the regulations.

The NRC outlined performance methods for land disposal facilities, such as models of groundwater flow and contaminant transport and descriptions of the natural and human-initiated disruptive events or processes that could significantly affect disposal system performance. Analytical methods for projecting the performance of the "disposal system" (i.e., the tank closure configuration) have been developed and are described briefly in Appendix B and in more detail in the general closure plan (DOE 1966). The residual waste in tanks at SRS will be "disposed of" at depths greater than 5 meters, will have additional engineered features such as strong grout layers at the top of the tank, and will have assurance of institutional controls beyond the 100-year period considered by the NRC in developing the 10 CFR 61 concentration values. Hazards below the acceptance criteria of 10 CFR 61 indicate an acceptable match of waste type and disposal option. For the SRS, the performance of a closed HLW tank system is projected to result in hazards that fall below the acceptance criteria in 10 CFR 61.

4.3 Institutional Control at the Savannah River Site

Although not listed as a Suor ... C performance objective, 10 CFR 61 requires the assurance of institutional control over waste disposal for 100 years after waste placement to ensure that the impacts from shorter lived radioisotopes would be minimal. The EIS for 10 CFR 61 (NRC 1981) states the assumption that an engineered barricade would provide resistance to intrusion for 500 years. DOE is capable of providing the institutional control required by the NRC. At present, access to the SRS is controlled, and public access to the F- and H-Area Tank Farms is prohibited.

DOE is seeking new missions for the SRS, and the Congress has endorsed the concept of expanding the Site's mission and exploring new technologies. Current SRS missions include environmental cleanup and the stabilization of radioactive wastes, which will go on for several decades. As a result, some of the newer double-shell HLW tanks will remain in continuous operation until DOE has moved all the high-level liquid waste to the Defense Waste Processing Facility (DWPF) for vitrification. Processing in one or both SRS canyon facilities will be necessary to stabilize nuclear materials that are stored on the site. This processing will generate still more wastes for storage in the operating tanks. DOE will continue to monitor the tank farms to ensure the safe management of the closed tanks and the immobilized residual wastes in them. DOE has committed to EPA and SCDHEC that it will maintain its active institutional controls for a minimum of 100 years after closure of the last tank system.

DOE will establish a control zone, including each tank farm area and extending to the points of exposure. The Department is actively seeking a Congressional designation of the SRS as a National Environmental Research Park, which would result in Federal control over all or part of the Site in perpetuity. DOE already has preliminary approval for the removal of part of the Hanford Reservation in Washington from public access in perpetuity.

4.4 References

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APPENDIX A. PROPOSED CLOSURE ACTIVITIES

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APPENDIX A. PROPOSED CLOSURE ACTIVITIES

A.1 Overview of the Waste Removal and Closure Process

The general plan for the closure of the high-level waste (HLW) tanks in the F- and H-Area Tank Farms at the Savannah River Site (SRS) examines the full range of closure configurations (waste removal and stabilization options) available to the U.S. Department of Energy (DOE) for tank closure (DOE 1996). Figure A-1 shows the waste removal and stabilization options available to DOE. This figure represents the full range of options that DOE has considered; the Department has established option 3B as the baseline for all tanks. Option 3C would be conducted as needed to meet performance objectives if it would be effective, which in all likelihood, will be required for sludge tanks.

Next DOE will characterize each tank system or group of tank systems (or module) individually to determine its inventory of residual contaminants, and the Department's activities for system closure. DOE will (1) use this information to conduct a performance evaluation of the various closure configurations and to compare the results with the performance objectives, (2) select a configuration that is technically and economically practical, and (3) prepare a report on that module that will describe how DOE intends to meet the performance objectives. DOE will proceed with closure activities only when it has demonstrated that the performance objectives will be satisfied.

To demonstrate conformance with incidental waste criterion 1 [i.e., the waste has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical], Table A-1 lists the potential technologies and their costs.

DOE will describe the proposed closure configuration for a given tank system in the tank-specific closure modules it will submit to the South Carolina Department of Health and Environmental Control (SCDHEC) for review and approval. Each module will contain characterization information and analyses to show that the proposed closure configuration (i.e., the combination of source removal/reduction and stabilization options) is protective of human health and the environment. The module will describe the end-state of the tank (e.g., type and characteristics of fill material, residual volume and contamination level, and cap requirements), modeling calculations to demonstrate that the performance of the closure configuration will meet the applicable performance objectives, and details (e.g., methods and schedule) for implementing the closure.

Closure Configuration Alternatives

Stages of Waste Removal		1	2	3	4	5
	A	1A	2A	3A	4A	--
	B	1B	2B	3B	4B	--
	C	1C	2C	3C	4C	--
	D	1D	2D	3D	4D	--
	E	--	--	--	--	5E

Increasing Cost (down) ↓

Increasing Cost (right) →

Closure Configuration Alternatives

1. -No fill material in tank
2. -Fill with sand
3. -Fill with grout
4. -Fill with saltstone
5. -Remove tanks from ground

Stages of Waste Removal

A. Bulk waste removal

B. Bulk waste removal
+ Spray washing

C. Bulk waste removal
+ Spray washing
+ Oxalic acid cleaning

D. Bulk waste removal
+ Mechanical and chemical cleaning involving advanced techniques

E. Clean tanks to enable removal of tank from ground

Figure A-1. Closure configuration options.

Table A-1. Waste removal alternative costs.

Option	Cost per tank[a]	Disposal costs of liquid waste per tank	Worker exposure (rem)
Bulk sludge removal or hydraulic salt removal	$9,000,000	$134,000,000[b]	2
Spray washing (incremental costs after bulk removal)	$1,200,000	$100,000	less than 1
Oxalic acid cleaning (incremental costs after spray washing)	$300,000	$500,000[c]	less than 1
Mechanical and chemical cleaning (incremental costs after oxalic acid cleaning)	Unknown but believed to be greater than $50 million per tank		
Clean tanks to extent allowing removal of tank from ground (incremental costs after oxalic acid cleaning, does not include removal)	Unknown but believed to be greater than $50 million per tank		

a. Estimates are for comparison purposes only, they are not of budget quality. All costs in FY 1996 dollars. Costs are total estimated cost only.

b. Based on estimated cost of the Defense Waste Processing Facility (DWPF) at $2.4 billion capital plus $4.3 billion operation expenses over 25 years. $6.7 billion divided by 50 tanks equals $134 million per tank.

c Based on 150,000 gallons of spent sodium oxalate solution to be disposed of in the Saltstone Manufacturing and Disposal Facility at $3 per gallon.

DOE will develop a post-closure monitoring and inspection plan based on the selected closure configuration and submit it as part of the tank-specific module. The objective of the monitoring and inspections will be to identify any changes in and to monitor the effectiveness of the HLW tank system closure configuration. DOE will develop procedures detailing inspection protocols, inspection reporting, and the corrective action process and will implement them based on the selected closure configuration. The SRS Environmental Restoration Program will finalize the details of post-closure care in accordance with the SRS Federal Facility Agreement; those details will be subject to EPA and SCDHEC oversight.

A.2. Selected Base Case

The alternatives presented in Section A.1 vary in their ability to meet the performance objectives in 10 CFR 61. Placing no fill in the tank would involve the smallest expense and the least amount of field work, and there would be no impacts on nearby tanks and no interruption of operations in the tank farm. However, there would be no stabilization of the residual waste and the tank structure.

Filling the tanks with sand, which would be operationally similar to backfilling them with grout (a pumpable backfill material), would not meet any of the established criteria. Sand is readily available and inexpensive. However, putting it in the tank would be more difficult than grout because it does not flow readily into voids and, over time, would settle in the tank.

Filling the tanks with saltstone (the low-activity fraction from HLW pretreatment at the In-Tank Precipitation Facility) would be the same as the filling them with uncontaminated grout with the exception of the additional source term associated with the fill material. This alternative has the advantage of reducing the amount of saltstone landfill space that would be required at SRS; however, it also has several significant disadvantages. The total cost of this alternative is much greater than using nonradioactive grout. The requirements for building a new radiological facility are more stringent than for a commercial concrete plant. Like the grout material DOE plans to use, the saltstone mix and chemical composition would have to be designed for specific tank inventories, the radioactive isotopes, and the internal configuration. Handling the radioactive saltstone would require the use of trained radiation workers, the equipment and vessels would become contaminated, and the whole process would take longer to complete due to the added complexity of radiation work. Placing saltstone in underground tanks would constitute radioactive waste disposal and would likely require permitting under state and Federal laws. DOE believes the higher cost of this alternative and the greater impact of releasing more radioactive material to the groundwater makes this option impractical.

Cleaning the tanks to the extent that would allow their removal (perhaps including oxalic acid cleaning and additional steps yet to be defined) would not meet criterion 1 due to the extremely high cost to remove the tank and considerable impacts on other SRS operations. The disadvantages of this alternative include the additional radiation exposure to workers during the removal process, extremely high cost to dispose of the tank components elsewhere, and the possibility that the disposal of the tank would create another zone of [illegible]ed use. The exposure to workers would be similar to large scale decontamination and decommissioning efforts involving cutting into contaminated metal and concrete and subsequent disposal of the pieces. The likelihood of generating airborne contamination is greatly increased which would require additional workers and protection to meet ALARA requirements.

DOE has not demonstrated options involving advanced mechanical and chemical cleaning techniques. The incremental cost for development and deployment of an innovative method for cleaning a relatively inaccessible large scale tank can only be guessed based on historical costs for other technological breakthroughs. The Department has studied a number of techniques involving such technologies as robotic arms, wet-dry vacuum cleaners, and remote cutters. However, none of these techniques are viable at this time.

Advanced waste removal alternatives focus aggressive cleaning techniques on a small portion of the tank. For example, a high pressure jet could be focused on a small portion of the tank wall, or the tank could be scrubbed by mechanical means. As an alternative, the steel tank could be cut into plates and disposed of elsewhere. Each of these techniques would require either the development of robotic techniques that could navigate through the maze of cooling coils in most HLW tanks in the SRS tank farms or the cutting of those coils. These cleaning techniques would require large development costs and a long time to perform because they would focus on one small area of the tank at a time.

DOE is sponsoring research into improved tank cleaning methods. If such methods could provide equal or superior cleaning effectiveness to the baseline activities, then DOE could substitute them for the spray washing described in Section 3.1 of this report.

For these reasons, DOE's selected closure option for the HLW tank systems is to remove the waste from the tanks using hydraulic slurrying techniques or other cleaning techniques of comparable effectiveness and, after waste removal, to fill each tank with a grout mix designed to stabilize the residual waste and to provide sufficient compressive strength for the closed tank configuration.

The first step of closing the HLW tank farms would be to close each individual tank. Figure A-2 is an sample closure configuration for a single tank system and Figure A-3 shows a sample area closure, including the layers in and above the tank. These layers are as follows:

- The residual waste at the bottom of the tank is the waste that remains after the application of removal techniques.

- Fill material consists of a combination of pumpable, self-leveling backfill materials (grouts) specifically formulated for each tank system closure. DOE will use an appropriate combination of the following fill materials:

  - Reducing grout consists primarily of cement, flyash or silica fume, and blast furnace slag. The chemical properties of liquid that leaches through this backfill material will reduce the mobility of certain radionuclides and chemical constituents. There are several radionuclides present in the tanks with long half lives that could impact long-term performance of the closure configuration. Two of these are plutonium and technetium. However, in an environment of high pH and reducing conditions, these radionuclides either form very low solubility compounds or are strongly bound onto surrounding particles. In either case, the

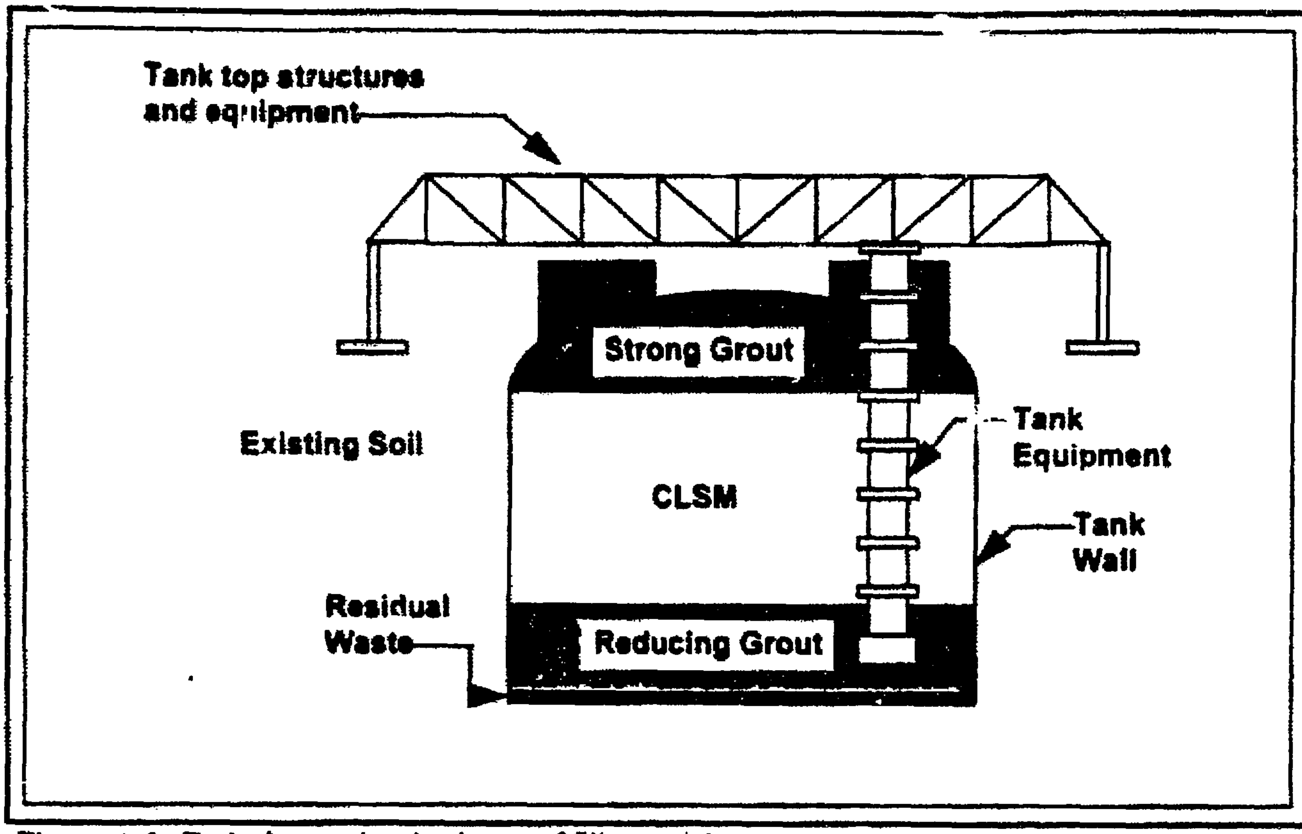

Figure A-2. Tank closure showing layers of fill material.

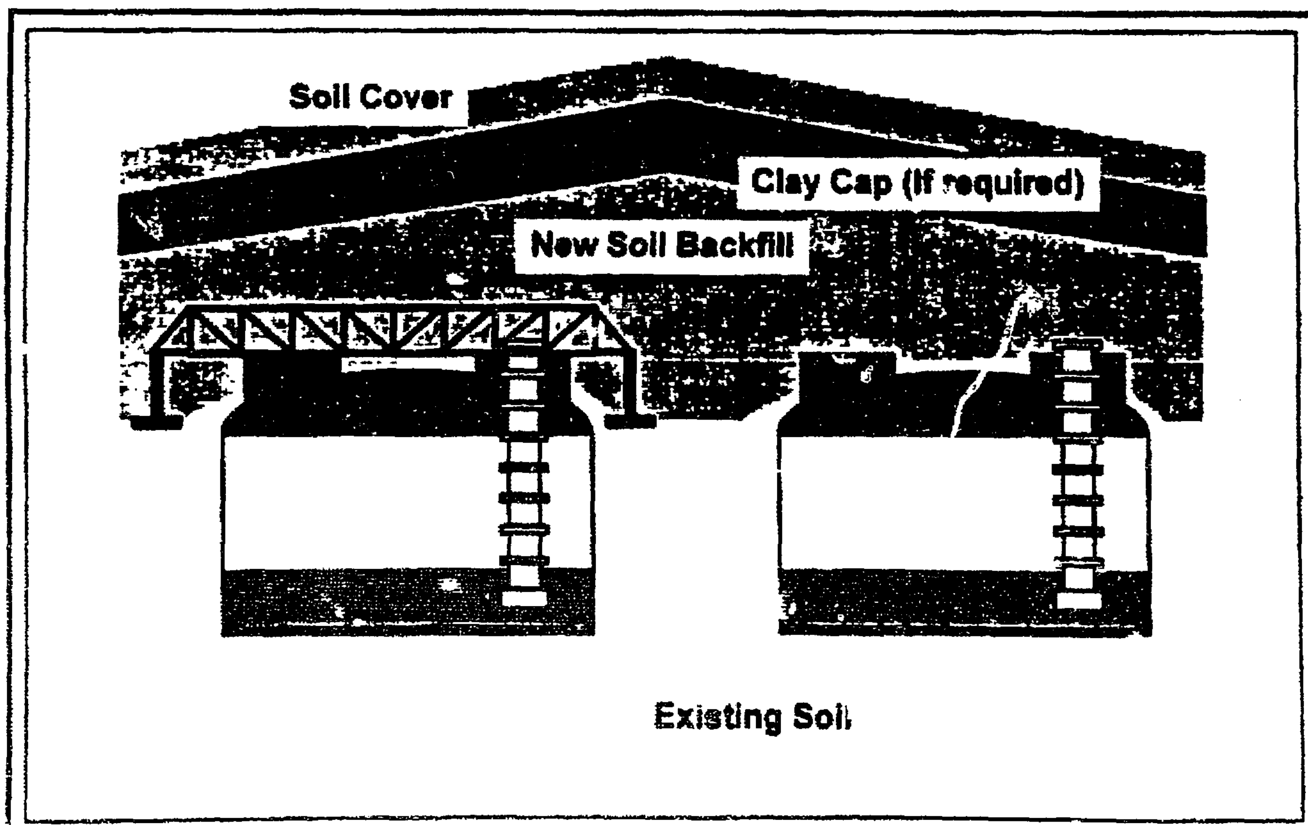

Figure A-3. Area closure.

mobility of the radionuclides is greatly reduced compared to conditions in the natural environment. Reducing grout provides a high pH, reducing environment thereby limiting the migration of some radionuclides and decreasing their impacts on groundwater.

- **Controlled low-strength material** (CLSM) is a self-leveling backfill material composed of sand and cement formers. Similar to reducing grout, it is pumped into the tank. Its compressive strength is controlled by the amount of cement in the mixture. CLSM has the following advantages over ordinary concrete or grout for most of the fill are: (1) its compressive strength can be controlled to provide adequate support for the overbearing weight; (2) its low heat of hydration allows large or continuous pours; and (3) it is relatively inexpensive. CLSM is widely used at the SRS, so there is a wealth of technical expertise on its formulation and placement.

- **Strong grout** is a low viscosity grout with compressive strengths in the normal concrete range. This formulation is advantageous near the top of a tank because its consistency is suited for filling voids created around risers and tank equipment. The grout would be injected in such a manner to ensure that voids were filled to the extent practicable. This could involve several injection points, each with a vent. This relatively strong grout will discourage accidental penetration of the waste (e.g., during excavation).

DOE will establish the necessity for a low-permeability (e.g., clay) cap to reduce rainwater infiltration after closure during the feasibility study for the overall remediation of the tank farms. As shown in Figure A-3, the area around the tanks could be backfilled with soil to cover risers, equipment, and other protuberances. If needed, DOE could place a cap over the group of tanks so rain falling on the area would drain away from the closed tanks. Because the tank systems are in close groupings, DOE would probably put the cap over an entire group of systems in one area.

In addition to the residual waste at the bottom of the tank, which is the major focus of closure activities, there will be residual contamination on equipment inside and near the tank (e.g., slurry pumps used for waste removal, cooling coils inside the tank, transfer piping in and out of the tank) and the secondary containment system and leak detection system for the tank. (This equipment was designed with minimal void spaces to facilitate thorough waste removal.) In addition, the tank farms contain other equipment for processing waste (e.g., evaporators, diversion boxes, pump tanks, and interarea transfer lines from F- and H-Area and from H-Area to DWPF and the Z-Area Saltstone Manufacturing and Disposal Facility). DOE anticipates that the amount of contamination left on this equipment will be small in comparison to the amount in the tanks. Where appropriate, the equipment will be backfilled and stabilized If possible, small equipment may be cleaned and reused.

A.3 References

DOE (U.S. Department of Energy), 1996, *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Site, Construction Permit Numbers 14,338, 14,520, 17,424-IW*, Revision 1, Savannah River Operations Office, Aiken, South Carolina, July 10.

APPENDIX B. GENERAL DESCRIPTION OF THE FATE AND TRANSPORT MODELING APPROACH

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APPENDIX B. GENERAL DESCRIPTION OF THE FATE AND TRANSPORT MODELING APPROACH

B.1 GTS Conceptualization

The general closure plan describes a construct for apportioning performance objectives (POs) known as a groundwater transport segment (GTS). GTSs represent the approximate flowpath of contaminants from a tank system or group of t[illegible] ed strictly on the groundwater potentiometric contours in the areas surrounding the high-level waste tanks and the nearby streams. For fate and transport modeling, the GTS is a convenient method to identify all potential sources whose contaminant plumes may overlap.

The GTS is also used as an aid in accounting for the performance objectives among all the sources (both tank and non tank) contained within the GTS. This accounting is based on the relative impact at the point of exposure at the time of greatest impact of the various sources in the GTS. To demonstrate compliance with drinking water standards, a hypothetical receptor is assumed to drink the groundwater at the location of maximum concentration at a point of exposure agreed upon between DOE and SCDHEC (i.e., the seepline). A fundamental assumption of the GTS is that contaminant plume flow is such that a particular GTS is independent of its neighboring GTSs, allowing the overall performance objectives to be applied totally to each GTS. For HLW tank accounting purposes, an adjusted PO is established by subtracting the contribution from non-tank sources in the GTS from the overall PO.

B.2 GTS Selection Methodology

A GTS consists of a physically defined area of the aquifers directly underlying the tank closure configuration [illegible] it extends in both the upgradient and downgradient groundwater flow direction. By definition, each GTS contains all HLW tanks and other contaminant sources that lie within its boundaries. The nominal width of the GTS is determined by the size of the tank closure configuration footprint perpendicular to the groundwater flow direction. The GTS extends upgradient to a point sufficient to include all potential upgradient contaminant sources or to a groundwater divide, whichever occurs first. The GTS extends downgradient to a point of exposure agreed upon by SCDHEC and DOE (i.e., the seepline). The lateral boundaries of the GTS are drawn perpendicular to the groundwater potentiometric contou[illegible] therefore, the width of a GTS may be variable along its length. Because of the three dimensional nature of groundwater flow and the layered aquifer system that lies beneath the general separations area (referred to as the GSA, which includes the F- and H-Areas Separations Facilities, the F and H Tank Farms, F and H Seepage Basins, and the Burial Ground Complex), a GTS may contain stacked layers which represent pathways through the potentially affected aquifers. Since the aquifers do not all discharge at the same time or to the same surface water body, multiple exposure points may occur for each GTS.

As will be seen in Sections B.3 and B.4, the GTS concept is not intended to define the modeling methodology. The types of sources involved (e.g., types of tanks) may suggest that the impact from the GTS may be calculated through several means. For instance, each source within the GTS could be modeled separately and the individual impacts summed to determine the total impact. Similarly, groups of sources could be modeled and the group impacts summed, or the entire GTS could be modeled at one time to determine the impacts. The GTS is used to ensure that all sources are accounted for; the actual method of doing so will depend on the sources themselves, the calculational techniques involved, and the fate and transport models employed.

B.3 The F- and H-Area GTSs

In Revision 0 general closure plan (DOE 1996a), DOE proposed the use of multiple GTSs within each of the Tank Farm areas. This approach was revised in the HLW Tank Closure Program Plan (DOE 1996c) to reflect only one GTS each for the F- and H-Area Tank Farms. Due to the three-dimensional nature of groundwater flow and leakage between the stacked aquifer layers beneath the GSA, each GTS will contain three layers. The boundaries of the Water Table Aquifer layer of the GTS, which is the first aquifer layer impacted by a future release from the Tank Farms, will be used to define the boundaries for the underlying Barnwell-McBean Aquifer layer of the GTS. In turn, the Barnwell-McBean Aquifer layer of the GTS will control the boundaries of the underlying Congaree Aquifer layer of the GTS. Therefore, the fate and transport modeling at each tank farm will include components for each of the aquifer layers within each GTS. Figures B-1, B-2, and B-3 show the boundaries of the GTS layers for each of the tank farm areas.

DOE will derive representative hydraulic parameters from the conceptual system described in Appendix E to utilize in the Multimedia Environmental Pollutant Assessment System (MEPAS), the fate and transport code currently being used. The selection of a unique set of potentiometric contours to represent site conditions over the modeled time period (10,000 years) is not possible. To eliminate potential bias in selecting a set of representative potentiometric contours, the steady-state potentiometric contours for each aquifer layer from a recent GSA-wide modeling effort will be used for this purpose. The potentiometric contours from the GeoTrans (1993) modeling effort were selected because the model calibration process used for that modeling effort is considered to reflect a set of hydraulic parameters that balances the GSA-wide modeling with localized model recalibration.

B.4 Integrating the F- and H-Area GTSs into Modeling Calculations

Under the concept of the GTSs described in Section B.3, DOE proposes to perform two types of calculations for each GTS pertaining to the high-level waste tanks:

- An *a priori* calculation of the projected impact of the entire GTS using assumptions on the degree of tank cleaning achievable

- A tank-specific calculation for each module of the closure plan using sampling results available following cleaning

The *a priori* calculation results are used to project whether the GTS will meet the overall performance objectives. This process helps to address the cumulative effect of all the tanks in the tank farm whose plumes may intersect. As individual tanks are prepared for closure, a sample of the tank contents will be taken and will be used to compare the actual source inventory of the tank to the estimated source term used as part of the *a priori* calculation. The sampling results will also be used to perform the tank-specific calculation on impacts at the point of exposure to ensure that the performance objective "budget" is not exceeded based on calculations using actual tank inventories.

DOE currently uses the MEPAS computer program to model the transport of contaminants. The program is EPA-recognized and uses analytical methods to model the transport of contaminants from a source unit to any point at which the user desires to calculate the concentration.

In its modeling effort, DOE makes assumptions about source term, source configuration, and hydrogeologic structure of the area between the tank farms and the point of exposure. The following sections discuss the major assumptions used by DOE in calculating concentrations of contaminants at the point of exposure.

B.4.1 SOURCE TERM IDENTIFICATION

To determine the source term for the *a priori* calculation, DOE reviews information pertaining to transfers of liquids to the high level waste tanks since their placement in the tank farms. This includes log books showing the data regarding transfers as well as sampling results, reel tape measurements and photographs that provided information on the solids content in the tanks. Based on all this information, DOE estimates the current inventory of solids in each tank and the concentrations of radiological and nonradiological constituents in the solids.

To determine the inventory of contaminants after cleaning of the tanks is accomplished, DOE assumes that the concentration of constituents in the solids remains unchanged. This assumption is realistic based on the fact that the presence of constituents in the solids indicates that the constituents are relatively insoluble and would be expected to remain insoluble throughout the tank cleaning process, which includes bulk removal of solids followed by water washing. Thus, the cleaning actions are expected to remove the more soluble constituents and reduce the volume of solids in the tanks; however, the cleaning may not necessarily change the concentration of constituents in the solids.

Based on available cleaning technology, DOE assumes that the cleaning process would still leave behind a nominal amount of solids in each tank. The density of the solids is relatively low (1.95 lbs./gal.); this value is used to determine the total inventory of constituents in each tank.

Based on this discussion, the process of quantifying the source term concentration and total inventory can be summarized as follows:

1. Current concentrations in the solids in each tank are estimated based on sampling results, logs of transfers, and other measurements

2. DOE assumes that the concentrations in the solids would remain constant after the tank cleaning process

3. DOE assumes that each tank could be cleaned with a nominal amount of solids remaining in each tank with a density of 1.95 lbs./gal.

4. DOE calculates the total inventory in each tank based on the assumed concentration and the calculated mass per unit tank based on the information in Step 3 above.

As each individual tank is prepared for closure, DOE will prepare a closure module that will be based on actual sampling results for the tank. If substantial deviations from the *a priori* modeling calculations are discovered such that actual sample measurements indicate a greater projected impact at the point of exposure, DOE will perform additional cleaning at that time to reduce the source term inventory. If additional cleaning is unfeasible technically or economically, DOE may take credit for previously completed tank closures where actual sampling results indicated a lower impact at the point of exposure than predicted by the *a priori* modeling calculations. For instance, if enhanced cleaning techniques on earlier tank closures resulted in a lower impact than necessary to meet performance objectives, this can be used to offset less effective cleaning techniques in later tank closures.

B.4.2 SOURCE CONFIGURATION

For the *a priori* calculations for the tank farms, DOE calculates the impacts at the point of exposure from groups of tanks that are similar in location and structure. In F-Area, for instance, all Type I tanks (Tanks 1-8) were grouped together, all the Type III tanks (Tanks 25-28, 33,34, and 44-47) were grouped together, and all the Type IV tanks (Tanks 17-20) were grouped together. These groupings are appropriate because the tanks in each grouping have approximately the same basemat thickness (an important consideration in calculating the retardation effects on contaminants). DOE also performed a sensitivity analysis to ensure that the distance between tanks within a grouping (e.g., all the Type III tanks in F-Area Tank Farm are not adjacent to each other) did not affect substantially the projected results at the point of exposure for a given GTS. The results of this analysis indicate that the distance from F-Area Tank Farm to the point of exposure is relatively large compared to the dimensions of the tank farm so that projected impacts at the point of exposure vary little as the source term is moved within F-Area Tank Farm.

DOE performed a separate MEPAS calculation for each grouping of tanks. For each calculation, DOE entered the source term data (in both concentration and total inventory) for the grouping distributed over a square with area equal to that of the tank bottoms in the grouping. For instance, for the Type I tanks, the source term for the MEPAS calculation would consist of the total inventory of the affected tanks and the concentration of contaminants in the grouping (i.e., the total inventory of the affected tanks divided by the total solids in these tanks) distributed over a square with area equal to the area of the eight Type I tanks

To account for overlapping of the contaminant plumes from the three seperate groupings of tanks, DOE performed the calculations with the three groupings at the same initial physical location (as discussed above, location of the source within the F-Area Tank Farm boundary has little influence on the calculated concentration at the point of exposure). DOE also summed the centerline concentrations from each plume at the point of exposure to ensure that the highest concentration is reported. Therefore, although the plumes from the groupings may not overlap entirely, DOE's calculation methodology provides an upper estimate for the projected impacts.

B.1.3 HYDROGEOLOGIC STRUCTURE

To obtain meaningful results from MEPAS, it is important to specify the hydrogeologic structure of the area that is being modeled. For the tank farms, DOE uses the following stratigraphic layers:

1. Source layer (the layer of material in the bottom of each tank that serves as the origin of the contaminants)

2. Basemat (the concrete underlayment of each tank)

3. Vadose zone (the unsaturated soil between the bottom of the tank and the water table aquifer)

4. Water table aquifer

5. Tan clay layer (the layer of clay that separates the water table aquifer from the Barnwell-McBean aquifer)

6. Barnwell-McBean aquifer

7. Green clay layer (the layer of clay that separates the Barnwell-McBean aquifer from the Congaree aquifer)

8. Congaree aquifer

As discussed in Section B.3, values from the previous geotechnical investigations, modeling, and monitoring at the general separations area will be used to specify movement of material between the aquifer layers. Values for the other parameters listed above depend on the tank grouping (e.g., Type I tanks have a different basemat thickness and vadose zone thickness compared to Type IV tanks).

The soil and grout layers above the source layer are accounted for primarily by taking credit for the water retardation they provide. For example, the hydraulic conductivity of the grout is much less than typical soil so that water infiltration into the source layer is substantially limited. However, grout cannot be assumed to be intact for an indefinite period of time. Therefore, DOE assumes that the grout develops catastrophic cracks in all tanks at 1000 years post-closure; this value is chosen so as to be less than the 1400 year estimate provided in the E-Area Vault Radiological Performance Assessment (WSRC 1994). To account for this degraded condition of the grout, DOE performs two sets of calculations: one set for when the grout is assumed to be totally intact and one set for when the grout is assumed to be totally degraded. The results from these two sets of calculations are combined (taking credit for the 1000-year difference in starting times) to determine the maximum concentration at the point of exposure within the 10,000 year period [see section B.5, below, for results].

B.4.4 INTERPRETATION OF RESULTS

As discussed in Section B.4.2, DOE sums the concentrations of each constituent at the centerline of the plume for the GTS at the point of exposure. Then DOE identifies the maximum concentration during the 10,000 year period following closure to determine compliance with performance objectives. For nonradiological constituents, these concentrations can be compared directly to the performance objectives. For the radiological constituents, the total effective dose equivalent is report addition to gross alpha concentration.

B.4.5 COMPARISON OF MODELING ASSUMPTIONS TO ACTUAL CONDITIONS

DOE recognizes that the modeling description above contains several assumptions that do not reflect actual conditions. All assumptions were developed to allow meaningful calculations to be performed that provide an upper bound to the "true" impact that may be realized at the point of exposure. Therefore, DOE believes that its modeling approach provides a reasonable estimate of the projected impacts at the point of exposure. Table B-1 compares the major modeling assumptions with the actual conditions in the F-Area Tank Farm as an example of how DOE's assumptions can be used to evaluate a complex source arrangement (the F-Area Tank Farm) using a more simplified yet reasonable approach.

B.5 Results

To date, DOE has performed modeling for the closure of Tanks 17 and 20, in addition to the *a priori* calculation for the entire F-Area Tank Farm (i.e., the F-Area GTS). Specific details and results for the modeling of Tanks 17 and 20 can be found in Appendix A of their respective closure modules (DOE 1997, DOE 1996b). Table B-2 summarizes the results for Tanks 17 and 20 and compared to the overall performance objectives.

Table B-1. Comparison of modeling assumptions for F-Area Tank Farm to actual conditions.

Actual Conditions	Modeling Assumption
1. F-Area Tank Farm has 22 individual tanks, each with area of 5674 ft^2 • 8 Type I Tanks • 10 Type III Tanks • 4 Type IV Tanks	1. F-Area Tank Farm can be represented by three area sources: • One source with area of 45,396 ft2 (Type I Tanks) • One source with area of 56,745 ft2 (Type III Tanks) • One source with area of 22,698 ft2 (Type IV Tanks)
2. Each tank has a unique inventory and concentration of contaminants.	2. Each area source can be represented as follows: • The inventory for each area source is equal to the total inventory of all tanks within the grouping • The concentration for each area source is equal to the total inventory in the area source divided by the total solids in the area source
3. Each tank has a unique plume with regard to space that overlaps other plumes in the vicinity; however, plume centerlines do not necessarily overlap.	3. The three area sources are located at essentially the same initial physical location and travel the same path to the seepline so that the centerline of the plumes is "forced" to overlap.
4. Each plume is time-dependent, and plumes may overlap in time	4. The plumes from each area source are time-dependent and are added for each point in time.
5. Future tank failures (i.e., failure of the grout) will occur randomly.	5. All tanks (the area sources) fail simultaneously.
6. Radiation dose from all radiological constituents is additive.	6. Radiation dose from all radiological constituents is additive.

Table B-2. Comparison of modeling results to overall performance objectives at the seepline.[a]

	Units	Adjusted PO	F-Area GTS Impact	Tank 20 Impact	Tank 17 Impact	Remaining PO
Radiological						
Beta-gamma dose	mrem/y	4.0	1.9	0.0055	0.02	3.97
Alpha concentration	pCi/L	15	3.9E-02	(b)	(b)	15
Total dose	mrem/y	4.0	1.9	0.0055	0.02	3.97
Non-Radiological						
Nickel	mg/L	0.1	(c)	0	(c)	0.1
Chromium [d]	mg/L	0.1	6.0E-05	5.0E-06	9.5E-06	0.1
Mercury	mg/L	0.002	(c)	0	(c)	0.002
Silver	mg/L	0.05	2.2E-03	1.9E-04	3.1E-04	0.049
Copper	mg/L	1.3	(c)	0	(c)	1.3
Nitrate	mg/L	10	1.5E-02	1.3E-03	4.8E-03	10
Lead	mg/L	0.015	(c)	0	(c)	0.015
Fluoride	mg/L	4.0	1.5E-03	1.3E-04	2.5E-04	4
Barium	mg/L	2.0	(c)	0	(c)	2

a. Values taken from Table 8-2 of the Tank 17 closure module (DOE 1997).
b. Concentration is less than 1.0E-13 pCi/L.
c. Concentration is less than 1.0E-06 mg/L.
d. Total chromium (chromium III and IV).

B.6 References

DOE (Department of Energy), 1996a, *Industrial Wastewater Closure Plan for F- and H-Area High Level Waste Tank Systems Savannah River Site, Construction Permit Numbers 14,338, 14,520, 17,424-IW*, Revision 1, Savannah River Operations Office, Aiken, South Carolina, July 10.

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APPENDIX C. SITE-SPECIFIC INTRUDER ANALYSIS

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APPENDIX C. SITE-SPECIFIC INTRUDER ANALYSIS

In its assessment of potential impacts from closure of high-level waste tanks at the Savannah River Site, DOE considered the possibility of exposure to an inadvertent intruder. The concept of the inadvertent intruder was developed based on information presented in NUREG-0782, *Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"* (NRC 1981) and was adapted to the tank closure scenario at the Savannah River Site. This appendix describes the differences in the intruder scenario between NUREG-0782 and the SRS-specific inadvertent intruder, lists the major assumptions used in the calculation of impact to the intruder, and presents the numerical results of the analysis.

C.1 Comparison of the Inadvertent Intruder Described in NUREG-0782 to the SRS-Specific Inadvertent Intruder

In NUREG-0782, the NRC evaluated several exposure scenarios for an inadvertent intruder and identified two major exposure scenarios upon which the Class C concentration limits were calculated as follows:

- **Construction Scenario:** After institutional control has ceased, the intruder is assumed to construct a house on top of the waste unit. The waste unit is assumed to be penetrated by construction activities (such as excavation of a basement), and contaminated soil is dispersed onto the ground surface to expose the intruder for extended periods of time.

- **Agriculture Scenario:** After institutional control has ceased, the intruder is assumed to live in the house built during the construction scenario. The intruder grows food on contaminated soil and is exposed through ingestion of this food as well as other direct and indirect pathways.

For high-level waste tank closure at the Savannah River Site, the scenarios above have limited applicability due to the location of the contaminated material. Specifically, the radioactive layer of material that would provide the greatest dose to an individual is located at the bottom of each waste tank, a minimum of 10 meters below the surface. The relatively deep placement of the material makes it highly unlikely that traditional construction activities for a resident dwelling would penetrate the waste material, even for construction of a basement. Thus, the construction scenario and agriculture scenario as defined in NUREG-0782 could not be expected to be avenues for exposure in the highly unlikely event that an inadvertent intruder were to establish a residence on top of the waste site.

In addition, the radioactive material in the high-level waste tanks will be stabilized using a grout formulation designed to last for extended periods of time. If a postulated intruder were to attempt to construct a house on top of a closed waste tank, he would most likely discover the presence of the grout under the topsoil layer, even after several hundred or thousand years post-closure. This discovery would be expected to prompt investigation into the matter as discussed in Section 4.3.4.3 of NUREG-0782.

DOE has considered the possibility, however, that as part of the construction scenario, the intruder could dig a well through one of the waste tanks to reach a water-bearing aquifer below. In this instance, the intruder could conceivably construct a house near the surface without disturbing the waste but would unknowingly penetrate into the waste form when drilling for water. As discussed in Chapter 3 of this document, site-specific analyses of groundwater contamination are performed independently of intruder analysis for purposes of waste classification. Therefore, the only source of exposure in this scenario (for waste classification purposes) would be the removal of drill cuttings from the waste form and dispersal of the material onto the ground surface around the intruder's home.

Under this exposure scenario, the following pathways for intake of radioactive material are postulated:

- Inhalation of resuspended soil which contains contaminated well cuttings
- Direct irradiation from the well cuttings distributed over the ground surface
- Direct irradiation from resuspended soil which contains contaminated well cuttings
- Ingestion of vegetation grown in soil contaminated with well cuttings

Based on the foregoing discussion, the inadvertent intruder, for purposes of high-level waste tank closure, has opportunity for exposure to only limited amounts of the waste material. Specifically, the intruder is postulated to be excavate a volume of material equal to the thickness of the waste layer multiplied by the cross-sectional area of the well drilling area. Therefore, the major difference between the general intruder analysis in NUREG-0782 and the site-specific analysis is the limitation on waste material to which an intruder may be exposed.

C.2 Major Assumptions Used in Calculation of Impacts to the Inadvertent Intruder

Because of the physical arrangement of the waste tanks and the geometry of the waste form, it is not reasonable to expect that an intruder would penetrate more than one of the waste tanks. However, to provide a conservative upper estimate, DOE has assumed that the source inventory from 10 of the tanks would be contained in an area smaller than that physically occupied by the 10 tanks (Cook 1997). This assumption results in calculations of impacts using waste concentrations in excess of any concentrations known to exist in the F-Area Tank Farm. DOE further postulated that the intruder drills through this hypothetical waste layer at 100 years following closure of the tanks and then disperses the cuttings over the ground surrounding his home.

DOE used the fate and transport computer code PATHRAE to calculate radiation doses to the intruder. Table C-1 lists some of the parameters used in the analysis.

Table C-1. Values for selected parameters used in the PATHRAE calculation.

Parameter	Value	
Inventory of Radioactive Material in Waste Layer	Cs-135	4.4E-3 Ci
	Cs-137	2.0E+3 Ci
	Eu-154	3.0E+2 Ci
	Se-79	3.8E-1 Ci
	Sn-126	7.1E-1 Ci
	Tc-99	6.7E+0 Ci
	U-238	1.1E-1 Ci
	Pu-239	1.1E+2 Ci
	Sr-90	3.0E+4 Ci
Minimum Depth to Waste Layer	9.92 m	
Thickness of Waste Layer	0.08 m	
Area of Waste Layer	2704 m^2	
Fraction of Food Consumed that is Grown on Contaminated Soil	0.5	
Fraction of Year Exposed to Direct Irradiation	0.5	
Fraction of Year Exposed to Resuspended Soil	0.25	
Average Dust Loading in Air	1.0E-7 kg/m^3	
Annual Adult Breathing Rate	8000 m^3/yr	
Fraction of Year Exposed to Resuspended Soil	0.25	

C.3 Results of Calculations

The results of the PATHRAE calculation show that the postulated inadvertent intruder could receive 1.2 mrem/yr from exposure to the well cuttings. This is well below the dose limit of 500 mrem/yr limit imposed by 10CFR61 for the inadvertent intruder. Table C-2 lists the calculated dose by exposure pathway.

Table C-2. Dose estimates by pathway for the inadvertent intruder.

Pathway	Dose
Inhalation of resuspended soil	1.0E-2 mrem/yr
Direct irradiation	8.1E-5 mrem/yr
Ingestion of vegetation	1.2 mrem/yr

C.4 References

Cook, J. R., 1997, "Evaluation of High-Level Residuals versus NRC Class C Criteria," SRT-WED-97-0176, memorandum to B. T. Butcher, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina.

NRC (U.S. Nuclear Regulatory Commission), 1981, Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste," NUREG-0782, Vol. 2, Washington, D.C.

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EXECUTIVE SUMMARY

Since the Savannah River Site (SRS) began operating in the early 1950s, its processes for the recovery of uranium and plutonium have generated liquid high-level radioactive waste. At present, the U.S. Department of Energy (DOE) stores approximately 34 million gallons of this w[illegible] the SRS in large underground tanks in facilities known as the F- and H-Area Tank Farms

There are 51 of these high-level waste (HLW) storage tanks. DOE intends to remove these tanks and their associated systems from service as they complete their missions. Because a'' but one of the tank systems are permitted as industrial wastewater treatment facilities under the South Caro [illegible] Pollution Control Act, DOE will close them in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities."

DOE has established a process for tank closure that will include a combination of waste removal, tank cleaning, and stabilization of the tank configuration. The waste that is the subject of this report consists of residual contaminated material that DOE could not clean from the tank bottom or that is embedded in small pits in the steel tank wall. The characteristics of this waste do not fit the prescriptive classification schemes contained in the regulations of DOE or the U.S. Nuclear Regulatory Commission (NRC). The NRC has published criteria on the classification of certain material as "incidental" waste. In this context, incidental waste activities would be exempt from NRC licensing at a DOE facility.

The NRC incidental waste classification is based on meeting the performance objectives in Title 10 of the Code of Federal Regulations, Chapter 61 (10 CFR 61). A Denial of Petition letter dated March 2, 1993 (Bernero 1993), states that certain waste generated at the DOE Hanford site could be incidental if it met the following criteria:

1. The HLW has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical.

2. The waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level radioactive waste, as established in 10 CFR 61.

3. The waste will be managed, pursuant to the Atomic Energy Act, in a manner that satisfies safety requirements comparable to the performance objectives established in 10 CFR 61.

These criteria apply to certain wastes to be removed from the Hanford double-shell tanks and processed for radionuclide separation. The residual from that separation had been proposed to be stabilized with grout for disposal as low-level waste. Criteria 1 and 3 are directly applicable to the planned tank closure activities at the SRS. The criterion 2 requirement to have the waste in a solid physical form is also applicable; however, meeting the Class C concentration limits in 10 CFR 61.55 may not be appropriate because those values were based on an intruder exposure scenario for disposal of waste rather than *in situ* stabilization. DOE requests NRC's consideration of an alternative to the Class C limits of 10 CFR 61.55 for the SRS tank system closures. This approach will not affect compliance of the SRS tank closures with the performance objectives of 10 CFR 61.

The closure activities for SRS HLW tanks will meet the NRC requirement in 10 CFR 61.41 for protection of the public. To demonstrate conformance to the applicable NRC criteria, DOE has described the process by which it will choose tank closure activities. The process requires the development of performance objectives for each tank closure and adherence to applicable laws for the protection of the public for the cumulative tank closure. DOE has examined a range of tank cleaning techniques and stabilization procedures. As described in Section 4.1, the DOE closure process will ensure the removal of key radionuclides to the extent technically and economically practical. The South Carolina Department of Health and Environmental Control will approve each tank closure and provide oversight to ensure the performance objectives are satisfied.

DOE has developed a computer model to predict the concentration values of radionuclides in the groundwater resulting from eventual leaching of the residual waste in each closed tank. This model determines the size and shape of a zone around closed tanks in which no drinking water wells can exist. DOE will rely on concentration values in the groundwater rather than on concentrations in the residual waste, thus providing assurance of protection of the public. DOE has determined the solid physical form of the residual waste by using the closure process to select the most appropriate stabilization activity for each tank. Providing greater public protection and meeting the 10 CFR 61 performance objectives for stability and structural integrity of the closed tank will meet the intent of the second criterion for incidental waste classification.

The third criterion stipulates management of the waste to meet performance objectives comparable to those in 10 CFR 61. Part 61.41 states that the annual dose to a member of the public resulting from releases of radioactive material shall not exceed an equivalent of 25 mrem to the whole body. Any configuration will release radioactive material into the groundwater after hundreds of years and the disintegration of the concrete and steel tanks. Water flowing through the area will leach the radioactive material from the soil into the groundwater. DOE will establish a zone around the tank farms that will extend to a point at which a member of the public would receive a dose no greater than the U.S. Environmental Protection Agency (EPA) annual limit of 4 mrem for drinking er contaminated by beta-gamma emitters. (lpha particle-emitting radionuclides would not reach the point of exposure within the 10,000-year period of analysis.) The public would be excluded from th zone through a combination of active and passive institutional controls. This zone would fully encompass any zone designed to meet the 25-mrem limit cited in 10 CFR 61.41 and, therefore, would be more restrictive than the NRC performance objectives.

DOE has established a process to ensure that any residual material in the SRS HLW tanks after the completion of planned closure activities will meet the definition of incidental waste and that the Department can manage such material to protect the public by meeting performance objectives more stringent than those in 10 CFR 61. DOE believes, therefore, that specific closure activities should proceed under its auspices as well as those of the EPA and the South Carolina Department of Health and Environmental Contro:

Reference

Bernero, R. M. (Director, Office of Nuclear Material Safety and Safeguards), 1993, letter to J. Lytle (Deputy Assistant Secretary for Waste Operations, Office of Waste Management, U.S. Department of Energy), U.S. Nuclear Regulatory Commission, Washington, D.C.

ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
CLSM	controlled low-strength material
DOE	U.S. Department of Energy
DWPF	Defense Waste Processing Facility
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration.
FFA	Federal Facility Agreement
g	gram
GTCC	greater-than-class-C
HLW	high-level waste
ITP	In-Tank Precipitation Facility
LLW	low-level waste
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
RCRA	Resource Conservation and Recovery Act
SMDF	Saltstone Manufacturing and Disposal Facility
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
WSRC	Westinghouse Savannah River Company

CHAPTER 1. INTRODUCTION

Since the Savannah River Site (SRS) began operating in the early 1950s, its processes for the recovery of uranium and plutonium have generated liquid high-level radioactive waste. At present, the U.S. Department of Energy (DOE) stores approximately 34 million gallons of this waste on the SRS in large underground tanks in facilities known as the F- and H-Area Tank Farms.

There are 51 of these high-level waste (HLW) storage tanks. DOE intends to remove these tanks and their associated systems from service as they complete their missions. Because all but one of the tank systems are permitted as industrial wastewater treatment facilities under the South Carolina Pollution Control Act, DOE will close them in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities."

DOE has prepared a general plan (DOE 1996) for the closure of the tank systems The plan describes the proposed waste removal techniques and stabilization options. It also describes the analytical methods used to predict impacts on the environment resulting from closed tank systems and presents the performance objectives for tank closure.

1.1 Purpose

Before closing the tanks, DOE will remove waste and stabilize any residual contamination (see Section 2.2). The purpose of this report is to provide a basis for the DOE position that the residual contamination in the HLW tanks is incidental waste. The NRC has established noncodified guidance for classifying waste that is incidental to but that is not regulated as HLW (Bernero 1993). During the preparation of this report, DOE performed a regulatory analysis that used the NRC guidance along with precedents and dose modeling to demonstrate that the residual contamination in the HLW tanks meets the NRC incidental waste definition and that the planned closure of the tanks is consistent with the performance objectives of NRC regulations for low-level waste disposal (10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste").

1.2 NRC Incidental Waste Classification

The NRC incidental waste classification is based on meeting the performance objectives in 10 CFR 61 and other criteria. A Denial of Petition letter dated March 2, 1993 (Bernero 1993), states that certain waste generated at the Hanford site could be considered incidental if it met the following criteria:

1. The HLW has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical.

2. The waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level radioactive waste, as established in 10 CFR 61.

3. The waste will be managed, pursuant to the Atomic Energy Act, in a manner that satisfies safety requirements comparable to the performance objectives established in 10 CFR 61.

DOE used both the performance objectives in 10 CFR 61 and Hanford criteria to determine the classification of the SRS tank residual waste.

1.3 Document Organization

The remainder of this report provides the background and reasons for the DOE position to classify the tank residual waste as incidental waste. Chapter 2 contains background information on the SRS HLW tanks and provides a regulatory history on the classification of HLW and incidental waste. Chapter 3 discusses the 10 CFR 61 performance objectives in the context of the three incidental waste criteria (above) in relation to the planned tank closures. Chapter 4 provides additional regulatory, environmental, and economic arguments for an incidental waste classification. Appendix A describes the baseline closure activities and the options available to DOE to perform tank closure; Appendix B describes the modeling performed to determine the doses associated with the closed tank systems.

1.4 References

Bernero, R. M. (Director, Office of Nuclear Material Safety and Safeguards), 1993, letter to J. Lytle (Deputy Assistant Secretary for Waste Operations, Office of Waste Management, U.S. Department of Energy), U.S. Nuclear Regulatory Commission, Washington, D.C.

DOE (U.S. Department of Energy), 1996, *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Site, Construction Permit Numbers 14,338*, 14,520, 17,424-IW, Revision 1, Savannah River Operations Office, Aiken, South Carolina, July 10.