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Regulatory Issues Associated with Closure of the Hanford AX Tank Farm Ancillary Equipment

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Abstract: Liquid mixed, high-level radioactive waste has been stored in underground single-shell tanks at the U.S. Department of Energy's (DOE's) Hanford Site. After retrieval of the waste from the single-shell tanks, the DOE will proceed with closure of the tank farms. The 241-AX Tank Farm includes four one-million gallon single-shell tanks in addition to sluice lines, transfer lines, ventilation headers, risers, pits, cribs, catch tanks, buildings, well and associated buried piping. This equipment is classified as ancillary equipment. This document addresses the requirements for regulatory close of the ancillary equipment in the Hanford Site 241-AX Tank Farm. The options identified for physical closure of the ancillary equipment include disposal in place, disposal in place after treatment, excavation and disposal on site in an empty single-shell tank, and excavation and disposal outside the AX Tank Farm. The document addresses the background of the Hanford Site and ancillary equipment in the AX Tank Farm, regulations for decontamination and decommissioning of radioactively contaminated equipment, requirements for the cleanup and disposal of radioactive wastes, cleanup and disposal requirements governing hazardous and mixed waste, and regulatory requirements and issues associated with each of the four physical closure options. This investigation was conducted by the Sandia National Laboratories, Albuquerque, New Mexico, during Fiscal Year 1998 for the Hanford Tanks Initiative Project.

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Regulatory Issues Associated with Closure of the Hanford AX Tank Farm Ancillary Equipment

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August 14, 1998

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Executive Summary

Liquid, mixed, high-level radioactive waste (HLW) has been stored in 149 single-shell tanks (SSTs) located in tank farms on the U.S. Department of Energy's (DOE's) Hanford Site. The DOE is in the process of retrieving any remaining mixed HLW and *physically* closing the tank farms. In support of the Hanford Tanks Initiative (HTI), Sandia National Laboratories has addressed the requirements for the *regulatory* closure of the ancillary equipment in one of the Hanford tank farms, the 241-AX Tank Farm.

The AX Tank Farm includes four 1,000,000-gallon SSTs, as well as sluice lines, transfer lines, ventilation headers, risers, pits and cribs, catch tanks, buildings, and wells. Collectively, this equipment is classified as ancillary equipment. The ancillary equipment is assumed to be contaminated with sludges derived from the mixed HLW that was transferred into and out of the tanks. The estimated total volume of sludge waste left in the sluice lines, transfer lines, ventilation headers, and risers (394 items total) is about 4% of that left in the four SSTs in the AX Tank Farm, assuming 99% retrieval of the tank waste

Four general options have been identified for the *physical* closure of the ancillary equipment:

(1) disposal in place;

(2) in-place treatment followed by disposal in place;

(3) excavation and disposal on site in an empty SST; or

(4) excavation and disposal outside the AX Tank Farm.

Regulatory closure requirements that may be applicable to the decontamination and decommissioning (D&D) of radioactively contaminated equipment include: (a) the Hanford Tri-Party Agreement (TPA); (b) DOE Order 5400.5 (and proposed 10 CFR 834); (c) DOE Order 5820.2A (and proposed DOE Orders 435.1 and 430.1); (d) the Joint DOE and U.S. Environmental Protection Agency (EPA) Policy on Decommissioning DOE Facilities; and (e) the U.S. Nuclear Regulatory Commission's (NRC's) 10 CFR 20 Subpart E.

Regulatory closure requirements that may be applicable to radioactive waste disposal include: (a) the Energy Reorganization Act of 1974; (b) DOE Order 5820.2A (and proposed DOE Orders 435.1 and 430.1); (c) DOE Order 5400.5; (d) the Nuclear Waste Policy Act of 1982; (e) 10 CFR 60; (f) 40 CFR 191; and (g) the NRC's definition of "incidental waste."

The regulatory closure of the radioactive component of the contaminated ancillary equipment could be addressed as either "radioactively contaminated equipment" or as "equipment which is HLW." *Either* regulatory path will require protection of the inadvertent human intruder, groundwater resources, and the member of public. If the ancillary equipment is assumed to be radioactively contaminated (but not HLW), the DOE low-level radioactive waste (LLW) disposal standards (Chapter III of DOE Order 5820.2A) would be the appropriate metric for closure.

If the ancillary equipment is assumed to be HLW, the NRC would be the regulator. Wastes generated during the further processing of HLW may be classified by the NRC as "incidental wastes," which can be disposed on site without NRC licensing. The NRC has established three criteria for determining if wastes from an HLW treatment facility are incidental. In simple terms, the three Incidental Waste Criteria are that (1) technically and economically practical efforts have be taken to remove the HLW, (2) the resulting waste is a solid that does not exceed the NRC's Class C limits, and (3) the wastes meet safety standards comparable to 10 CFR 61.

This report compares the radiological characteristics of the ancillary equipment to the NRC's Class C limits. Wastes that exceed the Class C limits are typically inappropriate for shallow land burial. The initial analysis shows that 36% of the 394 pieces of ancillary equipment do not exceed the NRC's Class C limits. Grouting the interior volume of each item would allow another 45% of the 394 items to be in compliance with the Class C limits if grout averaging is permitted. The remaining 19% would still have grout-averaging concentrations higher than the Class C limits.

As discussed in this report, the development of Hanford site-specific Class C limits would allow more waste to remain in place while still being protective of the inadvertent human intruder. Combining immobilizing grout, closure as incidental waste, and Hanford site-specific Class C limits could allow all the ancillary equipment to be closed in place. However, a number of important issues must be addressed:

- The outcome of the NRC review of the closure of Savannah Rivers's Tanks 17 and 20 could have a significant bearing on the closure of the Hanford tank farms and this issue should be monitored. As discussed in this report, the NRC seems comfortable using the incidental waste concept for intank closure of the holdup in Tanks 17 and 20, and there does not seem to be a fundamental reason why the incidental waste concept could not be applied to holdup in Hanford's ancillary equipment.

- Some stakeholders still question the NRC's authority to use "guidance" to "reclassify" HLW as incidental waste.

- The development of Hanford site-specific Class C limits could be viewed by stakeholders as an attempt to leave waste on site that historically has been unacceptable for shallow land burial.

- Under the EPA's definition of TRU waste, the NRC has the authority to approve disposal of wastes exceeding 100 nCi/g of TRU radionuclides on a case-by-case basis in accordance with 10 CFR 61. The ability to apply this authority to DOE-titled wastes should be discussed with the NRC.

- The authors are unaware of NRC accepting a site-specific Class C analysis. Therefore, DOE would have to work with NRC staff to develop a one-of-a-kind petition.

criteria can be met, in-place disposal of the radioactive component will require a combination of immobilizing grout, the incidental waste concept, and Hanford site-specific Class C limits.

A number of issues have been identified that require attention:

1. The NRC regulates the disposal of HLW, and if the classification of a waste is unclear, the NRC is the regulator that determines if a particular waste stream is HLW or incidental waste. The NRC should be consulted to determine their position on the closure metrics for the ancillary equipment. The DOE and NRC may want to formalize a working agreement to provide the NRC with the resources necessary to work with the DOE and others for a timely resolution of closure issues.

2. The disposition of the contaminated ancillary equipment will not occur without Ecology's approval. The role that Ecology (and EPA) play in classifying the ancillary equipment is unclear.

3. Ecology, as the lead agency for tank farm closure, should be consulted to determine if the inadvertent human intruder should be protected and, if so, what dose standard would be appropriate to protect the intruder. Although not researched, the Hanford Risk Assessment Methodology may provide an acceptable means of assessing doses to the inadvertent intruder.

4. This scoping review was based on an assumed contaminant inventory; a field study should be conducted to confirm the levels of contamination.

5. A consistent approach for addressing tank residue, ancillary equipment and contaminated soil is needed since all three of these are contaminated with waste from the same origin.

6. Several technical analyses need to be completed prior to selecting a final closure option(s). Each of the four physical closure options needs to be analyzed to determine the cumulative threat to groundwater at a boundary, the cumulative threat to the member of public at a boundary, and possible impacts to on site individuals, assuming a loss of institutional controls. Furthermore, the costs of implementing each option and the radiological doses to workers will also be important in selecting a final remedy.

7. The closure option selected for the contaminated soil and SSTs residue may dominate the decision on how to close the ancillary equipment. Based on analyses presented in this report, the volume of sludge holdup anticipated to be in the ancillary equipment is only 4% of the volume of sludge that may remain in the SSTs, assuming 99% retrieval.

8. Even though closure of the SST residue may (volumetrically) overshadow closure of the ancillary equipment, the large physical inventory of equipment, coupled with the fact that two-thirds of the equipment is anticipated to exceed the Class C limits, indicates that closure of the ancillary equipment may be difficult and should continue to receive HTI's attention.

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LIST OF ACRONYMS & ABBREVIATIONS

AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
ARARs	Applicable or Relevant and Appropriate Requirements
CAMU	Correction Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOE/RL	DOE, Richland Operations Office
DST	Double-Shell Tank
DW	Dangerous Waste
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
GTCC	Greater than Class C Waste
HLW	High-Level radioactive Waste
HSWA	Hazardous and Solid Waste Amendments (of 1984)
HTI	Hanford Tanks Initiative
IHI	Inadvertent Human Intruder
LAW	Low-Activity Waste
LDR	Land Disposal Restrictions
LLW	Low-Level Radioactive Waste
MCLs	maximum contaminant levels
mrem/yr	10^{-3} rem per year
MOP	Member of the Public
MOU	Memorandum of Understanding
MTCA	Model Toxics Control Act
MTR	Minimum Technological Requirements
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act of 1982
Order 5820.2A	DOE Order 5820.2A, Radioactive Waste Management
pCi	pico Curies or 10^{-12} Curies
PA	Performance Assessment
PATT	Performance Assessment Task Team
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SESC	SGN Eurisys Services Corporation
SNF	Spent Nuclear Fuel
SRS	Savannah River Site

SST	Single-Shell Tank
TEDE	Total Effective Dose Equivalent
TPA	Tri-Party Agreement
TRU	Transuranic
TSD	Treatment, Storage, and Disposal
WAC	Washington Administrative Code

DEFINITIONS

Applicable or Relevant and Appropriate Requirements (ARARs) - "Applicable" requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. "Relevant and appropriate" requirements are those clean-up standards which, while not "applicable" at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. ARARs can be action-specific, location-specific, or chemical-specific." (EPA, December 1991)

Atomic Energy Defense Activity - "any activity of the Secretary performed in whole or part in carrying out any of the following functions: ... (D) defense nuclear materials production (E) defense nuclear waste and materials by-products management..." (Nuclear Waste Policy Act of 1982 (NWPA))

Byproduct material - "... means (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the processing of producing or utilizing special nuclear material, and (2) the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." (Section 11e of the Atomic Energy Act (AEA))

Clean debris surface - "means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except that residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations, and the soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and soil in cracks, crevices and pits shall be limited to no more than 5% of each square inch of surface area." (40 CFR 268.45, Table 1, footnote 3)

Closure: Actions taken to reduce the human health and environmental threats posed by a hazardous waste treatment, storage, and disposal (TSD) facility or unit (along with its structures and contiguous land) after the facility or unit has received its final volume of hazardous waste. Closure must satisfy applicable requirements of 40 CFR Part 265, and of Washington Administrative Code (WAC) 173-303-610. For purposes of this Agreement, use of the word closure also includes actions necessary for the facility or unit to meet post closure requirements.

Dangerous Waste (DW): Those solid wastes designated in WAC 173-303-070 through 173-303-103 as dangerous or extremely hazardous wastes.

Decommissioning - "to remove a facility or site safely from service and reduce residual radioactivity to a level that permits -- (1) Release of the property for unrestricted use and termination of the license; or (2) Release of the property under restricted conditions and termination of the license." (10 CFR 20.1003, see 62 FR 39057)

Decontamination and Decommissioning (D&D):

- Decontamination: The process of removing radioactive and/or hazardous contamination from facilities, equipment, or soils by physical removal, washing, heating, chemical action, mechanical cleaning or other techniques to achieve a stated objective or end condition.

- Decommissioning: Actions taken to reduce the potential health and safety impacts of DOE contaminated facilities, including activities to stabilize, reduce, or remove radioactive materials or to demolish the facilities. (DOE Order 5840.2)

Disposal - "Emplacement of waste in a manner that assures isolation from the biosphere for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste." (DOE Order 5820.2A (9-26-88), Attachment 2)

Exposure Scenario - a particular set of hypothetical circumstances involving the transport of contaminants from the disposal location to a receptor.

Final Site Closure - "Those actions that are taken as part of a formal decommissioning or remedial action plan, the purpose of which is to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for active maintenance so that only surveillance, monitoring and minor custodial care are required." (DOE Order 5820.2A (9-26-88), Attachment 2).

Hazardous Waste: Those wastes included in the definitions of RCRA 1004(5) and RCW 70.105.010(15).

Hazardous Waste Constituent, also referred to as "hazardous constituent" or "constituent": A constituent that caused the Administrator of the Environmental Protection Agency to list the hazardous waste in 40 CFR Part 261, Subpart D or a constituent listed in Table 1 of 40 CFR 261.24. (Hazardous constituents are listed in 40 CFR Part 261, Appendix VIII.)

High-Level Radioactive Waste (HLW) - "(A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in process and any solid material derived from such liquid that contains fission products in sufficient concentration; and (B) other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation." (NWPA)

High Level Waste - "(For the purposes of this statement of policy, 'high-level liquid radioactive waste" means 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.)' 10 CFR 50 Appendix F (35 FR 17533)

High-Level Waste - "The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation." (DOE Order 5820.2A (9-26-88), Attachment 2).

High-Level Waste Facility - "a facility subject to the licensing and related regulatory authority of the Commission pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974." (10 CFR 60.2)

Inadvertent Human Intruder (IHI) - "A person who might occupy the disposal site after closure and engage in normal activities such as agriculture, dwelling construction or other pursuits in which the person might be unknowingly exposed to radiation from the waste." (10 CFR 61.2)

Low-Activity Waste - "Low-activity wastes at the Hanford Site are produced by treating the tank wastes. Low-activity waste is produced by treating the tank wastes and are "low-level" tank wastes that have not yet received the NRC concurrence as incidental." (WHC, 1996, page Terms-ii)

Low-Level Radioactive Waste (LLW) - "radioactive material that (a) is not high-level, spent nuclear fuel, transuranic waste or by-product materials as defined in section 11e(2) of the Atomic Energy Act of 1954; (b) the Commission, consistent with existing law, classifies as low-level radioactive waste." (NWPA)

Member of Public (MOP) - a hypothetical individual who might occupy the area near the disposal site after closure and engage in normal activities such as agriculture, dwelling construction or other pursuits in which the person might be unknowingly exposed to radiation from the waste. The MOP exposure scenario and the inadvertent intruder scenario are exclusive of each other. Guidance found in Wood, *et al.* (1994, p.21) develops the idea of a 100 m. buffer zone separating the hypothetical MOP from the disposal site.

Passive institutional control - "(1) permanent markers placed at a disposal site, (2) public records and archives, (3) government ownership and regulations regarding land or resource use, and (4) other methods of preserving knowledge about the location, design, and contents of a disposal system." (40 CFR 191.12)

Release - "any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, including the abandonment or discarding of barrels, containers and other closed receptacles containing any hazardous substance or pollutant or contaminant, but excludes (a) any release which results in exposure to persons solely within a workplace ... (b) emissions from the engine exhaust of a motor vehicle ... " (CERCLA Section 101(22))

Sludge - "At the Hanford Site, the term sludge is applied to those solids that settle and accumulate at the bottom of a storage tank; solids formed by precipitation or selfconcentration, primarily insoluble metal hydroxides and oxides precipitated from neutralized waste. Sludge usually was in the form of suspended solids when the waste was originally received in the tank from the waste generator. The sludges are considered to be HLW." (Grams, 1995)

Spent nuclear fuel (SNF) - "means fuel that has been withdrawn from a nuclear reactor following irradiation , the constituent elements of which have not been separated by reprocessing" (40 CFR 191.02(g))

State-only Wastes: Any liquid, solid, gas or sludge, regardless of quantity, that exhibits any of the physical, chemical, or biological properties described in WAC 173-303-070 through 103

Transuranic waste - "waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes with half-lives greater than twenty years, per gram of waste except for: (1) high-level radioactive wastes; (2) wastes that the Department of Energy has determined, with the concurrence of the EPA Administrator, do not need the degree of isolation required by 40 CFR 191 or (3) wastes that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61." (40 CFR 191.02(i))

1.0 INTRODUCTION

Liquid, mixed, high-level radioactive waste (HLW) has been stored in 149 single-shell tanks (SSTs) located in tank farms on the U.S. Department of Energy's (DOE's) Hanford Site. After retrieval of the mixed HLW that remains in the SSTs, the DOE desires to "close" the tank farms. In support of the Hanford Tanks Initiative (HTI), Sandia National Laboratories has addressed the requirements for the *regulatory* closure of the ancillary equipment in one of the Hanford tank farms, the 241-AX Tank Farm.

The AX Tank Farm includes four 1,000,000-gallon SSTs, as well as sluice lines, transfer lines, ventilation headers, risers, pits and cribs, catch tanks, buildings; and wells. Collectively, this equipment is classified as ancillary equipment. Four general options have been identified for the *physical* closure of the ancillary equipment: (1) disposal in place; (2) disposal in place after treatment; (3) excavation and disposal of ancillary equipment on site in an empty SST; and (4) excavation and disposal outside the AX Tank Farm.

This report addresses several broad topics:

- the background of the Hanford Site and ancillary equipment in the AX Tank Farm;
- a review of regulations for decontamination and decommissioning (D&D) of radioactively contaminated equipment;
- a review of requirements for the cleanup and disposal of radioactive wastes;
- a review of cleanup and disposal requirements governing hazardous and mixed wastes; and
- regulatory requirements and issues associated with each of the four physical closure options.

This analysis has identified several issues that should help the DOE in closing the SSTs and associated tank farms. Interactions between representatives of the Washington State Department of Ecology (Ecology), the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), the DOE, other stakeholders, and Hanford Site contractors will allow a more complete determination of regulatory drivers for closure of the AX Tank Farm.

2.0 SCOPE

This report addresses the regulatory issues associated with four predefined closure options for the ancillary equipment in the Hanford AX Tank Farm. An emphasis was placed on the regulations governing closure of radioactively contaminated equipment. As noted in the scope of work "... a limited review will be conducted relative to the hazardous waste component ... the limited scope of this effort will prevent the full exploration of the hazardous waste closure regulations." This regulatory review focused on buried equipment and did not specifically address the "wells" or the aboveground buildings.

3.0 BACKGROUND

3.1 Hanford Site History

The Hanford Site, near Richland, Washington, is a DOE installation encompassing about 600 square miles. The following overview of the Hanford Site history is extracted from the site environmental impact statement (DOE, 1996, p. S-3):

> From 1943 to 1989, the Hanford Site's principal mission was the production of weapons-grade plutonium. To produce plutonium, uranium metal was irradiated in a plutonium production reactor. The irradiated uranium metal, also known as spent nuclear fuel, was cooled and treated in a chemical separations, or reprocessing plant, where plutonium was separated from uranium and many other radioactive by-products. The plutonium was then used for nuclear weapons production. Large amounts of spent fuel were generated to produce enough plutonium to make a nuclear weapon. The chemical separations process generated large volumes of radioactive waste. The Hanford Site processed approximately 100,000 metric tons of uranium and generated several hundred thousand metric tons of wastes.

Waste that results from the reprocessing of spent nuclear fuel (SNF) is classified as HLW. In the 1940s through the early 1960s, 149 SSTs with capacities of 55,000 gallons to 1,000,000 gallons were built to store HLW in a region near the center of the Hanford Site. One hundred thirty-three of these tanks are 75 feet in diameter and 30 to 54 feet high; the remainder of the SSTs are smaller. The SSTs had a design life of 20 years. In addition to the actual SSTs, the tank farms contain an inventory of equipment that was necessary to move wastes in and out of the tanks and to ventilate and monitor the tanks. By the late 1980s, 67 of the SSTs were known or suspected leakers (DOE, 1996, p. S-5).

To address concerns about the integrity of the SSTs, the Hanford Site built 28 double-shell tanks (DSTs) between 1968 and 1986. Most of the free-standing liquid contained in the SSTs has been transferred to the DSTs, leaving approximately 36,000,000 gallons of waste in the SSTs. This current SST waste consists of salt cake (23,000,000 gallons), sludge (12,000,000 gallons), and supernatant liquids (600,000 gallons) (DOE, 1995, p. 1-3). The radioactive components consist of fission product radionuclides, such as strontium-90, cesium-137, and iodine-129, and actinide elements such as uranium, neptunium, plutonium, thorium, and americium. The radioactive components remaining in the SSTs sum to 104,000,000 curies (National Research Council, 1996, p. 14).

3.2 Ancillary Equipment

Each tank in a tank farm is supported by a variety of equipment that has been used for either waste storage operations or for monitoring tank contents. COGEMA Engineering Corporation (formerly SGN Eurisys Services Corporation (SESC)) performed an AX Tank Farm Ancillary

Equipment Removal Study (SESC, 1998) to determine the inventory of ancillary equipment in the AX Tank Farm and to anticipate contamination that may be encountered during the removal of ancillary equipment. Ancillary equipment does not include the actual SSTs, but applies to all identified equipment above the tank dome that has been in contaminated service.

The following description of the ancillary equipment is taken from portions of the SESC report.

> Sluice Lines - Piping used to transfer tank liquor into the tanks through high-velocity nozzles, allowing the breakup and suspension of tank waste solids... Each pipe is schedule 40 carbon steel with six-inch internal diameter. Forty-two sluice lines supporting sluice operations of the 241-AX and 241-AX Tank Farms are considered in this analysis.
>
> Transfer Lines - Piping used to transfer tank wastes into and out of tanks to various pits and diversion boxes, and piping used to transfer condensates or provide drainage form pits and diversion boxes ... Approximately 100 transfer lines have been considered in this analysis.
>
> Ventilation Headers - The four tanks in this farm have been actively ventilated. Each tank dome contains a large penetration for the air duct. The various ducts from the tanks join in headers and proceed to join with ducts from other tank farms prior to gas stream treatment and release. Ducting is nominally 24 inches in diameter and supported on concrete piers. Twelve major ventilation header sections are considered in this analysis.
>
> Risers - Each waste storage tank is penetrated with a number of steel pipes (risers) of various dimensions and purposes ... In all, 234 risers are considered in this analysis.
>
> Pits and Cribs - Pits are concrete structures used to house material transfer joints. Various lines (especially transfer lines) penetrate such pits through the wall and are terminated with nozzles. Such nozzles are 'jumpered' to other nozzles to allow a defined flow path for material being transferred down the line. Cribs are engineered soil receivers that may have received condensates and other liquors. In all, 46 pits and cribs are considered in this analysis (examples include: 216-A-39 crib; septic tank associated with 2707-AX changehouse; abandoned leach field associated with septic tank; active leach field associated with septic tank; 24" French drain (dry well) associated with 241-AX-152; 48" French drain (dry well) associated with vent header; 48" French drain (dry well) associated with A-702 Fan House; French drain (dry well) associated with A-701 Condenser building).
>
> Catch Tanks - A catch tank supports material transfers and transfer lines with the ability the receive material spills and mistransferred wastes. One catch tank for condensates in 241-A-417 is considered in this analysis. An additional catch tank in Diversion Box 241-AX-152 is also considered.

Buildings - In all, 14 buildings are considered in this analysis.

Wells - Wells are steel encased penetrations of the soil intended to monitor soil contamination. In all, 51 wells have been identified within the confines of the excavation and building area.

Taken together, the contaminated ancillary equipment presents a significant inventory of materials that must be addressed in the closure process.

3.3 Contamination of the Ancillary Equipment

In addition to assessing the inventory of equipment in the AX Tank Farm, SESC also estimated the level of contamination of each piece of ancillary equipment. *Wastes assumed to be present in the contaminated equipment are the sludges derived from material transferred into and out of the tanks in this farm and two adjacent SSTs in the AX Tank Farm.* Note that no specific field measurement of contamination or waste material composition exists for the subject equipment.

The SESC inventory of contaminants is based on a detailed understanding of the equipment design and sizing, as well as extensive knowledge of the application of the equipment item. In simple terms, SESC staff estimated the level of contamination by combining three factors: the internal volume of the piece of ancillary equipment, the volume of residual or "holdup" expected in that piece of equipment, and the "dilution" factor. The dilution factor is added because the holdup in the ancillary equipment is not expected to be as concentrated as the sludge in the SSTs. For example, sluice line 6-PSW-8062-M5 is 80 m long and has an internal volume of 1500 liters. This sluice line is assumed to be 0.1 full of material, which is assumed to be 0.7 times as concentrated as the sludge in SST AX-102. Therefore, the "equivalent volume" of sludge in 6-PSW-8062-M5 would be 100 liters (i.e., $0.1 \times 0.7 \times 1500$ liters).

The following description of how the inventory was derived is taken from portions of the Equipment Removal Study (SESC, 1998).

> Equipment in contact with particular wastes is assumed to be contaminated with those wastes. Waste sludge compositions for the six tanks and combined wastes are provided in Table 1 and Table 2 for chemical and radionuclide concentrations, respectively. These concentrations are expressed in moles (gram-moles) or curies per liter.
>
> For purposes of personnel exposure estimation, it should be noted that primary gamma emitting sources (^{137}Cs-^{137m}Ba) are conservatively estimated in this analysis.
>
> Operational history and current practice indicate significant aqueous flushing of lines and equipment after transfer of tank wastes and their sludges. The high solubility of sodium and cesium in the flush water would serve to dramatically

wash out these constituents from any settled sludges. No reduction of inventory estimate of these constituents has been made to reflect this dilution with flushing.

A contamination factor is intended to describe the fraction of an equipment item's volume that is occupied with settled sludges. Service factors are intended to weight the relative contamination within a single equipment type so that items tending to have served waste streams containing lower settelable solids contents will not be grossly overestimated in inventory.

The application of a Contamination Factor of 'Full' may be appropriate if equipment had been reported Failed and Full of Sludge. Intermediate descriptors are cultured by equipment type. Application of both service and contamination factors as 'Full' would lead to a combined term $S_{E,k}$[1] • $F_{E,l}$[2] of one. This would imply that the equipment item volume is 100 percent full of tank sludge.

The heaviest potential contaminations considered are those of transfer, sluice, and ventilation lines. Wells have been discounted from this analysis with the reasoning that soil contamination surrounding any well has already been considered among vadose zone contaminations and that the internal surface of well casings have not been in contaminated service.

It should be noted that no specific field measurement of equipment contamination or waste material composition exists for the subject equipment. Although sludge material compositions for tank waste materials are supported by process history and limited sampling, and equipment sizing is supported by existing Hanford engineering documentation, the estimated residual contamination volumes for the equipment in the 241-AX Tank Farm are based on the best judgment of SESC engineering staff.

The reader is referred to the SESC report for a detailed estimate of the level of contamination expected for each piece of equipment. A comparison of the levels of anticipated contamination to the levels necessary to protect human health is addressed in Chapter 5 of this report.

3.4 Justification for Field Characterization

This regulatory review accepts and uses the estimated levels of contamination expected in the ancillary equipment; however, actual field data on the level of contamination are needed prior to final remedy selection. An excellent example of the need for thorough characterization prior to selecting a closure option is provided by Smith (1996). Smith describes recent remedial actions that were undertaken to reduce doses from the Hanford 1304-N Emergency Dump Tank. Dose

[1] $S_{E,k}$ is defined as teh surface factor k for equipment type E

[2] $F_{E,l}$ is defined as the fouling factor l for equipment type E

reduction activities in this 1.2-million-gallon tank were scoped *prior* to complete characterization. Some of the problems encountered during remedial activities included the following:

(1) The volume and radiological activity of the rust and debris in the sparge lines was much greater than anticipated (greatly increasing the doses to D&D workers and requiring more people to work the job because of dose "burn out").

(2) The waste was much more radiologically active than originally anticipated (which quadrupled the analytical costs for actual waste characterization).

(3) The concentrations of lead and other metals were greater than anticipated (which increased disposal costs because the waste was assumed to be radioactive but was actually mixed waste).

4.0 APPLICABLE REGULATIONS

4.1 Introduction

To understand the regulatory issues associated with closure of the ancillary equipment, one must have a general understanding of the regulations governing hazardous, radioactive, and mixed wastes at Hanford. This section of the report reviews the following regulations:

(Section 4.2) the Hanford Tri-Party Agreement (TPA);
(Section 4.3) regulations governing radioactively contaminated equipment;
(Section 4.4) regulations governing radioactive waste; and
(Section 4.5) regulations governing hazardous/dangerous waste (DW).

The legal authority to regulate radioactive, hazardous, and mixed wastes is delegated to various regulators; however, it is important to remember that there is only one waste (with the radioactive and hazardous components inextricable locked together). Actual implementation of these closure requirements will require coordination between the various regulators and their associated regulations.

4.2 Tri-Party Agreement

To provide a comprehensive framework for the remediation of the Hanford Site, the EPA, the DOE, and Ecology entered into the Hanford Federal Facility Agreement and Consent Order (the Hanford TPA). The Hanford TPA consists of four sections: (1) the actual Federal Facility Agreement and Consent Order; (2) Attachment 1 (a letter from the US Department of Justice); (3) Attachment 2 (the Action Plan, which is the implementing document for the TPA and, by reference, is incorporated into the TPA); and (4) seven appendices.

TPA milestone M-45-00 is the most significant to this report because M-45-00 establishes the intent of the parties to retrieve as much mixed HLW from the SSTs as is technically possible and then "... all units located within the boundary of each tank farm will be closed in accordance with WAC 173-303-610. This includes contaminated soil and ancillary equipment." Because of its importance, sections of milestone M-45-00 are repeated here.

M-45-00	COMPLETE CLOSURE OF ALL SINGLE SHELL TANK FARMS.	9/30/2024
LEAD AGENCY: ECOLOGY	CLOSURE WILL FOLLOW RETRIEVAL OF AS MUCH TANK WASTE AS TECHNICALLY POSSIBLE, WITH TANK WASTE RESIDUES NOT TO EXCEED 360 CUBIC FEET (CU. FT.) IN EACH OF THE 100 SERIES TANKS, 30 CU. FT. IN EACH OF THE 200 SERIES TANKS, OR THE LIMIT OF WASTE RETRIEVAL TECHNOLOGY CAPABILITY, WHICHEVER IS LESS. ... FOLLOWING COMPLETION OF RETRIEVAL, SIX OPERABLE UNITS (TANK FARMS), AS DESCRIBED IN APPENDIX C (200-BP-7, 200 -PO-3, 200-RO-4, 200-TP-5, 200-TP-6, 200-UP-3), WILL BE	

> REMEDIATED IN ACCORDANCE WITH THE APPROVED CLOSURE PLANS. FINAL CLOSURE OF THE OPERABLE UNITS (TANK FARMS) SHALL BE DEFINED AS REGULATORY APPROVAL OF COMPLETION OF CLOSURE ACTIONS AND COMMENCEMENT OF POST-CLOSURE ACTIONS.
>
> FOR THE PURPOSES OF THIS AGREEMENT ALL UNITS LOCATED WITHIN THE BOUNDARY OF EACH TANK FARM WILL BE CLOSED IN ACCORDANCE WITH WAC 173-303-610. THIS INCLUDES CONTAMINATED SOIL AND ANCILLARY EQUIPMENT ... IN EVALUATING CLOSURE OPTIONS FOR SINGLE-SHELL TANKS, CONTAMINATED SOIL, AND ANCILLARY EQUIPMENT, ECOLOGY AND EPA WILL CONSIDER COST, TECHNICAL PRACTICABILITY, AND POTENTIAL EXPOSURE TO RADIATION. CLOSURE OF ALL UNITS WITHIN THE BOUNDARY OF A GIVEN TANK FARM WILL BE ADDRESSED IN A CLOSURE PLAN FOR THE SINGLE-SHELL TANKS.

TPA Milestone M-45-00 establishes a number of requirements that have a strong influence on regulations applicable to final closure of the ancillary equipment. First, the requirement to close all units within a tank farm boundary under Washington Administrative Code (WAC) 173-303-610 means that the tank farms will be closed as Resource Conservation and Recovery Act (RCRA) hazardous waste management units. Second, Ecology will be the lead agency for closure (this is discussed below). Third, in evaluating closure options for tank farms, Ecology and the EPA will consider cost, technical practicability, and potential exposure to radiation (which could provide some relief from the strict requirements of RCRA). Fourth, closure of an entire tank farm (SSTs, unretrievable waste in an SST, contaminated soil, and ancillary equipment) will be addressed by a single closure plan.

<u>Lead Regulatory Agency Concept</u>

To facilitate implementation of the TPA, the TPA designates "lead agencies." As the title implies, the lead agency has the lead for a particular action. However, the non-lead agency does not forfeit its regulatory authority to the lead agency. For example, Ecology has the lead to close the tank farms under the WAC, but the EPA retains its Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority.

Chapter 5 of the Hanford TPA Action Plan states that:

> Regulatory authority shall remain with the regulatory agency having legal authority for those decisions, regardless of whether that agency is the lead regulatory agency for the work. The lead regulatory agency shall oversee the work, and brief and obtain any necessary approvals from the agency with regulatory authority. For example, where Ecology is the lead regulatory agency at a CERCLA site, it shall brief EPA as necessary to obtain EPA approval before a remedial action is selected.

The NRC is not a party to the TPA; therefore, negotiations with the NRC are conducted outside the scope of the TPA.

4.3 Regulations Governing Radioactively Contaminated Equipment

4.3.1 Introduction

The process of cleaning up and closing radioactively contaminated facilities and equipment is known as decontamination and decommissioning (D&D). Decontamination is the process of removing radioactive and/or hazardous contamination from facilities, equipment, and soils to achieve a stated objective. Decommissioning then removes facilities and equipment from service so that the property can be released for unrestricted use or released under restricted conditions. There are specific requirements for the D&D of contaminated facilities and equipment. As discussed below, Chapter V of DOE Order 5820.2A sets D&D requirements for DOE-titled facilities.

Individual pieces of radioactively contaminated equipment are managed within the broader umbrella of the D&D process. Individual pieces of radioactively contaminated equipment can be:

- released for unrestricted use;
- stored (to allow radioactive decay);
- reused; or
- disposed.

There are specific requirements for the unrestricted release of contaminated equipment. As discussed in this report, Chapter V of DOE Order 5400.5 provides one such set of requirements. Decay in storage is a viable option for equipment that is only contaminated with short-lived radionuclides. Unfortunately, the ancillary equipment is contaminated with both short- and long-lived radionuclides, so this is not a viable closure option. Under specific circumstances, reuse of contaminated equipment is an option. Reuse requires both low levels of contamination and a future use. Reuse is not a viable option for the type of old, buried equipment associated with the AX Tank Farm. Disposal of the ancillary equipment as radioactive waste is a viable option, and radioactive waste disposal requirements are addressed in Section 4.4.

Three federal entities have the majority of the regulatory authority over the management and disposal of radioactively contaminated materials: the EPA, the DOE, and the NRC. Each of these entities has codified various laws, orders, directives, manuals, guidance documents, and branch technical positions which govern the various types of materials.

In very simple terms, the EPA has authority to write standards, the DOE has authority to write and enforce standards for radioactive wastes from "atomic energy defense activities," and the NRC has authority to write and enforce regulations for commercially-generated wastes. However, regulatory authority may depend on whether the radioactive waste has yet to be disposed (or emplaced) or has already been released to the environment (e.g., a spill or a leak). This topic is discussed later. The EPA has the lead role for writing regulations, and the DOE and NRC regulations/orders cannot be inconsistent with EPA standards. There are many notable exceptions to these generalizations.

4.3.2 Tri-Party Agreement

Section 8 of the Hanford TPA Action Plan addresses the decommissioning process. The facility decommissioning process defines the approach by which DOE, with involvement of the lead regulatory agencies, will take a facility from operational status to its final disposition. As noted in Section 8.1.2 of the Action Plan, the decommissioning process is only applicable to "key facilities," and the decommissioning requirements do not apply to any waste disposal unit or RCRA treatment or storage unit scheduled for closure. Milestone M-45-00 of the TPA requires closure of the tank farms under the WAC; therefore, closure requirements and not decommissioning requirements will apply to the tank farms.

4.3.3 DOE Order 5400.5 / Proposed 10 CFR 834

The DOE's overarching standard to protect the public from radiation is set by DOE Order 5400.5, "Radiation Protection of the Public and the Environment." Chapter II of this order establishes a dose limit of 100 mrem per year (effective dose equivalent) to protect the public from radiation from all exposure modes from all routine DOE operations (including remedial actions). Under unusual circumstances, the DOE may allow higher dose limits (not to exceed 500 mrem for a year) as provided by section II 1 a. (4) of the Order. The higher dose limit must be temporary and requires coordination with the Program Office and written authorization from DOE/HQ/EH-1.

DOE Order 5400.5 provides standards to protect the public from all sources of radiation from DOE operations. DOE Order 5400.5 has been interpreted by DOE as being applicable to DOE wastes that may remain after DOE operations have ceased (for example, see the *Guidance for a Composite Analysis of the Impact of Interacting Source Terms on the Radiological Protection of the Public from DOE LLW Disposal Facilities,* issued under an April 30, 1996 cover memorandum from James Owendoff , DOE Deputy Assistant Secretary for Environmental Restoration (ER) and Stephen Cowan, DOE Deputy Assistant Secretary for Waste Management.)

The Order also requires that doses shall be As Low As Reasonably Achievable (ALARA) for all DOE activities and facilities that cause a dose to the public. This requirement is in addition to the requirement to limit doses to less than 100 mrem/year. Even if the projected doses are acceptable, additional efforts should be undertaken to reduce doses to ALARA levels. An ALARA analysis is an optimization: Are there cost-effective actions that can be taken to reduce projected doses even further? The DOE Order does not place a monetary value on averted doses; however, NRC guidance for NRC-regulated facilities suggests the implementation of ALARA measures that cost less than $2,000 per person-rem of averted dose.

Potential doses from drinking water are addressed in Section II 1. d. of the Order, which requires that doses from DOE water supply systems shall not exceed 4 mrem per year. The 4 mrem per year standard for the drinking water pathway is in addition to the 100 mrem per year dose standard for all pathways (i.e., doses from DOE-operated water supplies cannot contribute more than 4 mrem of the 100 mrem per year, all pathways, total dose). Furthermore, DOE-operated water supplies must meet safe drinking water standards under 40 CFR 141.

In addition to setting a 100-mrem per year, all sources, all pathways dose standard, and the 4 mrem/year drinking water standard, DOE Order 5400.5 states that:

> DOE must *also* comply with legally applicable requirements (e.g., 40 CFR Parts 61, 191, and 192 and 10 CFR Parts 60 and 72), including administrative and procedural requirements." (Section II 1., *emphasis added*)

The management and control of radioactive materials in liquid discharges to the soil column is the subject of Section II 3. of the Order. These requirements for liquid discharges to the soil column were not researched, but could be applicable to the potential release of liquids during retrieval (i.e., sluicing) operations.

Chapter IV of DOE Order 5400.5 addresses *the release of real property having residual radioactive materials*. The requirements of the Order apply only to the release of materials with surface contamination, and no guidance is available for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (Section II 5. c. (6)). Importantly, DOE) Order 5400.5 does not address characterization requirements – for example, the types of instruments to use and the number of measurements to be taken.

Chapter IV of DOE Order 5400.5 presents radiological protection requirements and guidelines for cleanup of residual radioactive material and management of the resulting wastes and release of property. Chapter IV sets requirements for the different options for residual radioactive material: (1) unrestricted release; (2) storage; and (3) long-term management (i.e., disposal). The introduction of Chapter IV states that "*This chapter does not apply to uranium mill tailings or to properties covered by mandatory legal requirements.*"

Because the Hanford TPA is a mandatory legal requirement, the requirements of the TPA and not the requirements set in Chapter IV are binding on closure of the ancillary equipment in the tank farms. As discussed later, the metrics that Ecology and the EPA might apply to in-place closure of radioactive materials require some clarification.

Even though the Chapter IV requirements for cleanup of residual radioactive material and management of the resulting wastes are not binding on the Hanford cleanup, Chapter IV requirements can still be viewed as nonbinding guidance. Figure IV-1 in Chapter IV offers release limits for the unrestricted release of materials, based on total residual contamination. These release limits are offered for groups of radionuclides, such as Sr-90, the various isotopes of uranium, and beta-gamma emitters. Figure IV-1 does not provide release limits for transuranics. The footnotes associated with Figure IV-1 offer recommendations for addressing "hot spots" and removable material. Section IV 4. a. states that "Residual Radionuclides in Soil... Guidelines... shall be derived from the basic dose limits (100 mrem per year) by means of an environmental pathway analysis using specific property data. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2." Finally, Section IV 6. d. (2) states that the long-term management (i.e., disposal) of radioactive materials that are not mill tailings shall be in accordance with DOE Order 5820.2A, as applicable.

Chapter IV (which is not binding on the cleanup of Hanford) also provides examples of specific situations that warrant DOE use of supplemental standards and exceptions:

1. Where remedial actions would pose a clear and present risk of injury to workers or members of the public, not withstanding reasonable measures to avoid or reduce risk.

2. Where remedial actions, even after all reasonable mitigative measures have been taken, would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near the affected properties now or in the future. A clear excess of environmental harm is harm that is grossly disproportionate to health benefits that may be reasonably anticipated.

3. Where the cost of remedial actions for contaminated soil is unreasonably high relative to long-term benefits and where residual material does not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a property should be considered in evaluating this risk. (Section IV 7. C)

DOE Order 5400.5 has been effective since 1990. The DOE has proposed (60 FR 45381, August 31, 1995) a regulation, 10 CFR 834, to replace Order 5400.5. The draft of 10 CFR 834 has not been reviewed by the authors because it is a draft and because of the limited scope of this review.

In summary, DOE Order 5400.4 sets a 100-mrem per year dose standard to protect the public from radiation from all sources and all pathways from all routine DOE operations. For drinking water supplies operated by DOE, an additional criteria is that the drinking water pathway shall not cause a dose in excess of 4 mrem per year. These two dose standards must be met, in addition to compliance with "mandatory legal requirements." Chapter IV of DOE Order 5400.5 presents radiological protection requirements for cleanup of residual radioactive material and release of property. Chapter IV states that the long-term management (i.e., disposal) of radioactive materials must be in accordance with DOE Order 5820.2A, as applicable. However, the requirements of Chapter IV do not apply to properties covered by mandatory legal requirements such as the Hanford TPA.

This is somewhat confusing and it is the authors' interpretation that DOE operations must (1) comply with all of DOE Order 5400.5 unless there are mandatory legal requirements; then (2) the DOE operations must comply with the mandatory legal requirements <u>and</u> DOE Order 5400.5, except for the requirements set in Chapter IV.

4.3.4 DOE Order 5820.2A / Proposed DOE Order 435.1

The majority of DOE Order 5820.2A addresses the management and disposal of the different types of radioactive waste (e.g., Chapter III sets requirements for the management and disposal of DOE-titled low level radioactive waste (LLW)). However, Chapter V of DOE Order 5820.2A addresses the "Decommissioning of Radioactively Contaminated Facilities." Order 5820.2A is not promulgated or codified, but does serve to meet the DOE's obligations under the Atomic Energy Act (AEA).

The purpose of Chapter V of DOE Order 5820.2A is to establish policies and guidelines for the management and D&D of radioactively contaminated facilities under DOE ownership or control. The next few paragraphs discuss relevant portions of Chapter V.

Section V 3.c.(2) of DOE Order 5820.2A requires that all HLW and stored hazardous materials should be removed by the operator prior to entering into the decommissioning phase. Section V 3.d.(1)(c) requires characterization of "... the type, form, quantity and location of hazardous chemical and radioactive material from past operations..."

Actual closure criteria are to be established in the "Environmental Review Process," which is discussed in Section V 3.c.d.(2). The Environmental Review Process requires that the CERCLA, Superfund Amendments and Reauthorization Act (SARA), National Environmental Policy Act (NEPA), and/or RCRA "status" of each project shall be identified and that a remedial investigation shall be performed, if required. Candidate decommissioning alternatives shall be identified, assessed, and evaluated and a preferred decommissioning alternative shall be selected based on the results of the Environmental Review Process.

After the preferred decommissioning alternative is selected, a Decommissioning Project Plan shall be prepared as required by Section V 3.d.(3). The Decommissioning Project Plan should include characterization data; an evaluation of decommissioning alternatives; plans for meeting the requirements of NEPA, RCRA, CERCLA, SARA, and all necessary permits; the radiological criteria to be used; projections of occupational exposures; estimated quantities of waste to be generated; and detailed information on cost and schedule. After completion of the decommissioning activities, a final radiological and chemical survey report shall be prepared, as required by Section V 3.d.(5).

In summary, Chapter V of DOE Order 5820.2A sets a number of procedural requirements for the management and D&D of radioactively contaminated facilities. *Chapter V of DOE Order 5820.2A does not set decommissioning standards; rather, the Order requires compliance with other applicable regulations.*

DOE Order 5820.2A has been in effect since 1988. Another DOE order, "Manual and Guidance, 435.1" has been proposed as the replacement for DOE Order 5820.2A. However, the requirements for the D&D of radioactively contaminated facilities will not be moved to the proposed Order 435.1. Instead, decommission requirements will be addressed by a new, stand-alone DOE Order, which is DOE Order 430.1.

4.3.5 Proposed DOE Order 430.1

Requirements for the "Decommissioning of Radioactively Contaminated Facilities" are currently set forth in Chapter V of DOE Order 5820.2A. The requirements for the decommissioning of radioactively contaminated facilities are being moved to DOE Order 430.1, "Life Cycle Asset

Management," which has been released as a draft. Associated with draft Order 430.1 are three guides and a standard: (1) DOE Guide 430.1-2 "Surveillance and Maintenance During Facility Disposition"; (2) DOE Guide 430.1-3 "Deactivation Implementation Guide"; (3) DOE Guide 430.1-4 "Decommissioning Implementation Guide"; and (4) SAFT-0060 (Volumes I and II) "Integration of Safety and Health into Facility Disposition Activities."

The requirements of draft DOE Order 430.1 and the associated guides were not reviewed because they are drafts and because of the limited scope of this regulatory review.

4.3.6 Joint DOE and EPA Policy on Decommissioning DOE Facilities

On May 22, 1995, the DOE and EPA issued a joint policy on "Decommissioning of Department of Energy Facilities Under CERCLA." The policy establishes the approach agreed upon by the EPA and the DOE for decommissioning surplus DOE facilities consistent with the requirements of the CERCLA:

> The policy establishes that decommissioning activities will be conducted as non-time-critical removal actions, unless the circumstances at the facility make it inappropriate. Use of non-time-critical removals for conducting decommissioning activities effectively integrates EPA oversight responsibility, DOE lead agency responsibility, and state and stakeholder participation.

The DOE/EPA policy states that the roles and responsibilities for decontamination of DOE facilities listed on the National Priorities List (NPL) will be defined, in part, by the associated Interagency Agreement. At Hanford, the TPA is the CERCLA Interagency Agreement. Therefore, the joint DOE/EPA policy defers to the Hanford TPA for decommissioning requirements at Hanford.

4.3.7 NRC's 10 CFR 20 Subpart E

The D&D of NRC-licensed facilities is governed by 10 CFR 20, Subpart E, which was finalized on July 21, 1997 (62 FR 39088). The DOE's Hanford site is not an NRC-licensed facility, and the NRC's 10 CFR 20, Subpart E requirements do not apply. As a point of reference, this section provides a simple overview of the NRC's D&D requirements.

The NRC's 10 CFR 20 Subpart E criteria set an *all source terms*, all pathways, dose limit of 25 mrem per year Total Effective Dose Equivalent (TEDE) for "the average member of the critical group" for the unconditional release of a licensed facility. The time-frame of compliance is 1,000 years. A site-specific analysis similar to a performance assessment (PA) is performed to determine if an NRC facility undergoing D&D meets these unrestricted release criteria. Protection of groundwater resources is not an independent performance objective. Under the NRC's requirements, the groundwater pathway could contribute up to 25 mrem/year, assuming that no other pathway contributes to the annual dose.

If the unrestricted release criteria of 25 mrem per year TEDE cannot be met, there is a second tier (with higher dose standards) for "restricted releases." Restricted release sites require the use of "institutional controls" (see the Definitions section in the beginning of this report). The dose standard for a restricted release site is based on the consequences of the failure of the institutional controls. If the institutional controls were no longer in effect, there must be reasonable assurance that the TEDE from residual radioactivity to the average member of the critical group is ALARA and would not exceed either:

(1) 100 mrem per year; or
(2) 500 mrem per year provided the licensee
  (i) demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/year value are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;
  (ii) makes provisions for durable institutional controls;
  (iii) provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that the institutional controls remain in place as necessary.

In many ways, the NRC D&D criteria are similar to the DOE criteria for disposal of LLW (i.e., Chapter III of DOE Order 5820.2A, which is discussed later). The DOE LLW disposal requirements set a 25-mrem/year dose standard for the member of the public (MOP), similar to the NRC's 25 mrem/year unrestricted release criteria (the methods of calculating dose are actually different, but the difference is not relevant to this overview). The DOE LLW disposal requirements also set a 100 mrem/year chronic and 500 mrem acute dose standard for protection of an inadvertent human intruder (IHI), which is similar to the NRC's 100 or 500 mrem/year chronic dose standard, assuming failure of institutional controls. For the protection of groundwater resources, the DOE LLW disposal criteria are much more restrictive the NRC D&D criteria.

In summary, the NRC D&D criteria for release of NRC-licensed facilities is an all-source-terms, all-pathways standard that is similar to the DOE LLW disposal criteria. Because the Hanford Site is not an NRC licensed facility, the NRC D&D criteria do not apply, but the similarity to DOE requirements for LLW disposal is important to note.

4.4 Regulations Governing Radioactive Waste

4.4.1 Introduction

In this country, radioactive waste is divided into five types:

- SNF;
- HLW;
- TRansUranic (TRU) Waste;

- Byproduct Material[3]; and
- LLW.

Closure of the ancillary equipment could involve the definitions and disposal standards for LLW and HLW, discussed below. Closure does not require a discussion of TRU, SNF, or byproduct material. However, note two significant facts: First, SNF, HLW, and byproduct material are defined by their origin and not by how much radioactivity these wastes contain; of the five types of waste, only TRU waste is defined by how much radioactivity is in the waste. Second, *if a waste meets the definition of TRU waste and the waste also meets the definition of HLW, the waste will be managed as HLW and not TRU waste* (see exception (1) in the definition of TRU waste in the Definitions section of this report).

Regulations governing the disposal of radioactive waste are complicated; therefore, this section provides only an overview of some of the major pieces of relevant legislation. A more detailed discussion of these topics can be found in Cochran and Shyr (1997).

Nuclear energy became subject to federal regulation with the passing of the Atomic Energy Act (AEA) of 1946. Through the AEA, Congress gave control of the production and use of fissile materials to the Atomic Energy Commission.

When the EPA was created in 1970 by Reorganization Plan No. 3, President Nixon transferred to the EPA jurisdiction the functions of the Atomic Energy Commission for establishing generally applicable environmental standards for the protection of the environment from radioactive materials "... in the general environment *outside the boundaries of locations under the control of persons possessing or using radioactive material*" (emphasis added, Reorganization Plan No. 3 section 2(a)6). Thus, the EPA was granted the authority to set release standards but not granted authority to implement the release standards. Then, in 1980, CERCLA gave the EPA broad authority to "clean up" releases of hazardous substances, including radionuclides. The EPA's enforcement authority is limited to cleanup activities under CERCLA and does not apply to "disposal" operations.

The Energy Reorganization Act of 1974 redirected federal energy efforts. The Atomic Energy Commission was abolished and replaced by the NRC and the Energy Research and Development Agency (the Energy Research and Development Agency later became the DOE). Section 202 of the Energy Reorganization Act also gave the NRC licensing authority for facilities used primarily for the receipt and storage of HLW. Under Section 202 authority, the NRC will license the disposal of HLW.

The DOE implements its AEA authority through a set of Directives, DOE Orders (which are not codified), and regulations. The most relevant of these DOE Orders is DOE Order 5820.2A, which establishes "... policies, guidelines and minimum requirements by which the DOE manages its radioactive and mixed waste and contaminated facilities." This Order is divided into Chapters,

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[3] The DOE manages Naturally Occurring Radioactive Material as if it were byproduct material under Chapter IV of DOE Order 5820.2A.

with Chapter I addressing the management of HLW and Chapter III addressing management of LLW. These two chapters are discussed in detail later in this report. Order 5820.2A has been in effect since September 1988 and is being revised. DOE Order 435.1 is currently available in draft and will eventually replace Order 5820.2A as the DOE order governing the disposal of radioactive waste.

All the above laws are applicable to the *disposal* of radioactive waste. A second set of laws and guidance documents is applicable to *cleanup* of radioactive wastes. Of these laws, the CERCLA and the regulations created to implement the statute (i.e., the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)) are the broadest. CERCLA provides the EPA with authority to address releases and threatened releases of hazardous substances, including hazardous wastes and radioactive wastes. The EPA's CERCLA Program has created a system to designate the highest priority sites for cleanup, and those sites are NPL sites. The Hanford Site is on the EPA's NPL. At Hanford, the EPA CERCLA Program is defined by the Hanford TPA.

4.4.2 High-Level Waste

HLW is the waste that results from the reprocessing of SNF to recover unfissioned uranium and plutonium. The legal definitions of HLW are provided in the Definitions section of this report. Although the definitions of HLW vary, the variations are not relevant to this report. The common elements in each definition include: (1) radioactive waste material; (2) from the reprocessing of SNF; and (3) the lack of concentration- or specific activity-based limits.

HLW is defined by origin, not constituents; therefore, there is no concentration below which HLW ceases to be HLW. The definitions of HLW include phrases like "highly radioactive" and "in concentrations requiring permanent isolation." However, these terms are never quantitatively defined. The ancillary equipment is assumed to be contaminated with sludges derived from the mixed HLW that was transferred into and out of the tanks. Because there is no lower quantitative boundary in the definition of HLW, ancillary equipment containing mixed HLW might or might not be classified as HLW.

The topic of whether the ancillary equipment is simply radioactively contaminated material or HLW is discussed in detail later in this report. Assuming the ancillary equipment might be classified as HLW, this section reviews the regulations governing disposal of HLW.

<u>Nuclear Waste Policy Act</u>

The NWPA of 1982 establishes the national program for the disposal of SNF and HLW. The NWPA does not set quantitative standards for disposal of HLW; rather, the NWPA defines U.S. policies and assigns responsibilities. The NWPA assigns three agencies responsibility for disposal of HLW:

- The EPA is to set the standards for the disposal;
- The DOE is to develop and operate the mined geologic repository;
- The NRC is to license the repository; and

- The EPA and NRC are to regulate the disposal program (National Research Council, 1995).

Does the NWPA Apply to the Unrecoverable Residue in the SSTs?

If HLW were closed *in situ* at the Hanford Site, would the NWPA be applicable? The DOE's 1987 environmental impact statement (EIS) for the disposal of Hanford defense high-level, transuranic, and tank wastes states that the NWPA does not require that all materials regarded as HLW be disposed in a geologic repository (DOE, 1987, Vol. 1, p. 6.8). The NRC expressed concern about the DOE's 1987 consideration of *in situ* disposal of significant volumes of HLW at the Hanford Site (DOE, 1987, Vol. 5, Record No. 239), and the Natural Resource Defense Council took a strong exception to the DOE position, noting that "Nowhere in this elaborate plan (NWPA) did Congress authorize a single alternative to geologic disposal of HLW." (DOE, 1987, Vol. 5, Record No. 240).

The 1988 DOE Order 5820.2A, which also governs disposal of HLW differentiates between "new and readily retrievable HLW" and HLW that is not readily retrievable, stating that the NWPA applies to the new and readily retrievable HLW and that other HLW may be suitable for on site stabilization. The relevant sections of the DOE Order imply that the NWPA may not apply to all HLW.

In the 1996 final EIS for the Hanford tank waste remediation system (DOE, 1996a, Volume 1, Section 6.1.3) the DOE states that "... DOE does not view disposal (of HLW) in a national repository as being legally required, and DOE intends to determine the appropriate disposition of HLW on a case-by-case basis."

Finally, Sections 8(a), 8(b) and 8(c) of the NWPA seem to imply that disposal of HLW from atomic energy defense at Hanford is exempt from the requirements of the NWPA. Section 8.(a) of the NWPA states:

> ATOMIC ENERGY DEFENSE ACTIVITIES- Subject to the provisions of subsection (c), the provisions of this Act shall not apply with respect to any atomic energy defense activity or to any facility used in conjunction with any such activity.

Under Section 8.(b) the President did not find the need for a defense-only repository, and finally under Section 8.(c):

> APPLICABILITY TO CERTAIN REPOSITORIES - The provisions of this act shall apply with respect to any repository not used exclusively for the disposal of high-level radioactive waste or spent nuclear fuel resulting from atomic energy defense activities, research and development activities of the Secretary, or both.

Therefore, it appears that a "repository" for HLW that is only from atomic energy defense activity is exempt from the requirements of the NWPA. However, the DOE does not raise this defense in any of the above-cited DOE documents and this issue should be further researched before a final conclusion can be drawn.

At this time it is not clear if the NWPA applies to the disposal of all HLW. Even if the NWPA does apply, it is important to remember that the NWPA sets *policy, not disposal standards.* The EPA is responsible for developing standards for disposal of HLW, and the NRC is responsible for writing and enforcing licensing standards for the HLW disposal facility.

EPA Standard for Disposal of HLW

The EPA's general standard for the disposal of HLW is 40 CFR 191, "Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes." In 58 FR 66399, the EPA states: "Although developed primarily through consideration of mined geologic repositories, 40 CFR 191, including today's amendments, applies to disposal of the subject wastes by any method, with three exceptions." The three exceptions are ocean disposal, disposal systems located within 0.25 mile of an underground source of drinking water (subject of future rulemaking), and HLWs disposed before 1985. A fourth exception is that the current version of 40 CFR 191 is not applicable to sites being characterized under Section 113(a) of the NWPA (see 40 CFR 191.11(b)(3)). *40 CFR 191 is the only promulgated, or even proposed, standard for disposal of HLW.*

Could the EPA's 40 CFR 191 be applied to the unrecoverable Hanford tank residue? The simple answer is yes, but the EPA still needs to write the Groundwater Protection Requirements for disposal systems located within 0.25 mile of an underground source of drinking water (see 58 FR 66410 for details). The Containment Requirements, Assurance Requirements, and Individual Protection Requirements of the current version of 40 CFR 191 could be applied to Hanford, only the Groundwater Protection Requirements have yet to be promulgated.

A second issue relates to the link between the current version of 40 CFR 191 and the NWPA. The EPA's 40 CFR 191 is not applicable to sites being characterized under the authority of the NWPA, so if the NWPA governs the disposal of the SSTs residue, the current version of 40 CFR 191 is not applicable. If the NWPA does not govern the disposal of the ancillary equipment, the current version of 40 CFR 191 is applicable (except that the Groundwater Protection Requirements are not in place).

NRC Standard for Licensing HLW Repositories

The NRC's 10 CFR 60 sets forth the NRC *licensing* criteria for "Disposal of High-Level Radioactive Waste in Geologic Repositories." 10 CFR 60 sets rigorous requirements for public involvement, as well as performance objectives, land ownership, siting criteria, design criteria, and license applications. As an example of the NRC's criteria, 10 CFR 60.113(a)(1)(ii)(B) requires that the release rate of any radionuclide from the disposal system following the containment period shall not exceed one part in 100,000 per year.

The NRC's 10 CFR 60 is written specifically for the licensing of the DOE to receive SNF and HLW at a geologic repository "... constructed or operated in accordance with the Nuclear Waste Policy Act of 1982...." Therefore, the NRC's licensing criteria for disposal of HLW *only applies to sites authorized by the NWPA.*

DOE Standard for Disposal of HLW

Because the Hanford ancillary equipment is DOE-titled and located on a DOE facility, Chapter I of Order 5820.2A (DOE, 1988) also governs the disposal of HLW, as follows:

> 2. POLICY. All high-level waste generated by DOE operations shall be safely stored, treated and disposed ... Geologic disposal shall comply with both Nuclear Regulatory Commission regulations and EPA standards...
>
> 3d Disposal. New and readily retrievable waste shall be processed and the high-level waste fraction disposed of in a geologic repository according to the requirements of the Nuclear Waste Policy Act of 1982 (Public Law 97-425) as amended. Options for permanent disposal of other wastes, such as single shell tank waste, shall be evaluated and include such methods as in-place stabilization as well as retrieval and processing, as required for new and readily retrievable waste. Analytical predictions of disposal system performance shall be prepared and incorporated in the National Environmental Policy Act process...
>
> > (2) Other Wastes. .... Options for permanent disposal of singly contained tank waste shall be evaluated and include such methods as in-place stabilization as well as retrieval and reprocessing, as required for new and readily retrievable waste in paragraph 3d(1).

Like the NWPA, the DOE Order does not set standards for disposal; rather, the Order requires compliance with the existing legal structure. Note that the DOE Order makes a policy statement that defines different disposal options for HLW where (1) new and readily retrievable HLW will be disposed in a deep geologic repository in accordance with the NWPA, and (2) HLW that is not readily retrievable shall be evaluated for in-place stabilization as well as retrieval and reprocessing.

Proposed DOE Standard for Disposal of HLW

As previously discussed, DOE Order 435.1 has been proposed, and, once finalized, it will replace the existing DOE Order 5820.2A. The July 31, 1998 version of Order 435.1 consists of three levels or tiers. At the top is the actual Order (DOE O 435.1), which requires (1) compliance with applicable Federal, State, and local laws; (2) compliance with applicable DOE Orders; and (3) compliance with DOE M 435.1 "Radioactive Waste Management Manual." Order 435.1 does not apply to facilities licensed by the NRC or to the geologic disposal of HLW.

The Radioactive Waste Management Manual (DOE M 435.1) is the second of the three tiers, and is similar to the current DOE Order 5820.2A. Chapter II of DOE M 435.1 addresses the management of HLW and incidental waste (incidental waste is discussed below). The third tier is an Implementation Guide (DOE G 435.1), which is divided into four chapters, with Chapter II addressing HLW.

Because of the limited scope of this regulatory review, and the dynamic nature of the draft Order, the impacts of DOE 435.1 have not been researched in detail. Based on a cursory review, three issues are relevant. First, the draft order offers two – and only two – options for management of HLW: manage as HLW or reclassify the low activity waste fraction as incidental waste. There is no option in the draft order to negotiate with the NRC in situations where neither HLW nor incidental waste are appropriate. Second, the existing DOE policy statement in Order 5820.2A separating "new and readily retrievable HLW" from HLW that is not readily retrievable has been eliminated. Text in the current version of DOE G 435.1 II.B. indicates DOE's expectation that wastes which are not readily retrievable will be classified as incidental waste. Third, the current draft of DOE G 435.1 II.B. states that if the classification of a waste as incidental waste is clear, then DOE can make the determination without NRC concurrence. However, "the NRC expects the DOE to consult with them for those waste streams that the DOE has some question of whether the waste is high-level waste [or incidental waste]."

4.4.3 Incidental Waste

Because HLW is defined by origin and not by content, must all the waste be managed as HLW? Not necessarily, because the low activity waste (LAW) generated incidental to the further treatment of HLW could possibly remain on site and be disposed as if it were LLW. The NRC states that "incidental wastes generated in further treatment of HLW (e.g., salt residues or miscellaneous trash from waste glass processing) would be outside the... [legal definition] ...of HLW" (58 FR 12343).

The Savannah River Site (SRS) has used the concept of incidental waste to support its closure efforts for Tanks 17 and 20 (Shyr and Bustard, 1997). The incidental waste approach has also been used at Hanford to facilitate on site disposal of the LAW fraction from the treatment of Hanford tank waste.

The concept of incidental waste is almost 30 years old. In the June 3, 1969 Federal Register (34 FR 8712), the Atomic Energy Commission (AEC) discusses closure of nuclear fuel reprocessing plants (recall that HLW is generated as a result of the reprocessing of nuclear fuel). The AEC noted that the term HLW did not include "incidental wastes" resulting from (spent nuclear fuel) reprocessing plant operations. Unfortunately, the note that "incidental wastes" would be outside of the legal definition of HLW was not included in the legal definition of HLW which was released on November 14, 1970 (35 FR 17533). However, in that same 1970 Federal Register, the AEC did state that the reprocessing plant, (which would contain residual HLW) would not be managed as HLW and that the requirements for the D&D of the reprocessing plant would be developed later:

> Viewed from the perspective that each generation is trustee of the environment for succeeding generations, the Commission considers that the public interests requires that *a high-degree of decontamination* capabilities be included in such facilities and that any residual radioactive contamination after decommissioning be *sufficiently low as not to present a hazard to the public health* and safety. Specific requirements for decontamination and decommissioning of fuel reprocessing facilities will be developed in consultation with competent groups. (*emphasis added*)

These same underlying criteria (a high degree of decontamination capabilities and concentrations sufficiently low as not to present a hazard to the public health) continue to be used today as the underlying basis for separating HLW from incidental waste.

Incidental waste is not a "category" of radioactive waste; rather, incidental waste is a concept that the AEC and the NRC have used to separate HLW from the LAW fraction generated during the further treatment of HLW. Incidental waste is defined by both origin and characteristics. If the LAW fraction of HLW has the characteristics of LLW, then the LAW fraction may be classify as incidental waste, which is not subject to NRC licensing and which DOE can manage as either DOE titled LLW or DOE titled transuranic waste .

4.4.3.1 Separating Incidental Waste from HLW

The quantitative boundary between HLW and incidental waste was initially defined by the NRC as the result of concerns raised about the amount of radioactivity that would be disposed at Hanford in near-surface grout vaults. The DOE planned to treat liquid HLW waste from the tanks, vitrify the high-level fraction for eventual disposal in a geologic repository, treat the LAW fractions by mixing them with a cement-like grout, and dispose of the incidental waste in near-surface vaults (Report on Defense Plant Wastes, 1990).

A petition sent by Washington State, Oregon State, and the Yakama Indian Nation asked the NRC to change the definition of HLW so that the NRC would regulate the Hanford incidental waste fraction from the treatment facility destined for the grout vaults. The states and tribe petitioned because of their concern that DOE was not doing all it could to separate HLW radionuclides from the incidental fraction prior to on site disposal. The petition was specific to the treatment facility and the waste stream proposed for the grout vaults.

In the petition, the NRC was asked to adopt a rule classifying all wastes in the tanks as HLW unless the NRC determines, on a case-by-case basis, that (1) the DOE has eliminated as much radioactivity from the material to be grouted as "technically feasible" and (2) the NRC would oversee the pretreatment process and several other requirements.

In response to the petition, the NRC defined a set of three tests to determine if a LAW stream is incidental waste (58 FR 12345):

> The basis for the Commission's conclusion is that the reprocessing wastes disposed of in the grout facility would be "incidental" wastes because of DOE's assurances that:
>
> - the HLW has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical;
> - the incidental wastes 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 as set out in 10 CFR part 61; and

- the incidental 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 part 61 are satisfied.

In this report, these three tests are identified as the Incidental Waste Criteria. These same criteria were presented in a letter dated March 2, 1993 from R. Bernero of the NRC to J. Lytle of the DOE. The letter is discussed later in this report.

Incidental waste is defined by policy, not regulation; there are still some stakeholder concerns that the NRC cannot use a policy statement to redefine or reclassify HLW. However, the AEC's intent to separate incidental waste from HLW is clearly expressed in the 1969 Federal Register and has been reinforced by various NRC actions over the past 20 years.

The three Incidental Waste Criteria were originally developed for evaluating a waste stream from an HLW treatment facility. Recently, the SRS and the NRC have applied this concept to closure of unretrievable holdup in the SRS's Tanks 17 and 20. This report suggests application of these same criteria to the holdup in the ancillary equipment to determined if ancillary equipment should be managed as incidental waste or as HLW.

4.4.3.2 Previous Use of Incidental Waste Concept at Hanford

On three occasions, the NRC has provisionally agreed that the LAW fraction from a treatment facility for Hanford tank waste meets the criteria for incidental waste, is not HLW, and is not subject to NRC licensing. With the NRC's agreement that a LAW meets the Incidental Waste Criteria, the LAW is then classified as incidental waste, which can be managed as if it were LLW (for further clarification, see the definition of LAW in the Definitions section of this report).

Shortly after the completion of the DOE EIS for the disposal of Hanford defense high-level, transuranic, and tank wastes (DOE, 1987), DOE and NRC staff met to discuss the preferred alternative proposed in the EIS. That preferred alternative was to treat the wastes retrieved from the DSTs and to dispose of the LAW fraction from the treatment facility as grout in near-surface vaults. The NRC provisionally agreed that the LAW fraction from the treatment facility would not be HLW subject to NRC licensing. The NRC further suggested that if DOE could demonstrate that at least 90% (the largest practical amount) of first-cycle solvent extraction wastes had been removed, the NRC would concur that the LAW would not be subject to NRC licensing and could be disposed in the near-surface vaults (November 29, 1988 letter from Michael Bell of the NRC to Ronald Gerton of the DOE Richland Area Office (DOE/RL); see p. A-7 of Westinghouse Hanford Company [WHC] 1996a).

However, stakeholder concerns resulted in a petition sent by Washington State, Oregon State, and the Yakama Indian Nation to the NRC. The petition requested that the NRC change the definition of HLW so that the NRC would regulate the LAW fraction (the incidental waste) from the Hanford treatment facility. The NRC denied the petition and again concluded that the LAW fraction was incidental waste. The petitional denial includes the three criteria used by the NRC at Hanford to determine if the LAW fraction is incidental waste.

Subsequently, DOE/RL made three major changes to its strategy for management of tank waste. First, concerns about the stability of grout resulted in the decision to vitrify the LAW fraction (instead of making grout); second, DOE treatment facilities will be privatized; third, retrievable wastes from the SSTs and the DSTs will be treated in the treatment facility to separate the HLW and LAW fractions.

Reflecting these three changes in the strategy, DOE/RL requested NRC agreement that Hanford tank waste planned for on site disposal as vitrified waste would be incidental waste and therefore not subject to NRC licensing. DOE/RL based their November 7, 1996 request on two reports: "Technical Basis for Classification of Low-Activity Waste Fraction from Hanford Tanks," (WHC, 1996) and "Hanford Low-Level Tank Waste Interim Performance Assessment" (Mann et al., 1996).

In a letter dated June 9, 1997, the NRC responded to the DOE/RL request of November 7, 1996. Although this NRC letter addresses the LAW fraction from the treatment facility, there are several pieces of information that are relevant to closure of the ancillary equipment, specifically:

> ... Low-Activity Waste (LAW) meets the incidental waste classification criteria specified in the March 2, 1993 letter from R. Bernero, NRC to J. Lytle, U.S. Department of Energy. (Letter dated June 9, 1997)

The criteria in the Lytle letter are identical to the Incidental Waste Criteria presented in 58 FR 12345 and in this report. Therefore, the three criteria presented in 58 FR 12345 continue to be the criteria used to determine if a waste is incidental or high-level.

> ... the staff's preliminary finding is a provisional agreement that the LAW portion of the Hanford tank waste planned for removal from the tanks and disposed on site is incidental waste and is, therefore, not subject to NRC licensing authority. Staff considers that the information presented is not sufficient to make an absolute determination at this time. (Letter dated June 9, 1997)

The NRC provisionally agreed with the DOE/RL proposal of November 7, 1996. The acceptance is provisional because much of the information presented to the NRC is draft or generic (e.g., the DOE has not selected an on site disposal configuration for the LAW). Also, the NRC accepts the format of the Technical Basis Report:

> Approximately 8.5 MCi of activity will remain in the LAW fraction, which corresponds to about 2% of the estimated 422 MCi generated at the Hanford site (based on a December 31, 1999 decay date).

Early discussions of the criteria for incidental wastes were based, in part, on percentage removal (e.g., if 90% were removed, the remaining fraction might be incidental waste). Current criteria for incidental waste do not specifically set a limit on the percentage of curies that must be removed; however, as this statement reflects, percentage removal is still a secondary consideration:

> The DOE PA was performed to the requirements of DOE Order 5820.2A, "Radioactive Waste Management," September 26, 1988. This Order is similar to the 10 CFR Part 61 performance objectives.

Importantly, the NRC agrees that the requirements of DOE Order 5820.2A, Chapter III (as interpreted by Mann et al.) are comparable to the requirements set out in 10 CFR 61:

> Please submit future PAs as supplements to the Technical Basis Report so that they can be reviewed to confirm the current analysis and resolve any outstanding issues.

Finally, the NRC plans to take an active role in "reviewing" the DOE LLW PAs for on site disposal of incidental waste.

4.4.3.4 Previous Use of Incidental Waste Concept at Savannah River

The SRS recently used the concept of incidental waste to close two tanks that had been used for storage of mixed HLW. SRS's Tanks 17 and 20 were closed by stabilizing the unretrievable residue in place with grout. The process used by the SRS to solidify the residual tank waste in Tank 20 was described in Shyr and Bustard (June 1997). The NRC is currently reviewing the closure of these tanks to determine if the wastes that remain after closure meet the incidental waste criteria.

In a letter dated June 30, 1998, the NRC requested additional information regarding tank closure and classification of the residual waste as "incidental." A complete analysis of the NRC's nine page information request is beyond the scope of this report. A few important observations are that: (a) the NRC is proceeding with the use of the incidental waste concept for in place closure of unretrievable tank residue; (b) the NRC is using the three incidental waste criteria as a means of separating HLW from incidental waste; (c) the NRC is requiring detailed documentation to support the incidental waste determination and (d) the NRC is placing a heavy emphasis on the assumptions used by the NRC in the early 1980's to develop the Class C limits. The greatest significance of the June 30, 1998 letter is that the NRC is using the incidental waste concept for closure of intank residue, and there does not seem to be a fundamental reason why the incidental waste concept could not be applied to holdup in ancillary equipment.

4.4.4 Low-Level Waste

The NWPA defines LLW as "radioactive material that (a) is not high-level, spent nuclear fuel, transuranic waste or by-product materials as defined in section 11e(2) of the Atomic Energy Act of 1954; (b) the Commission (the NRC), consistent with existing law, classifies as low-level radioactive waste." *LLW is defined by what it is not* (it is not HLW, SNF, TRU, or byproduct material). The NWPA also grants the NRC the authority to classify other wastes as LLW. Although the title implies that LLW is not very radioactive, there is no quantitative upper limit. Some very radioactive wastes (e.g., excess cobalt sources) are legally classified as LLW.

The EPA has the authority to set standards for disposal of LLW; however, the EPA has yet to finalize 40 CFR 193 as the general disposal standard for LLW. Therefore, this paper addresses only the DOE and NRC standards for LLW disposal.

DOE Standards for Disposal of LLW after 1988

The DOE sets and enforces its own standards for disposal of LLW from "atomic energy defense activities." The DOE standards are contained in Chapter III of DOE Order 5820.2A. The DOE standards for disposal of LLW are only applicable to LLW disposed after the effective date of DOE Order 5820.2A, which is September 26, 1988. Paragraph 3(a) of Chapter III states that DOE LLW shall be disposed in a manner that meets four criteria:

1. Protect public health and safety in *accordance with standards* specified in applicable EH Orders and other *DOE Orders.*

2. Assure that external exposure to the waste and concentrations of radioactive material which may be released into surface water, groundwater, soil, plants, and animals results in an effective dose equivalent that does not exceed *25 mrem/yr to any member of the public. Releases to the atmosphere shall meet the requirements of 40 CFR 61.* Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

3. Assure that the committed effective dose equivalents received by individuals who inadvertently may intrude into the facility after the loss of active institutional control (100 years) will not exceed *100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure.*

4. Protect *groundwater resources, consistent with Federal, State, and local requirements. (emphasis added)*

In summary, the DOE Order sets standards to protect the MOP, the IHI, and groundwater resources. Compliance with the DOE Order is demonstrated through a *site-specific study or* performance assessment (PA). Sometimes, DOE facilities ship LLW to NRC-licensed facilities for disposal, in which case the DOE generators must meet the NRC facility-specific waste acceptance criteria.

The Order also requires that doses shall be ALARA. ALARA analysis is an optimization: Are there cost-effective actions that can be taken to reduce projected doses even further? For example, would burial of the waste in a different, and more expensive, container reduce the projected doses to the MOP, and is the extra cost justified by the reduced doses?

Many important performance objectives are not defined in the Order. For example, the time frame of compliance is not specified. This problem was recognized and DOE/HQ/EM-35 established a Performance Assessment Task Team (PATT) to integrate the activities of the DOE facilities that are preparing PAs for the disposal of new LLW as required by Chapter III of the

Order. The PATT guidance is documented in Wood et al. (1994). The time frame of compliance is also discussed at some length in Wood et al. (1994), which recommends using a 10,000-year compliance period. The PA (Mann et al., 1996), which supported the November 7, 1996 Hanford request for incidental waste classification, used a 10,000-year time frame of compliance. For commercial LLW, the NRC guidance recommends a 10,000-year time frame for the PA (NRC, 1997a, p. 3-11).

Under a cover memorandum dated October 31, 1996, the DOE issued more recent guidance on the interpretation of the requirements of Chapter III of DOE Order 5820.2A. This guidance, *Interim Content and Format Guide and Standard Review Plan for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments*, suggests the use of a 1,000-year compliance time frame.

DOE guidance found in Wood et al. (1994, p. 21) and the more recent DOE guidance develop the idea of a buffer zone separating the hypothetical MOP from the disposal site. Therefore, the typical point of compliance for protection of the MOP and groundwater resources is the boundary of a buffer zone around the LLW disposal facility. The concept of a buffer around a LLW disposal facility is also endorsed in the NRC guidance (NRC, 1997a).

DOE Standards for LLW Disposed before 1988

The DOE requirements for disposal of LLW (contained in Chapter III of DOE Order 5820.2A) are only applicable to LLW disposed after 1988. An external oversight board found that the DOE should assess the possible impact to human health from both pre- and post-1988 LLW. In the May 31, 1995 memorandum titled "Inclusion of Pre-1988 Source Term and Other Sources of Radioactive Contamination in Low-Level Waste Disposal Facility Performance Assessments," Jill Lytle (then DOE Deputy Assistant Secretary for Waste Management) committed the DOE to preparing all-source-terms "composite analyses." Guidance for preparation of the composite analyses was issued under an April 30, 1996 cover memorandum *Guidance for a Composite Analysis of the Impact of Interacting Source Terms on the Radiological Protection of the Public from DOE LLW Disposal Facilities,* from James Owendoff, DOE Deputy Assistant Secretary for Environmental Restoration (ER) and Stephen Cowan, DOE Deputy Assistant Secretary for Waste Management.

The standards for the composite analyses are similar to the standards for disposal of post-1988 LLW, with four major exceptions:

1. the source term for the composite analysis includes all sources of radioactive contamination that could interact to affect the dose to the MOP (not just the post-1988 LLW);
2. the dose limit for the MOP is 100 mrem/yr (not 25 mrem/yr);
3. there is no requirement to protect the IHI; and
4. the point of compliance is a future DOE land use boundary, not the 100-m boundary typically assumed for post-1988 LLW (the DOE 1996 guidance is vague on this important topic, deferring to each DOE facility to defend a future land use boundary).

Like the DOE standard for post-1988 LLW, the DOE requirements for a composite analysis require the protection of groundwater resources consistent with state and federal standards. In summary, DOE LLW disposal facilities must complete a PA for post-1988 LLW and a composite analysis for all interacting sources of radioactive contamination where the standards for pre- and post-1988 LLW disposal are different. A composite analysis is currently being completed for the Hanford 200 Areas.

Proposed DOE Standard for Disposal of LLW

As previously discussed, DOE Order 435.1 has been proposed, and, once finalized, it will replace the first four chapters of existing DOE Order 5820.2A (the fifth chapter of DOE Order 5820.2A will be replaced by DOE Order 430.1). Due to the limited scope of this review, the impacts of the implementation of proposed DOE Order 435.1 were not assessed.

NRC Standards

The NRC sets and enforces standards for disposal of LLW from commercial facilities (e.g., hospitals and power reactors). The NRC licensing and disposal standards are contained in 10 CFR 61. As allowed by Section 274 of the AEA, the NRC also grants authority to "Agreement States" to regulate commercial LLW disposal facilities.

The NRC's 10 CFR 61 sets standards to protect the MOP, the IHI, and workers, as well as standards for long-term site stability. The NRC's dose-based standards to protect the MOP are similar to the DOE's dose-based standards to protect the MOP. The NRC standards, like the DOE standards, require a site-specific analysis or PA to demonstrate protection of the MOP.

To protect the IHI, the NRC and DOE have taken different approaches. The DOE demonstrates protection of the IHI through a *site-specific* PA, using a 100-mrem/year chronic dose standard and a 500-mrem acute dose standard. The NRC demonstrates protection of the IHI through an analysis of a generic disposal site, using a 500-mrem acute and chronic dose standard. Based on the generic analysis, the NRC divides LLW into four classes and sets different disposal requirements for each of the four classes. These classes of LLW are Class A, Class B, Class C, and Greater-Than-Class-C (GTCC). GTCC LLWs are typically inappropriate for shallow land burial; therefore, the Class C limits take on a special significance.

Site-Specific Class C Limits

In addition to setting generic class limits, the NRC also allows for the development of site-specific Class C limits. The NRC " ... may, upon request, or on its own initiative, authorize other provisions for the classification and characteristics of wastes on a special case 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 this part" (emphasis added, 10 CFR 61.58). The DOE has always developed site-specific limits that protect the IHI. Deriving site-specific Class C limits for Hanford Site would be no different, except that the analysis may have to be presented in the format that the NRC used to develop the existing Class C limits. Cochran and Shyr (1997) describe the intrusion models and parameter values used by the NRC in deriving the 10 CFR 61 Class C limits and proposed parameter values for deriving Hanford site-specific Class C limits. By acknowledging site-specific factors at Hanford, the proposed site-specific Class C limits are more liberal than the generic Class C limits, while still being protective of the IHI.

4.5 Regulations Governing Hazardous/Dangerous Waste

4.5.1 Introduction

The ancillary equipment is assumed to be contaminated with mixed waste, meaning the waste has characteristics which require compliance with regulations governing both radioactive waste and hazardous waste. The two previous sections of this report reviewed the requirements for management of radioactively contaminated equipment (Section 4.3) and requirements governing disposal of radioactive waste (Section 4.4).

At the Hanford Site, hazardous waste cleanup and disposal are regulated under three broad legal authorities; CERCLA, RCRA, and the state dangerous waste (DW) program. The Hanford TPA is the overarching agreement that assigns CERCLA, RCRA, and state DW program authorities to various sources of contamination. CERCLA, RCRA, and the state DW program overlap in many areas.

In general, CERCLA was created by Congress to respond to releases and potential releases of hazardous substances from past-practice activities. CERCLA provides the EPA with broad regulatory authority.

RCRA was enacted by Congress to provide for the "cradle to grave" management of hazardous waste by all generators, transporters, and owners/operators of treatment, storage, and disposal (TSD) facilities. Ecology has the authority to carry out the RCRA program in Washington State through its own DW management program. Washington State regulations for DW management are substantially similar to, but in some cases more restrictive than, the RCRA regulations.

In 1984, RCRA was amended by the Hazardous and Solid Waste Amendments (HSWA). HSWA provides for corrective action for releases at RCRA facilities, regardless of the time of release. This HSWA authority is similar to, but not as broad as, the EPA's CERCLA authority. The State of Washington has also received authorization to carry out a portion of the HSWA, including corrective actions. For that portion, Ecology's authorized program operates in lieu of the federal requirements. However, some HSWA provisions are yet to be delegated to the state, and the EPA retains authority to implement those provisions. The TPA assigns CERCLA, RCRA, and state DW program authorities to various sources of contamination.

Four physical closure options are being considered for closure of the contaminated ancillary equipment. Two options involve in-place closure and two the options involve excavation of the equipment and redisposal. Therefore, this section of the regulatory review is divided into the following subsections:

- the TPA (4.5.2);
- RCRA/State RCRA Requirements for In-Place Closure (Section 4.5.3);
- RCRA/State RCRA to Requirements to Excavate and Rebury (Section 4.5.4); and
- CERCLA (Section 4.5.5).

Excavation and reburial in an SST would require the use of an SST as a land disposal unit. The regulations set very stringent standards for new land disposal units (i.e., landfills). These standards include adherence to land disposal restrictions (LDRs) and minimum technological requirements for land disposal facilities (e.g., a double liner, leachate collection system and monitoring). There may be some relief for some of these requirements, as discussed in Section 4.5.4.4.

The regulations governing hazardous waste cleanup and disposal are very complicated. This report provides only a limited overview, and most statements made in this section are not referenced for independent verification. These sections on hazardous waste regulations draw heavily on three references: Government Accounting Office (1997), Jacobs Engineering Group (1998), and Rosenthal (1997). In some cases, text was borrowed directly from these references.

4.5.2 Tri-Party Agreement

Under the TPA, the agencies have determined that the tank farms will be closed under the DW regulations under interim status. Milestone M-45-00 requires that all units within a tank farm boundary be closed as single TSD units under WAC 173-303-610. Under WAC 173-303-610, the baseline planning for closure is to demonstrate the ability of the DOE to close tank farms under clean-closure. If the tank farms cannot be clean-closed, the DOE would close the tank farms as landfills or under modified closure, provided for in the Hanford Site RCRA permit.

4.5.3 RCRA/State RCRA for In-Place Closure

This section reviews the hazardous waste regulations that may be applicable to closing the ancillary equipment in place. Tank farm closure requirements are linked with the concept of "debris," which is presented before discussing closure requirements.

<u>Debris</u>

Debris is solid material exceeding a 60 mm particle size that is intended for disposal and that is either (1) a manufactured object, (2) plant or animal matter, or (3) natural geologic material. Structures and equipment that will be demolished or are intended for discard may be debris; therefore, the ancillary equipment (although it may not be destined for demolition) would nevertheless be intended for discard in place. Process residuals are not considered to be debris by Ecology.

Under the Hazardous Debris Rule, debris contaminated with a listed hazardous waste or exhibiting the characteristic of a hazardous waste may be treated using one of three types of treatment technologies. These technologies are extraction technologies (i.e., physical, chemical, or thermal), destruction technologies (i.e., biological, chemical, or thermal), or immobilization technologies (i.e., microencapsulation, microencapsulation, or sealing).

If an extraction technology (e.g., high-pressure water spray) is used to achieve a "clean debris surface," then the debris would no longer need to be managed as a hazardous waste. The legal definition of "clean debris surface" is provided in the Definitions section of this report, and meeting such a standard would be very difficult. If debris are decontaminated using an immobilization technology (e.g., grouting), the ancillary equipment is still subject to hazardous waste standards (e.g., must be at a RCRA-permitted facility, postclosure care, etc.). Ecology does not require use of the Hazardous Debris Rule to achieve decontamination, and will consider proposals for other decontamination methods or other performance standards for Hazardous Debris Rule treatment methods. Such proposals are required to include information demonstrating (1) compliance with the general closure performance standards; (2) compliance with federal, state, and local requirements; and (3) protection of human health and the environment.

Model Toxics Control Act

The Model Toxics Control Act (MTCA) can be used to define hazardous waste cleanup levels, points of compliance, and additional site-specific requirements for contaminated media. Three options for levels of cleanup exist within the MTCA: Method A; Method B; and Method C.

Method A requires cleanup to background levels. Method B requires cleanup to levels that would not result in unacceptable health risks, assuming a residential farmer exposure scenario; in some circumstances, Method B could be applied to the upper 15 feet of soil, with monitoring and limited postclosure care of the contaminated parts of the system (e.g., the soil below 15 feet). Method B uses 10^{-6} for individual carcinogens and 10^{-5} for multiple carcinogens (WAC 173-340). Method C is based on an industrial land use exposure scenario. Method C health risk levels are based on an incremental lifetime cancer risk of 10^{-5} for individual carcinogens and for multiple carcinogens or pathways. Method C equations use frequency of contact and rates of ingestion that are one-half the values used under MTCA Method B.

General Federal Closure Regulations

Under the TPA, the tank farms are TSD units that will be closed under state DW regulations (WAC 173-303). The DW regulations found under WAC 173-303 implement RCRA in Washington State. Three options exist for closure of the tank farms. Two of the options, clean closure and landfill closure, are defined in federal and state regulations (40 CFR 264.197 and WAC 173-303-640). The third option, modified closure, is defined in the Hanford RCRA Permit. Technical analyses will be required to determine which of these closure options is achievable.

Clean Closure - Clean closure will require removal of the contaminants until natural background levels are achieved, or until risk-based standards are achieved, or until decontamination standards are met.

For defining decontamination-based clean closure, Ecology will use methods provided in the Hazardous Debris Rule or alternative performance standards approved by Ecology. Clean closure could possibly be achieved by extraction, destruction, or immobilization. Decontamination of the equipment using an immobilization technology (e.g., grouting) will not relieve the closure system from compliance with the postclosure care requirements.

Ecology may use MTCA to define risk-based cleanup levels for contaminated media. Under MTCA, clean closure uses background levels or residential exposure standards as measures for acceptance, and the analysis is performed on a case-by-case basis. This would be a very difficult standard to meet.

Modified closure - The concept of modified closure is unique to Hanford and is found in Section II.K of the Hanford RCRA Permit. It appears to allow contaminated media to meet less stringent cleanup standards with postclosure care if the unit itself meets clean closure standards. Modified closure for the tank farms can be achieved if the tanks and ancillary equipment obtain clean closure and the soil and groundwater obtain MTCA Method C requirements (Rosenthal, 1997).

Landfill Closure - Closure as a landfill typically involves leaving some waste in place with corrective action taken for contaminated soil and groundwater performed under postclosure requirements. This type of closure usually involves the construction of a low-permeability cover over the contaminated media to reduce water infiltration and prevent inadvertent human intrusion and a long-term groundwater monitoring program under postclosure (typically 30 years).

Landfill Cover Requirements

If waste remains in place after closure, the owner must construct a RCRA-compliant cap. Landfill closure requirements require a cover designed and constructed to:

(1) provide long-term minimization of liquid migration through the closed landfill,

(2) function with minimum maintenance,

(3) promote drainage and minimize erosion or abrasion of the cover,

(4) accommodate settling and subsidence so the cover's integrity is maintained.

(5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoil present.

Postclosure Care

If waste remains in place after closure, the owner must comply with the postclosure care requirements contained in WAC. Postclosure care must be maintained for 30 years (which can be modified by Ecology) and a notice must be placed in the deed that restricts land usage and the types and locations of hazardous wastes disposed in the landfill. Additionally, the owner and operator must "maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of WAC 173-303-645," which regulates releases from regulated units and requires implementation of corrective actions if releases exceed levels established in the closure permit.

Licensing of Treatment Processes

Approval from Ecology and possibly the EPA would be needed if the decision is made to clean the ancillary equipment in place and then use an "immobilization" technology (e.g., grouting). Importantly, treatment in place should not be interpreted as "placement or disposal."

Other Issues

Two other issues should be considered. First, given the large inventory of buried, contaminated ancillary equipment, clean closure seems unlikely (although DOE must demonstrate that clean closure is not feasible). Therefore, the ancillary equipment will probably be closed under modified closure or landfill closure. A site-specific analysis will be required to determine if the ancillary equipment can be closed under MTCA Methods B or C or if some of the equipment will need to be removed to meet closure standards. Second, the unretrievable residue in the SSTs and contaminated soil may dominate the closure decisions. For example, if the contaminated soil in the AX Tank Farm cannot be practically retrieved and the AX Tank Farm must be closed as a landfill, there is little incentive to clean-close the ancillary equipment.

4.5.4 RCRA/State RCRA to Excavate and Rebury

4.5.4.1 Introduction

Excavation of the ancillary equipment and disposal on site in an empty SST is one of the four closure options being considered for the ancillary equipment. This section address the requirements to excavate the equipment and then rebury the equipment on site in an empty SST.

RCRA allows placement of hazardous wastes in tanks and vaults for purposes of disposal, provided the unit meets current landfill standards. Because of the problems associated with many old land disposal units, the standards for construction and operation of new land disposal units are more stringent.

4.5.4.2 Minimum Technological Requirements

RCRA establishes design and operating specifications, known as minimum technological requirements (MTRs), for facilities such as incinerators and landfills that either treat or dispose of hazardous waste. The Federal MTRs for closure of a hazardous waste landfill require (1) two or more liners, (2) a leachate collection system, (3) a groundwater monitoring system, and (4) postclosure care and monitoring. Ecology uses a slightly different approach than MTRs. Ecology employs a "best management practice" approach (WAC 173-303-140) and tiers everything using this philosophy. Retrofitting an old SST to meet these MTRs could be very difficult.

4.5.4.3 Land Disposal Restrictions

LDRs are requirements that must be met prior to the land disposal of hazardous waste. For a "characteristic waste," a closure decision is based on concentration (e.g., vinyl chloride cannot be disposed in concentrations in excess of 6 mg/kg). For a "listed waste," the LDR treatment standard is technology-based (e.g., prior to disposal, HLW must be vitrified). For listed waste, the hazard must be treated using the technology specified, and even through the hazard has been treated it must still be disposed in a RCRA approved landfill (i.e., does not exit RCRA). There are both federal and state LDRs.

The EPA has generally set its LDR treatment standards at concentration levels that could be attained if the *best demonstrated available technology* were used to treat the contamination. Using the best demonstrated technology available is typically costly. Additionally, wastes treated to LDRs must be disposed in a land disposal unit meeting MTRs.

The federal treatment standard for hazardous debris is found in 40 CFR 268.45. Hazardous debris must be treated for each "contaminant subject to treatment" or using the technologies list in Table 1 of 40 CFR 268.45. If debris is contaminated with a listed hazardous waste, the debris must be treated to the same standard as that of the listed hazardous waste (i.e., treated to the 40 CFR 268.40 standards), or the debris can be treated by extraction, destruction, or immobilization.

HLW is a "listed waste" identified in 40 CFR 268.40, and the technology-based treatment standard is "vitrified in units in compliance with applicable radiation protection requirements under control of the NRC." Even if the ancillary equipment is not HLW, the ancillary equipment may also be a "characteristic" RCRA hazardous waste (which is also subject to LDRs).

In the federal system, LDRs do not have to be met if wastes were placed on land before the EPA established the LDRs, unless the waste is removed and disposed of again. If the excavated ancillary equipment is a RCRA hazardous waste, then LDRs must be met prior to redisposal. It is the authors' understanding that Ecology has taken the position that LDRs are not subject to a clock; therefore Ecology could require that LDRs be met prior to in-place closure. This issue should be discussed with Ecology as it will greatly influence the closure process.

4.5.4.4 Other Considerations

4.5.4.4.1 Hanford Tri-Party Agreement

TPA Milestone M-45-00 offers the following clause, which could provide some relief from the onsite application of LDRs and MTRs.

In evaluating closure options for single-shell tanks, contaminated soil, and ancillary equipment, Ecology and EPA will consider cost, technical practicability, and potential exposure to radiation.

4.5.4.4.2 Corrective Action Management Unit

The EPA's corrective action management unit (CAMU) rule offers significant latitude for certain RCRA corrective actions. Under this rule, wastes can be excavated, moved, permanently treated, or disposed within a defined onsite area if certain site-specific design and operating requirements are met. Closure operations conducted within a CAMU are not subject to LDRs or MTRs.

A permit to use a CAMU must be obtained. At the federal level, the use of CAMUs may not be possible because in 1993 some stakeholders, including the Environmental Defense Fund, filed a lawsuit questioning whether the EPA has authority to exempt hazardous waste from LDRs and MTRs. However, WAC 173-303-646 retains the option of designating a CAMU. Designation of a tank farm as a CAMU would allow wastes to be managed on site without triggering LDRs or MTRs.

4.5.4.4.3 Delisting and "Contained Out"

The DOE could petition to delist specific wastes from the RCRA system. Such a petition would be required at both the Federal and State levels. Such a petition would also have to justify why the wastes do not require management under RCRA (which would difficult to justify). In a similar line of reasoning, recognizing that at some concentration levels the contaminated media no longer pose a hazard to health or the environment, the EPA has allowed its regions and states to exclude, or "contain out," such media from RCRA's regulation on a case-by-case basis. The "contained out" decision would also have to be based on the argument that the waste does not pose a risk to human health. Delisting and "contained" out would exempt wastes from LDRs and the use of RCRA-licensed land disposal units. Considering the nature of the contaminated equipment, delisting the wastes or requesting a "contained out" exemption may not be possible.

4.5.4.4.4 Exemptions from Land Disposal Restrictions

If excavated, some of the ancillary equipment maybe subjected to LDRs prior to disposal (either redisposal in an SST or disposal outside the AX Tank Farm in a RCRA-licensed facility). If direct compliance with a given LDR is not desirable, there are a number of regulatory options for demonstrating compliance with the intent of LDRs:

- demonstrate that the waste will not migrate (a no-migration petition);
- if the LDR is concentration-based, a second option is to demonstrate that another method of treatment provides the same level of protection (a treatability variance);
- if the LDR is technology-based, a third option is to demonstrate that an equivalent technology performs as well as the required treatment technology;

- as discussed in this report, a fourth option would be onsite disposal in a designated RCRA CAMU (as allowed under WAC 173-303-646);
- for *state-only* DW LDRs, a person may petition Ecology for an exemption by demonstrating that compliance with LDRs will impose an unreasonable economic burden in relation to the hazard to public health and the environment (WAC 173-303-140); and finally
- if compliance with LDRs causes very high worker doses, which is in conflict with AEA requirements, then the AEA requirements for low doses to worker would supersede the RCRA requirements to meet LDRs (this option is discussed below).

A full review of these options is beyond the scope of this regulatory review.

4.5.5 CERCLA

CERCLA, also referred to as "Superfund," was enacted by Congress in 1980. Its purpose is to provide both funding and enforcement authority to address abandoned hazardous waste sites and other sites where hazardous substances are being released. The EPA has been given authority for carrying out the provisions of CERCLA. A key element for application of CERCLA is the listing of a site on the NPL. On November 3, 1989, four areas of the Hanford Site were officially listed on the NPL.

Under its CERCLA authority, the EPA entered into the Hanford TPA as a means of expediting the cleanup of the Hanford Site and clarifying the roles of the three parties. Under the TPA, Ecology will close the tank farms as RCRA TSD units under WAC 173-303-610. The AX Tank Farm is contaminated with radioactive waste and the EPA, under CERCLA, has regulatory authority to address releases of radioactive wastes from atomic energy defense activities. One source of information concerning the EPA standards for closure is found in the recent EPA guidance on "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination." This guidance was issued as OSWER No. 9200.4-18, Memorandum of August 22, 1997 from Stephen Luftig, director of EPA Office of Emergency and Remedial Response and Larry Weinstock, Acting Director of EPA Office of Radiation and Indoor Air:

> ARARs are often the determining factor in establishing cleanup levels at CERCLA sites. However, where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: 1) carcinogens at a level that represents an excess upper bound life-time cancer risk to an individual of between 10^{-4} and 10^{-6}; ... (40 CFR 300.430(e)(2)(i)(A)(2))... The site-specific level of cleanup is determined using the nine criteria specified in Section 300.430(e)(9)(iii) of the NCP... *Cancer risk from both radiological and non-radiological contaminants should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants...* Cleanup should generally achieve a level of risk within the 10^{-4} to 10^{-6} risk range based on the reasonable maximum exposure for an individual... If a dose assessment is conducted at the site, then *15 millirem per year* (mrem/yr) effective dose

> equivalent (EDE) should generally be the maximum dose limit for humans. This equates to approximately 3×10^{-4} increased lifetime risk and is consistent with levels generally considered protective ... The concentration levels for various media that correspond to the acceptable risk level established for cleanup will depend in part on land use at the site... *Institutional controls generally should be included as a component of cleanup* alternatives that would require restricted land use in order to ensure the response will be protective over time... EPA will conduct reviews at least once every five years to monitor the site for any changes including changes in land use. (*emphasis added*)

The EPA's suggested use of 15 mrem/yr as the dose standard for protection of the MOP is reasonably consistent with existing DOE and NRC requirements to protect the MOP from buried LLW. However, the EPA's suggested 15 mrem/yr is not consistent with either DOE or NRC requirements to protect the IHI (where DOE and NRC use 100 and 500 mrem/yr). The DOE and NRC both set a higher dose standard for the IHI because the exposures would not be routine, and would be the result of a short-term failure of institutional controls. Protection of the IHI is an important metric for the disposal of LLW. Although not researched, the Hanford Risk Assessment Methodology may provide an acceptable means of assessing doses to the inadvertent intruder. Ecology, as the lead for closure, should determine if the IHI should be protected and, if so, what dose standard should be used.

4.5.6 Conflicts Between Regulations for Hazardous and Radioactive Wastes

Under section 1006(a) of RCRA, federal and state RCRA requirements for treating radioactive mixed waste are legally applicable only to the extent that their application is not inconsistent with AEA requirements. Inconsistent is defined as:

- encompassing situations in which satisfying both sets of regulations would be technically unfeasible;
- increasing the radiation hazards; or
- compromising national security interests.

The authors are personally unaware of any situations where AEA requirements superseded RCRA.

4.6 Summary

This section highlighted the complicated regulatory framework governing closure of the ancillary equipment in the AX Tank Farm. Based on this regulatory framework, Section 5 will link the regulations to the four proposed closure options.

5.0 CLOSURE OPTIONS FOR ANCILLARY EQUIPMENT

5.1 Physical Closure Options

This report address the regulatory requirements associated with four predefined physical closure options for the ancillary equipment. Options that were not considered include (1) excavation for treatment and unrestricted release, (2) excavation for treatment and reuse, and (3) storage for decay in place. As discussed earlier in this report, the four predefined closure options are the only viable options for closure. Each of these closure options is discussed below.

Disposal In-Place

This closure option presents the baseline or "no action" alternative. Decisions concerning the SSTs and the contaminated soil could influence the baseline. For example, closure of the SSTs and contaminated soil could involve capping the entire AX Tank Farm, independent of the ancillary equipment. Therefore, the baseline alternative could include some future actions, such as capping.

Treatment and Disposal In-Place

Under this closure option, the ancillary equipment would be treated in place prior to closure in place. The treatment of the equipment would be implemented if the current inventory of contaminants exceeds health-based standards for in-place closure. Conceptually, treatment could include some form of flushing followed by grouting.

Excavate and Dispose Inside an AX Single-Shell Tank

Removal of all the ancillary equipment, followed by redisposal in one of the on site SSTs is the third physical closure option. Under this option, an empty SST would serve as a "vault" for the disposal of the excavated equipment. After placement of the contaminated equipment in the SST, the SST might be backfilled with grout and closed with a special cap to isolate the wastes from the biosphere. Removal of equipment from the AX Tank Farm will require the excavation of large volumes of soil, as well as removal of the large inventory of contaminated equipment. It is anticipated that a large structure will be constructed over the site to prevent the possible release of contaminants. Relatively high doses to remediation workers might also be anticipated.

Excavate and Dispose Outside of the AX Tank Farm

This option is similar to the previous option, except the excavated equipment would be disposed outside the AX Tank Farm in an appropriate facility. As with the previous option, removal of equipment will require construction of a containment structure and excavation of large volumes of soil. Relatively high doses to remediation workers might also be anticipated. Contaminated equipment will be treated outside of the AX Tank Farm prior to disposal in a licensed disposal facility.

A Combination of Options

This report analyzes each of these options independently; however, the final closure of the ancillary equipment may be a combination of physical closure options. For example, in-place closure of the majority of the ancillary equipment may be coupled with the removal of hot spots prior to final closure.

Volume of Contaminants in the Ancillary Equipment

Prior to applying the different legal requirements to each of the proposed closure options, a review of contaminate volume is appropriate. Table 1 compares the estimated volume of sludge waste left in the sluice lines, transfer lines, ventilation headers, and risers (394 items) to the volume of contaminants remaining in the four SSTs in the AX Tank Farm (assuming that 99% of the waste in the SSTs has been removed). The total volume of waste estimated to remain in the ancillary equipment is only 13% of the volume estimated to remain in the SSTs.

Because the wastes in the ancillary equipment are assumed to be more dilute than the sludges remaining in the SSTs, the "equivalent volume" of sludge remaining in the ancillary equipment is only 4% of the volume assumed to remain in the SSTs at closure.

Table 1. Comparison of Waste Volume in Ancillary Equipment and Tanks at AX Tank Farm

Equipment and Tank Type	Sludge Waste Volume (gallons)	Total Waste Volume (gallons)
Transfer Line	170	657
Sluice Line	110	342
Ventilation Header	83	373
Riser	16	68
Total Equip Waste Vol (A)	378	1440
Total AX Tank Waste Vol @ 99% retrieval (B)	10768	10768
A/B (%)	4%	13%

Based on this analysis, selection of the closure option for the entire AX Tank Farm may not be dominated by the need to close the ancillary equipment. The volume of contaminants that may remain in the four SSTs (assuming 99% removal) is much greater than the volume of sludge assumed to remain in the ancillary equipment. Therefore, the closure option selected for the contaminated soil and SST residue (assuming 99% retrieval) may predefine the closure option for the ancillary equipment.

5.2 Regulatory Issues Associated with Closure

5.2.1 Introduction

This section presents regulatory issues related to the long-term closure of ancillary equipment in the Hanford AX Tank Farm. The regulatory closure of the ancillary equipment is complicated by myriad regulations governing hazardous, radioactive, and mixed wastes. Closure of the AX Tank Farm also involves Ecology, EPA, DOE, NRC, and other stakeholders.

Because the regulations are defined in "parcels," this regulatory review is divided into similar parcels. Specifically, the regulations governing the D&D of radioactively contaminated equipment are addressed first and the regulations governing hazardous waste are addressed second. A proposed unified regulatory approach is presented in the last section.

5.2.2 Mixed Waste

The legal requirements that regulate cleanup and disposal of radioactive and hazardous wastes were developed independently. However, there is only one waste – with the radioactive and hazardous components inextricably locked together. Actual implementation of the closure requirements will require coordination among the various regulators and their associated regulations. For example, it is not clear how landfill closure requirements might be integrated with the DOE requirements to protect the IHI from radioactive waste for 1,000 or 10,000 years.

5.2.3 Radioactive Component

5.2.3.1 Introduction

The D&D of the ancillary equipment involves NRC, Ecology, EPA, DOE and their associated regulations. The NRC regulates disposal of HLW, the DOE self-regulates the *disposal* of LLW, and the EPA regulates the *cleanup* of hazardous waste (which includes radioactive waste). Based on the TPA, Ecology is the lead agency for Tank Farm Closure under their WAC.

The regulatory closure of the radioactive component of the contaminated ancillary equipment could be addressed as either "radioactively contaminated equipment" or as "equipment which is HLW." *In the next two sections we present arguments for each of these two interpretations.*

5.2.3.2 Closure of Radioactively Contaminated Equipment

Unlike the SSTs, the ancillary equipment was not used to store HLW. The ancillary equipment is contaminated, typically with a residual film, but the ancillary equipment itself is not HLW. Using this line of reasoning, the DOE requirements to D&D radioactively contaminated equipment is found in Section IV 6. d. (2) of DOE Order 5400.5 which states that the long-term management (i.e., disposal) of radioactive materials that are not mill tailings shall be in accordance with DOE Order 5820.2A, as applicable.

Chapter III of DOE Order 5820.2A requires that doses to any MOP not exceed 25 mrem/yr. Releases to the atmosphere shall meet the requirements of 40 CFR 61. Reasonable efforts should be made to maintain releases to ALARA levels. The committed effective dose equivalents received by individuals who inadvertently may intrude into the facility after the loss of active institutional control (100 years) should not exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. Finally, groundwater resources should be protected, consistent with federal, state, and local requirements.

A technical analysis is needed to determine if the untreated ancillary equipment meets these DOE criteria. If these criteria cannot be met, the ancillary equipment could be treated in-place with some type of flushing and possible backfilling with grout. The flushing would remove some contaminants and the grout would help immobilize the remaining contaminants.

The DOE disposal standards found in Chapter III are similar to the standards that would be used to assure safe disposal of commercial LLW under NRC regulations and are also similar to the NRC's 1997 criteria for the D&D of NRC-licensed facilities. Assuming that the ancillary equipment is not HLW, neither of these NRC criteria is legally applicable to the closure of the ancillary equipment; however, the similarities in the requirements are reassuring.

Issues

Because HLW is defined by origin and not by concentration, there may be some concern that the contaminated ancillary equipment should be managed as HLW and not as radioactively contaminated equipment (this option is described below).

Two issues require attention. First is the need for a consistent approach for addressing the SST residue, ancillary equipment and contaminated soil because the SST residue, holdup in the ancillary equipment and contaminated soil all have at their origin the same waste. A second issue is related to protection of groundwater resources and the MOP. Demonstrating protection of the IHI is a straightforward comparison between the data on the level of contamination and the NRC's Class C limits. For the Class C limits, each piece of ancillary equipment can be evaluated in isolation of other potential sources of contamination. Demonstrating protection of the MOP under DOE Order 5820.2A is not so simple. Multiple sources of contamination could interact to affect the doses to the future MOP. It is not clear if the residue in each tank can be evaluated in isolation of the other sources of contamination. This issue should be discussed with the NRC and reviewed in light of (1) the requirements of the TPA (which requires a single closure plan for each entire tank farm), (2) the DOE requirement for a "composite analysis," and (3) NEPA's requirement that the analysis of environmental impacts not be "segregated."

The above paragraphs offer one possible method for defining metrics for closure of the radioactive component of the contaminated ancillary equipment. Another option is offered in the next section.

5.2.3.3 Closure of the Ancillary Equipment as High-Level Waste

Almost all the radioactive contamination in the AX Tank Farm is from HLW. Some of these radionuclides are now contained in the SSTs, some are in the holdup in the ancillary equipment, and some have been released to the soil column.

The legal definition of HLW is source-based. There is no concentration below which HLW ceases to be HLW. If the ancillary equipment is contaminated with HLW, then the ancillary equipment itself is HLW.

Assuming that the SSTs, the unretrievable waste in the SSTs, the contaminated soil, and the ancillary equipment are all HLW would allow the application of a single set of closure metrics to the entire tank farm. This would be similar to the approach required by the TPA. Under the TPA, each SST farm is one operable unit (including tanks, contaminated soil, and ancillary equipment). Each SST farm will be closed as a TSD facility under a single closure plan, using a single set of regulatory standards: WAC 173-303.

Conceptually, the NRC's Incidental Waste Criteria could be applied to any radioactively contaminated element in the AX Tank Farm. HLW holdup in the sluice lines would be managed under the same set of standards as HLW holdup in the SSTs. The NRC's Incidental Waste Criteria could serve as the basis for closure of all sources of radioactive contamination in the AX Tank Farm. The NRC developed these criteria to evaluate waste streams originating from an HLW treatment facility and the NRC and DOE are currently applying these criteria to closure intank residue at the SRS.

In simple terms, the NRC's Incidental Waste Criteria require that:

- technically and economically practical efforts be taken to remove the HLW;
- the resulting waste is a solid that does not exceed the NRC's Class C limits; and
- the wastes meet safety standards comparable to 10 CFR 61.

As previously discussed, the NRC has concurred that the DOE requirements for LLW disposal are appropriate for satisfying the third criteria. Therefore, the Incidental Waste Criteria and the DOE LLW disposal standards are very similar.

Petition

A "petition" is the format for seeking NRC approval of an incidental waste classification. The NRC provisionally accepted Hanford's 1996 technical basis for classification of the LAW fraction from the Hanford Site tanks (WHC, 1996). Therefore, a good format for a petition to the NRC is the format used in WHC (1996).

Meeting the Class C Limits

Demonstrating protection of groundwater resources and the MOP requires a site-specific analysis. However, the Class C limits are presented as specific activities in the NRC's 10 CFR 61. Table 2 compares the radiological characteristics of the ancillary equipment (SESC, 1997) to the NRC's Class C limits. Wastes that exceed the NRC's Class C limits are typically inappropriate for shallow land burial. The initial analysis shows that 36% of the 394 pieces of ancillary equipment analyzed do not exceed the NRC's Class C limits.

The analysis presented in Table 2 demonstrates that grouting the interior volume of each item would allow another 45% of the 394 items to be in compliance with the Class C limit if grout averaging is permitted. The remaining 19% would still have a grout-averaging concentration higher than the NRC Class C limits. As discussed earlier, the development of Hanford site-specific Class C limits could allow for higher disposal limits while still being protective of the IHI. Therefore, the combination of immobilizing grout, coupled with site-specific Class C limits, could allow all the ancillary equipment to meet Class C limits while still being protective of the IHI.

Table 2. Waste Classification of AX-Tank Farm Ancillary Equipment

Type of Equipment	Number of Items	% Meeting NRC Class C Limits	% Meeting Class C After Grout
Transfer Line	106	16%	58%
Sluice Line	42	0%	67%
Ventilation Header	12	0%	67%
Riser	234	54%	94%
Total	394	36%	81%

Issues

The large inventory of ancillary equipment, coupled with the fact that two-thirds of the equipment may exceed Class C limits, indicates that closure of ancillary equipment may be difficult.

The NRC regulates the disposal of HLW, and if the LAW fraction is not clearly incidental, the NRC is the regulator that determines if a particular waste stream is HLW or incidental waste. The DOE and the NRC may want to formalize a working agreement to provide the NRC with the resources necessary to work with the DOE and others for a timely resolution of closure issues.

The outcome of the NRC review of the closure of SRS Tanks 17 and 20 could have a significant bearing on the closure of the Hanford tank farms, and this issue should be monitored. As noted in Section 4.4.3.4, the NRC is comfortable using the incidental waste concept for closure of this intank residue. If the NRC is comfortable applying the incidental waste concept to intank holdup, there does not seem to be a fundamental reason why the incidental waste concept could not be applied to holdup in ancillary equipment.

The disposition of the radioactive component will not occur without Ecology's approval. The role that Ecology (and EPA) play in classifying the ancillary equipment is unclear. At a minimum, Ecology and EPA should continue to be informed of closure actions for the radioactive component of the ancillary equipment so that they can be satisfied that NRC and DOE actions are protective of human health.

In 1993, the NRC noted that "there was no fundamental challenge to the concept of incidental wastes" (58 FR 12343). However, some stakeholders still question the NRC's authority to use "guidance" to "reclassify" HLW as incidental waste. This issue should be addressed with the NRC.

The ability to comply with the third criterium (meeting safety standards comparable to 10 CFR 61) should be assessed simultaneously. Meeting safety standards comparable to 10 CFR 61 is linked to (1) a 10,000-year, 25-mrem/year dose standard to protect the hypothetical MOP, and (2) a 10,000-year standard to protect groundwater resources. Two known issues should be discussed with the NRC prior to performing the 5820.2A PA: (1) Should the PA address only the contents of an individual tank, or all interacting source terms? (2) What is the time frame of compliance?

Previous NEPA activities have not addressed closure of the SSTs. Prior to selecting a final closure option for the SSTs, the DOE should amend the existing EIS or prepare stand-alone NEPA documentation for SST closure.

Under the EPA's definition of TRU waste (40 CFR 191.02(i)), the NRC has the authority to approve disposal of wastes exceeding 100 nCi/g of TRU radionuclides on a case-by-case basis in accordance with 10 CFR 61. The ability to apply this authority to DOE-titled wastes should be discussed with the NRC.

Acceptance of a site-specific Class C limit could have ramifications broader than the Hanford Tank Farms. For example, other NRC-licensed facilities might desire to negotiate their own site-specific limits, which could reopen discussion on the basis of the NRC's 10 CFR 61 Class limits.

The authors are unaware of NRC accepting a site-specific Class C analysis. Therefore, the DOE would need to work with NRC staff to develop a one-of-a-kind petition.

The development of site-specific Class C limits could be viewed by stakeholders as an attempt to leave waste on site that historically has been unacceptable for shallow land burial based on existing Class C limits.

Conclusions

Two different approaches for addressing the radioactive component in the ancillary equipment have been presented (manage as radioactively contaminated equipment or manage as HLW). These two approaches may seem different, but they are more similar than not. *Either* regulatory path for the radioactive component will require protection of the IHI, the MOP, and groundwater resources.

Under the first approach, regulatory closure of the residue in the ancillary equipment would be inconsistent with the regulatory closure of any unretrievable SST residue. Ideally, regulatory closure of the SST residue, ancillary equipment and contaminated soil would proceed under a single closure strategy.

There are three substantive differences between these approaches and they show up as additional requirements under the second approach. First, the NRC would assume a prominent role as a regulator at Hanford. Second, demonstrating that reasonable efforts have been taken to remove the HLW from the tank farm would be more formally reviewed. Third, approval of Hanford site-specific Class C limits will be necessary.

5.2.4 Hazardous Component

5.2.4.1 Introduction

This section reviews the regulatory requirements for closure of the hazardous component of the contaminated ancillary equipment. The TPA established a fairly clear path for closure of the ancillary equipment, although a number of key issues still require resolution. The discussion is divided between requirements for in-place closure and requirements for excavation and redisposal.

5.2.4.2 In Situ Options

Under the TPA, the tank farms are TSD units that will be clean-closed, or closed as a landfill, or closed using modified closure. The ancillary equipment could be addressed as debris. Under the Hazardous Debris Rule, debris contaminated with a listed hazardous waste or exhibiting the characteristics of a hazardous waste may be treated using extraction technologies, destruction technologies, or immobilization technologies (e.g., grouting). Ecology does not require use of the Hazardous Debris Rule to achieve decontamination; however, for the sake of simplicity, it is assumed that the Hazardous Debris rule applies and that neither extraction nor destruction technologies are viable options for *in situ* closure.

If the debris is decontaminated using an immobilization technology (e.g., grouting), the ancillary equipment is still subject to hazardous waste standards (e.g., must be at a RCRA permitted facility, post-closure care, etc.).

The MTCA can be used to define hazardous waste cleanup levels for contaminated media such as the ancillary equipment. Three options for levels of cleanup exist within the MTCA: Method A, Method B, and Method C. Given the large inventory of the ancillary equipment and the level of radiological contamination, we assume that *in situ* cleanup to background levels under Method A is impractical. Cleanup of the ancillary equipment to Method B or Method C could be applied to the upper 15 feet of soil, with monitoring and limited postclosure care of the contaminated parts of the system (e.g., the soil below 15 feet).

Additionally, closure of the tank farms will probably require compliance with the EPA's overall requirement that cleanups should generally achieve a level of risk within the 10^{-4} to 10^{-6} risk range based on the reasonable maximum exposure of an individual and the possible use of institutional controls.

Technical analyses will be required to determine which of these closure options is achievable. To proceed with this regulatory analysis, we assume clean closure to be impractical and that the AX Tank Farm will be closed as a landfill. Closure as a landfill will require meeting Landfill Cover Requirements and Postclosure Care requirements.

In-place treatment and/or grouting will probably require approval from Ecology and possibly the EPA. It is the authors' understanding that Ecology has taken the position that LDRs are not subject to a clock; therefore, Ecology could require that LDRs be met prior to *in-place* closure. This issue should be discussed with Ecology as it will greatly influence the closure process.

5.2.4.3 Removal Options

Excavation and redisposal of ancillary equipment on site may trigger two significant sets of additional requirements that may not apply if the wastes are closed in place. Redisposal will require compliance with LDRs and MTRs (compliance with LDRs may also be required for in-place disposal, as noted above). Each of these requirements is very significant.

In the federal system, LDRs do not have to be met if wastes were placed on land before the EPA established the LDRs, unless the waste is removed and redisposed. If the waste is removed and redisposed, even if it is removed inside a tank farm and redisposed inside a tank farm, LDRs must be met. If the ancillary equipment is classified as HLW, the LDR for HLW is vitrification. Therefore, excavated ancillary equipment may have to be vitrified prior to redisposal. Even if the ancillary equipment is not HLW, the ancillary equipment maybe a characteristic waste, which will trigger other LDRs.

As another issue, if an SST is used as a disposal vault, it will have to be retrofitted to meet MTRs. The federal MTRs for closure of a hazardous waste landfill require (1) two or more liners; (2) a leachate collection system; (3) a groundwater monitoring system; and (4) postclosure care and monitoring. Ecology uses a slightly different approach than MTRs. Ecology employs the use of a "best management practice" approach (WAC 173-303-140) and tiers everything using this philosophy. Retrofitting an old SST to meet MTRs could be very difficult (basically eliminating the option of using an SST for redisposal of ancillary equipment).

The CAMU rule allows wastes to be excavated, moved, permanently treated, or disposed within a defined area without triggering LDRs or MTRs. At the Federal level, the use of CAMUs may not be possible; however, WAC 173-303-646 retains the option of designating a CAMU. Designation of a CAMU provides much greater regulatory flexibility, making physical closure option (3) viable. Without designating a tank farm as a CAMU, option (3) can almost be eliminated from consideration.

5.3 Summary

Figures 1, 2 and 3 are provided to summarize and simplify the closure requirements for the ancillary equipment. The proposed unified approach presented above is for the purposes of discussion and is not specifically authorized within the confines of the existing regulatory structure.

	Inadvertent Intruder Protected from Rad per DOE 5820.2A, III 3. (a)	Member of Public Protected from Rad. per DOE 5820.2A, III 3. (a)	Groundwater Resources Protected from Rad.	Meets Land Disposal Restrictions	Meets Min. Technological Reqt.s for Landfill	Treatment Facility Permit	Meets Ecology Landfill Closure Requirements (onsite exposure & groundwater)	Meets EPA's 10** -4 Risk Level for ALL Contaminants	Cap & Post-Closure Care	NEPA (for closure of entire tank farm)
Close in place	Y	Y	Y				Y	Y	Y	Y
Treat & close in place	Y	Y	Y			Y	Y	Y	Y	Y
Excavate, dispose in SST	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Excavate, dispose outside tank farm	*	*	*	*	*	*	*	*	*	Y

*These requirements must be met at a licensed, off-site facility

Figure 1. Regulatory Requirements for Closure of Ancillary Equipment (Assuming equipment is radiologically contaminated, but not with HLW, see text for details)

	HLW Removed to Extent Tech. & Econ. Practical	Meets NRC's Class C Limits (inadv. intruder protected from rad.)	Member of Public Protected from Rad. per DOE 5820.2A, III 3. (a)	Petition to NRC for Incidental Waste	Groundwater Resources Protected from Rad.	Meets Land Disposal Restrictions	Meets Min. Technological Reqt.s for Landfill	Treatment Facility Permit	Meets Ecology Landfill Closure Requirements (onsite exposure & groundwater)	Meets EPA's 10** -4 Risk Level for ALL Contaminants	Cap & Post-Closure Care	NEPA (for closure of entire tank farm)
Close in place	Y	Y	Y	Y	Y				Y	Y	Y	Y
Treat & close in place	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y
Excavate, dispose in SST	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Excavate, dispose outside tank farm	*	*	*	*	*	*	*	*	*	*	*	Y

*These requirements must be met at licensed, off-site facilities

Figure 2. Regulatory Requirements for Closure of Ancillary Equipment
(Assuming equipment is contaminated with HLW - see text for details)

	HLW Removed to Extent Tech. & Econ. Practical	Meets NRC's Class C Limits (inadv. intruder protected from rad.)	Member of Public Protected from Rad. per DOE 5820.2A, III 3. (a)	Petition to NRC for Incidental Waste	Groundwater Resources Protected from Rad.	Meets Land Disposal Restrictions	Meets Min. Technological Reqt.s for Landfill	Treatment Facility Permit	Meets Ecology Landfill Closure Requirements (onsite exposure & groundwater)	Meets EPA's 10** -4 Risk Level for ALL Contaminants	Cap & Post-Closure Care	NEPA (for closure of entire tank farm)
Close in place	Y	Y	Y	Y	Y				Y	Y	Y	Y
Treat & close in place	Y	Y	Y	Y	Y				Y	Y	Y	Y
Excavate, dispose in SST	Y	Y	Y	Y	Y				Y	Y	Y	Y
Excavate, dispose outside tank farm	*	*	*	*	*	*	*	*	*	*	*	Y

*These requirements must be met at licensed, off-site facilities

Figure 3. Regulatory Requirements for Closure of Ancillary Equipment (Assuming closure in a Corrective Action Management Unit and that the equipment is contaminated with HLW, see text for details)

5.4 Unified Approach to Closure

The final closure of the ancillary equipment in the AX Tank Farm is governed by four parties, stakeholders, and a complex set of statutes, regulations, DOE Orders, guidance, manuals, branch technical positions, precedents, and agreements.

As a simple example, the DOE and NRC will negotiate the metrics for addressing issues associated with closure of the contaminated ancillary equipment, which may be classified as HLW. If the ancillary equipment is classified as HLW, the DOE may undertake a number of technical analyses to determine if the ancillary equipment can be reclassified as incidental waste. These analyses will use metrics that the DOE and NRC typically use for disposal of LLW. These activities are not recognized by the current TPA. (Neither HLW nor the NRC are specifically mentioned in the TPA milestone for tank farm closure.) In some fashion, Ecology (and perhaps EPA) may be involved in these negotiations and analyses.

Under the TPA, Ecology will apply the WAC to close the HLW tank farms while keeping the EPA appraised of the closure activities at the land surface. The EPA, through the TPA and CERCLA, will address groundwater contamination.

Could all the regulatory requirements for all SST residue, ancillary equipment, and contaminated soil be reduced to a few metrics? The answer is yes, if the regulators and stakeholders agree on a few simplifying assumptions. Furthermore, the TPA offers an excellent vehicle for defining a conceptually simple set of closure metrics.

<u>Simplifying assumptions:</u>

(1) The parties agree to remediate the 200 East and 200 West areas as single, contaminated units.

(2) There will be three metrics for demonstrating protection of human health and the environment: (a) protection of the MOP at the edge of the buffer zone established by the DOE for the composite analysis of the 200 East and 200 West areas; (b) protection of groundwater resources at the edge of the 200 East and 200 West buffer zones; and (c) protection of an IHI, assuming a temporary failure of institutional controls. For radioactive wastes, the NRC and DOE typically assume a buffer zone around a disposal facility. The EPA (and perhaps the State) also allow the use of a single outer boundary around an area containing multiple sources of contamination.

(3) The parties agree to apply the Incidental Waste Criteria to all radioactive contamination in teh 200 East and West buffer zones. Consistent with the TPA, the DOE will perform retrieval operations on the SSTs. Ancillary equipment and contaminated soil exceeding the NRC's Class C limits will be addressed.

(4) Protection of groundwater resources will be assessed at the edge of the 200 East and 200 West buffer zones for 1,000 or 10,000 years, based regulatory guidance and on current

water well construction techniques. Safe drinking water act standards (i.e., Maximum Contaminant Levels) must be met. Additionally, the cumulative risks to the MOP from drinking water pumped at the edge of the 200 East and 200 West buffer zones must meet the MOP risk standard.

(5) Risks to the MOP, at the edge of the 200 East and West buffer zones, from both hazardous and radioactive wastes, shall not exceed 1×10^{-4} for 1,000 or 10,000 years based on regulatory guidance.

(6) For protection of the IHI from the radioactive component, the parties agree to use the same "intruder construction and agriculture" exposure scenarios that the NRC used to develop the class limits presented in 10 CFR 61. Consistent with the NRC development of 10 CFR 61 and DOE guidance for LLW PA, groundwater from directly beneath the tank farms is not included in the dose assessment for the IHI.

(7) For protection of the IHI from the hazardous component, the parties agree to use MTCA Method B (residential exposure scenario, upper 15 feet of soil) or MTCA Method C (industrial land use exposure scenario). Assumptions about the durability of institutional controls will need to be negotiated.

(8) Risks to the IHI from radioactive wastes shall not exceed 100 mrem per year chronic dose or 500 mrem acute dose. These dose limits are consistent with the limits used by the NRC to development the Class C limits and consistent with the current DOE requirements to protect the IHI from LLW.

Simplified View of Implementation

(1) Determine the risks to the IHI, assuming that the IHI exposure could occur at any location within the 200 East and West buffer zones. Use the NRC's intruder construction and agriculture exposure scenarios. The NRC assumes excavation of a hole for a basement which is 20 × 10 m at the bottom, and 26 × 16 m at the top. Therefore, the "exposure unit" would be a rectangle measuring 26 × 16 m. For MTCA Methods B and C, similar exposure units would also have to be defined for MTCA residential and industrial exposure scenarios.

(2) If some areas within the 200 East and West buffer zones fail to meet the standard for protection of an IHI, then those "hot spots" must be identified for surgical removal or for in-place remediation.

(3) Assuming that the hot spots have been removed or remediated, assess the potential impact to groundwater resources at the edge of the 200 East and West buffer zones using common water well construction techniques. Then assess the risks to the MOP at these same buffer zone boundaries.

(4) Some areas within the 200 East and West buffer zones may cause exceedences of the standards for protection of groundwater and/or protection of the MOP. These areas should be identified for surgical removal or for in-place remediation.

(5) The technical and economical practicability of the removal and remedial measures that have been identified must be assessed.

(6) The NEPA EIS process should be used to involve stakeholders, and present the options, risks, and costs for tank farm closure. Actual remedy selection could be made through the NEPA process.

Issues

(1) Implementation of this unified approach should be undertaken as a revision to the TPA.

(2) Because the classification of wastes as either HLW or incidental waste is addressed by this Unified Approach, the NRC should be involved.

(3) A significant number of important details must be defined to actually implement this approach. As an example, the exposure scenarios must be defined in exacting detail (e.g., How many hours would an intruder spend in his garden and how many pounds of leafy vegetables would be consumed annually?). Fortunately, the NRC, DOE, EPA, and Ecology have all set precedents for performing PAs and risk assessments; unfortunately, the precedents may differ (e.g., Should 10,000 years be used as the time frame of concern for disposal of hazardous wastes?).

(4) Remediating the tank farms to meet health-based risk levels may be technically and economically impractical. The parties should assess how risk and costs will be balanced. The nine "balancing criteria" defined by the EPA in the NCP for remedy selection may be appropriate for this task. The process of balancing health risks against costs could be made through the NEPA process.

6.0 CONCLUSIONS

The AX Tank Farm includes four 1,000,000-gallon SSTs, as well as sluice lines, transfer lines, ventilation headers, risers, pits and cribs, catch tanks, buildings, and wells. Collectively, this equipment is classified as ancillary equipment. The ancillary equipment is assumed to be contaminated with sludges derived from the mixed HLW that was transferred into and out of the tanks. The estimated total volume of sludge waste left in the sluice lines, transfer lines, ventilation headers, and risers (394 items total) is about 4% of that left in the four SSTs in the AX Tank Farm, assuming 99% retrieval of the tank waste

Four general options have been identified for the *physical* closure of the ancillary equipment:

(1) disposal in place;

(2) in-place treatment followed by disposal in place;

(3) excavation and disposal on site in an empty SST; or

(4) excavation and disposal outside the AX Tank Farm.

Regulatory closure requirements that may be applicable to the D&D of radioactively contaminated equipment include: (a) the TPA; (b) DOE Order 5400.5 (and proposed 10 CFR 834); (c) DOE Order 5820.2A (and proposed DOE Orders 435.1 and 430.1); (d) the Joint DOE and EPA Policy on Decommissioning DOE Facilities; and (e) the NRC's 10 CFR 20 Subpart E.

Regulatory closure requirements that may be applicable to radioactive waste disposal include: (a) the Energy Reorganization Act of 1974; (b) DOE Order 5820.2A (and proposed DOE Orders 435.1 and 430.1); (c) DOE Order 5400.5; (d) the NWPA; (e) 10 CFR 60; (f) 40 CFR 191; and (g) the NRC's definition of "incidental waste."

The regulatory closure of the radioactive component of the contaminated ancillary equipment could be addressed as either "radioactively contaminated equipment" or as "equipment which is HLW." *Either* regulatory path will require protection of the inadvertent human intruder, groundwater resources, and the member of public. If the ancillary equipment is assumed to be radioactively contaminated (but not with HLW), the DOE LLW disposal standards (Chapter III of DOE Order 5820.2A) would be the appropriate metric for closure.

If the ancillary equipment is assumed to be HLW, the NRC would be the regulator. Wastes generated during the further processing of HLW may be classified by the NRC as "incidental wastes," which can be disposed on site as DOE titled LLW without NRC licensing. The NRC has established three criteria for determining if wastes from an HLW treatment facility are incidental. In simple terms, the three Incidental Waste Criteria are that (1) technically and economically practical efforts have be taken to remove the HLW, (2) the resulting waste is a solid that does not exceed the NRC's Class C limits, and (3) the wastes meet safety standards comparable to 10 CFR 61.

This report compares the radiological characteristics of the ancillary equipment to the NRC's Class C limits. Wastes that exceed the Class C limits are typically inappropriate for shallow land burial. The initial analysis shows that 36% of the 394 pieces of ancillary equipment do not exceed the NRC's Class C limits. Grouting the interior volume of each item would allow another 45% of the 394 items to be in compliance with the Class C limits if grout averaging is permitted. The remaining 19% would still have grout-averaging concentrations higher than the Class C limits.

As discussed in this report, the development of Hanford site-specific Class C limits would allow more waste to remain in place while still being protective of the inadvertent human intruder. Combining immobilizing grout, closure as incidental waste, and Hanford site-specific Class C limits could allow all the ancillary equipment to be closed in place. However, a number of important issues must be addressed:

- The outcome of the NRC review of the closure of Savannah Rivers's Tanks 17 and 20 could have a significant bearing on the closure of the Hanford tank farms and this issue should be monitored. As discussed in this report, the NRC seems comfortable using the incidental waste concept for intank closure of the holdup in Tanks 17 and 20, and there does not seem to be a fundamental reason why the incidental waste concept could not be applied to holdup in Hanford's ancillary equipment.

- Some stakeholders still question the NRC's authority to use "guidance" to "reclassify" HLW as incidental waste.

- The development of Hanford site-specific Class C limits could be viewed by stakeholders as an attempt to leave waste on site that historically has been unacceptable for shallow land burial.

- Under the EPA's definition of TRU waste, the NRC has the authority to approve disposal of wastes exceeding 100 nCi/g of TRU radionuclides on a case-by-case basis in accordance with 10 CFR 61. The ability to apply this authority to DOE-titled wastes should be discussed with the NRC.

- The authors are unaware of NRC accepting a site-specific Class C analysis. Therefore, DOE would have to work with NRC staff to develop a one-of-a-kind petition.

The closure of the AX Tank Farm is also governed by (a) the TPA; (b) (RCRA, primarily as implemented by Washington State's DW Regulations; and (c) CERCLA. Because of the limited scope of this review, regulations governing hazardous and mixed wastes were not as thoroughly reviewed as regulations governing radioactive waste.

Under the TPA, the tank farms will be closed under Washington Administrative Code 173-303-610. If the tank farms cannot be "clean closed," the DOE would close the tank farms as landfills. Ecology may use the Hazardous Debris Rule to define clean closure of individual pieces of equipment, and Ecology may use the MTCA to define cleanup levels for the contaminated media.

Approval from Ecology and possibly the EPA would be needed if the decision is made to clean the ancillary equipment in place and then use an "immobilization" technology (e.g., grouting). Given the large physical inventory of buried, contaminated ancillary equipment, clean closure seems unlikely.

Excavation and redisposal of ancillary equipment on site will trigger two significant sets of additional requirements that may not apply if the wastes are closed in place. Redisposal will require compliance with RCRA LDRs and MTRs. The LDR treatment standard for HLW is vitrification, as a worst case, if the ancillary equipment is classified as HLW and excavated, it will have to be vitrified prior to redisposal. If an SST is used as a disposal vault, it will have to be retrofitted to meet MTRs, which could require retrofitting with a liner and a leachate collection system.

In the federal system, LDRs do not have to be met if wastes were placed on land before the EPA established the LDRs, unless the waste is removed and redisposed. It is the authors' understanding that Ecology has taken the position that LDRs are not subject to a clock; therefore, Ecology could require that LDRs be met prior to *in-place* closure. This issue should be discussed with Ecology as it will greatly influence the closure process.

The CAMU rule allows wastes to be excavated, moved, permanently treated, or disposed within a defined area without triggering LDRs or MTRs. At the federal level, the use of CAMUs may not be possible; however, WAC 173-303-646 retains the option of designating a CAMU. Designation of a CAMU provides much greater regulatory flexibility. Unless a tank farm is designated as a CAMU (or closed under CERCLA), option (3) can almost be eliminated from further consideration.

In Chapter 5 of this report, each of the four physical closure options is reviewed with respect to regulatory requirements for closure. The results of this regulatory analysis are presented in three matrices that plot the four physical closure options against the various regulatory requirements. A conceptually simple method to combine regulations governing HLW, incidental waste, LLW, Dangerous Waste, and CERCLA cleanup criteria is also presented in Chapter 5.

Assuming that health-based criteria can be met, in-place disposal or in-place disposal after in-place treatment are the simplest regulatory options to implement for the hazardous component. Use of a CAMU will provide much greater regulatory flexibility. *Assuming that health-based criteria can be met*, in-place disposal of the radioactive component will require a combination of immobilizing grout, the incidental waste concept, and Hanford site-specific Class C limits.

A number of issues have been identified that require attention:

1. The NRC regulates the disposal of HLW, and if the classification of a waste is unclear, the NRC is the regulator that determines if a particular waste stream is HLW or incidental waste. The NRC should be consulted to determine their position on the closure metrics for the ancillary equipment. The DOE and NRC may want to formalize a working agreement to provide the NRC with the resources necessary to work with the DOE and others for a timely resolution of closure issues.

2. The disposition of the radioactive component will not occur without Ecology's approval. The role that Ecology (and EPA) play in classifying the ancillary equipment is unclear.

3. Ecology, as the lead agency for tank farm closure, should be consulted to determine if the inadvertent human intruder should be protected and, if so, what dose standard would be appropriate to protect the intruder. Although not researched, the Hanford Risk Assessment Methodology may provide an acceptable means of assessing doses to the inadvertent intruder.

4. This scoping review was based on an assumed contaminant inventory; a field study should be conducted to confirm the levels of contamination.

5. Several technical analyses need to be completed prior to selecting a final closure option(s). Each of the four physical closure options needs to be analyzed to determine the cumulative threat to groundwater at a boundary, the cumulative threat to the member of public at a boundary, and possible impacts to on site individuals, assuming a loss of institutional controls. Furthermore, the costs of implementing each option and the radiological doses to workers will also be important in selecting a final remedy.

6. A consistent approach for addressing tank residue, ancillary equipment and contaminated soil is needed since all three of these have at their origin the same waste.

7. The closure option selected for the contaminated soil and SSTs residue may dominate the decision on how to close the ancillary equipment. Based on analyses presented in this report, the volume of sludge holdup anticipated to be in the ancillary equipment is only 4% of the volume of sludge that may remain in the SSTs, assuming 99% retrieval.

8. Even though closure of the SST residue may (volumetrically) overshadow closure of the ancillary equipment, the large physical inventory of equipment, coupled with the fact that two-thirds of the equipment is anticipated to exceed the Class C limits, indicates that closure of the ancillary equipment may be difficult and should continue to receive HTI's attention.

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