WASTE INCIDENTAL TO REPROCESSING

CITATION DETERMINATION

Q-CIT-G-00001

Revision 0

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ACRONYMS AND ABBREVIATIONS

ARP	Actinide Removal Process
CDMC	Contact Decon and Maintenance Cell
CFR	Code of Federal Regulations
CSSX	caustic side solvent extraction
DOE	U.S. Department of Energy
DOE-SR	Department of Energy – Savannah River
DWPF	Defense Waste Processing Facility
FR	Federal Register
HLW	high-level waste
HM	H [canyon] modified
LLW	low-level waste
LW	Liquid Waste
LWO	Liquid Waste Operations
MCU	Modular Caustic Side Solvent Extraction Unit
NRC	U.S. Nuclear Regulatory Commission
PCBs	polychlorinated biphenyls
PE	plutonium equivalent
PUREX	Plutonium/Uranium Extraction
REDC	Remote Equipment Decon Cell
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
TRU	transuranic
UDQ	unreviewed disposal question
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WITS	Waste Information Tracking System

1.0 INTRODUCTION

1.1 Purpose

The purposes of this procedure are as follows:

- To document determinations made by the citation process that certain materials and equipment contaminated by high-level waste (HLW) from spent nuclear fuel reprocessing at the Savannah River Site (SRS) are not HLW and can be managed as low-level radioactive waste (LLW) or transuranic (TRU) waste or their mixed waste counterparts, and
- To establish an efficient process for making additional determinations by the citation process that other materials and equipment contaminated by HLW from site spent nuclear fuel reprocessing are not HLW.

The principal technical basis for these citation determinations appears in U.S. Department of Energy (DOE) Manual 435.1-1, *Radioactive Waste Management*, which is discussed in Section 1.4. This manual implements the requirements of DOE Order 435.1, *Radioactive Waste Management.*[1]

NOTE

This procedure supersedes Procedure HLW-SUP-99-0060, *Citation Determination and Evaluation of Waste Incidental to Reprocessing* (WSRC 2000) for citation determinations.

The primary objectives for this new procedure were to update the citation document in Procedure HLW-SUP-99-0060 and to streamline the process for making waste-incidental-to-reprocessing determinations by the citation process. This procedure does not addresses waste-incidental-to-reprocessing evaluations performed in accordance with DOE Manual 435.1-1.

The latest waste-incidental-to-reprocessing procedures from other DOE sites were considered in preparation of this procedure (Hanford 2008, INTEC 2001, and WVNSCO 2007).

1.2 Applicability and Scope

This procedure applies to citation waste-incidental-to-reprocessing determinations covered in DOE Manual 435.1-1 for radioactive waste that meets waste acceptance criteria for disposal onsite or offsite as LLW, for disposal offsite as mixed LLW, or disposal offsite at the Waste Isolation Pilot Plant as TRU waste or mixed TRU waste.

As noted previously, this procedure does not apply to waste-incidental-to-reprocessing evaluations addressed in DOE Manual 435.1-1, nor does it apply to waste determinations made in accordance with Section 3116 of the Ronald W. Reagan National Defense Authorization Act

[1] Because DOE Order 435.1, *Radioactive Waste Management*, states that all radioactive waste shall be managed in accordance with the requirements of DOE Manual 435.1-1, the manual provisions constitute DOE requirements.

for Fiscal Year 2005 (U.S. Congress 2004), which are commonly referred to as 3116 waste determinations.

This procedure will be included in the appropriate Radioactive Waste Management Basis for the generating and disposal facilities.

1.3 Key Terms

To place the technical basis for the processes described in this procedure into context, an understanding of certain key terms is important.

High activity waste. High activity waste is the portion of HLW that contains large concentrations of fission products and is therefore highly radioactive. HLW is generally separated into high activity and low activity waste streams. This term *high activity waste* is synonymous with high radioactivity waste.

Highly radioactive. The term *highly radioactive* as used in this procedure generally refers to radioactive waste with radionuclide concentrations above the Class C limits. The NRC has taken the position that radioactive material that contains concentrations of short-lived radionuclides in excess of the Class C limits of Table 2 of 10 CFR Part 61.55 can produce significant radiation levels and generate substantial amounts of heat and therefore should be considered highly radioactive (DOE Guide 435.1-1, II-4). (For SRS, meeting the waste acceptance criteria for the E-Area LLW disposal facilities is equivalent to not being highly radioactive for reasons described in Attachment 3.)

HLW is defined as the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation (DOE Manual 435.1-1, II-1).

Key radionuclides are those radionuclides that are controlled by concentration limits in 10 CFR 61.55: the long-lived radionuclides C-14, Ni-59, Nb-94, Tc-99, I-129, Pu-241, Cm-242, and alpha emitting transuranic nuclides with half-lives greater than five years, along with the short-lived radionuclides H-3, Co-60, Ni-63, Sr-90, and Cs-137. In addition, key radionuclides and any others that are important to satisfying the performance objectives of 10 CFR Part 61, Subpart C for land disposal of radioactive waste and the comparable performance objectives of Chapter IV of DOE Manual 435.1-1.[2] (DOE Guide 435.1-1, II-22)

LLW is radioactive waste that is not HLW, spent nuclear fuel, TRU waste, byproduct material (as defined in section 11e (2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material (DOE Manual 435.1-1, IV.A).

Low activity waste. Low activity waste is the portion of HLW that does not contain large concentrations of fission products and is therefore not highly radioactive. HLW is

[2] The Waste Acceptance Criteria (WAC) Manual procedure for the E-Area LLW disposal facilities (SRNS 2009a) identifies the following key performance assessment radionuclides for those facilities: H-3, C-14, Sr-90, Tc-99, I-129, U-234, U-235, and Np-237.

generally separated into high activity and low activity waste streams. This term *low activity waste* is synonymous with low radioactivity waste.

Maintenance instructions are procedures issued to accomplish work related to radioactive equipment and materials and to document satisfactory accomplishment of this work. Maintenance instructions form a key part of the work package used by workers.

Mixed Low-Level Waste is LLW that also contains a hazardous component subject to regulation under the Resource Conservation and Recovery Act.

Mixed TRU waste is TRU waste that also contains a hazardous component subject to regulation under the Resource Conservation and Recovery Act.

Rejected to waste. A term commonly used to signify the point at which material, equipment, or liquid is declared to be waste because it is no longer needed and cannot be reused or recycled.

Reprocessing of spent nuclear fuel refers to chemical separation of spent nuclear fuel to separate uranium and/or plutonium from waste materials such as fission products, non-plutonium transuranic elements, and associated metal and chemical waste materials. Reprocessing does not include head-end processes, such as cladding removal, that occur prior to separation of spent nuclear fuel constituent elements, nor does reprocessing include post-reprocessing processes that increase the purity of recovered uranium and plutonium to levels consistent with their intended end use (DOE 2006b).[3]

Secondary waste, as the term is used in this procedure, consists of waste by-products resulting from the management, retrieval, treatment, storage, handling, analysis, and/or disposal of HLW that have become radioactively contaminated by such waste. Secondary waste is contaminated with waste associated with spent nuclear fuel reprocessing and may contain small amounts of such waste.[4]

Site contractor, as the term is used in this procedure, refers to the maintenance and operations contractor or the liquid waste contractor, as applicable.

TRU waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for the following: (a) HLW, (b) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency (EPA), does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations (40 CFR 191), or (c) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. (DOE Manual 435.1-1, III.A)

Waste determination. This term refers to a finding by the Secretary of Energy, or another DOE official as designated in DOE Manual 435.1-1 or designated by the

[3] The processing of irradiated tritium-producing burnable absorber rods in the Tritium Extraction Facility is not considered to be spent nuclear fuel processing because the irradiated material is not spent nuclear fuel and neither uranium nor plutonium are involved in the process.

[4] The term *secondary waste* is not explicitly defined in DOE Manual 435.1-1 or DOE Guide 435.1-1. However, the definition given here is consistent with the provisions of those technical standards.

Secretary, that a waste associated with the reprocessing of spent nuclear fuel is not HLW. Waste determinations are made by either the citation process or the evaluation process in accordance with DOE Manual 435.1-1, or by evaluation in accordance with Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (U.S. Congress 2004).

Waste form. This term refers to the physical and chemical characteristic of the waste. Waste acceptance requirements specify that wastes received at the disposal facility are in a physically/chemically stable form (DOE Guide 435.1-1, page II-64).

Waste incidental to reprocessing. Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not HLW, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste (or their mixed waste counterparts), as appropriate (DOE Guide 435.1-1, II.B). Waste incidental to reprocessing (commonly referred to as WIR) is therefore not a type of radioactive waste but rather a category of waste associated with spent fuel reprocessing that can be managed as one of two waste types depending on the concentrations of its transuranic constituents. The term *waste incidental to reprocessing* is generally considered to refer to a process.[5]

Waste matrix. The mass over which the activity is divided in making the waste determination[6] is the waste matrix. This includes the waste material itself as well as any stabilization media that must be added to meet waste acceptance criteria for mobility, physical form, structural stability or free liquids. (The mass of added shielding, the container, or any rigid liners is not included in the calculation.) (DOE Guide 435.1-1, page III-1)

Waste stream. This term refers to waste from a particular source that has the same physical, chemical, and radiological characteristics.

1.4 Technical Basis

The technical basis for determining that certain waste associated with reprocessing of spent nuclear fuel may be managed as LLW or TRU waste is found in DOE Manual 435.1-1. This manual describes the requirements and establishes specific responsibilities for implementing DOE Order 435.1, *Radioactive Waste Management*, for the management of the Department's HLW, TRU waste, LLW, and the radioactive component of mixed waste. DOE Guide 435.1-1 provides suggestions and acceptable ways of implementing the provisions of DOE Manual

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[5] Waste incidental to reprocessing refers to a process for identifying waste streams that would otherwise be considered high-level waste due to their sources of generation or concentration, but can be managed in accordance with the DOE requirements for transuranic or low-level waste, if the requirements for waste incidental to reprocessing are met (DOE Guide 435.1-1, page II-18).

[6] The term *waste determination* in this context in the DOE Manual 435.1-1 definition is referring to establishing whether radioactive material is TRU waste. However, the same waste matrix concept also applies to LLW.

435.1-1. The DOE requirements and guidance are consistent with interpretations made by NRC related to the definition of HLW.[7]

Guidance contained in DOE's *Program Execution Plan for Making Determinations that Certain Wastes from Spent Nuclear Fuel Reprocessing are Not High-Level Waste* (DOE 2006b) was also considered in preparation of this procedure, even though this plan does not apply to waste determinations made by the citation process.

Requirements for Waste Incidental to Reprocessing

Chapter 2 of DOE Manual 435.1-1 specifies the applicable requirements as follows:

> "Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not high-level waste, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate. When determining whether spent nuclear fuel reprocessing plant wastes shall be managed as another waste type or as high-level waste, either the citation or evaluation process described below shall be used:
>
> (1) **Citation**. Waste incidental to reprocessing by citation includes spent nuclear fuel reprocessing plant wastes that meet the description included in the Notice of Proposed Rulemaking (AEC 1969) for proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not limited to: contaminated job wastes including laboratory items such as clothing, tools, and equipment.
>
> (2) **Evaluation**[8]. Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that:
>
> (a) Will be managed as low-level waste and meet the following criteria:
>
> 1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and
>
> 2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, *Performance Objectives*; and
>
> 3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form

[7] In NRC 1993, NRC denied a petition from the states of Washington and Oregon to revise the definition of HLW. In this letter, NRC noted that the principles for waste classification are well established and can be applied on a case by case basis without revision to the regulations. NRC noted that certain reprocessing wastes are incidental waste and not HLW, including "ion exchange beds, sludges, and contaminated laboratory items such as clothing, tools, and equipment."

[8] The requirements for the evaluation process are included here for perspective and completeness even though this Citation procedure document does not implement the evaluation process.

at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, *Waste Classification*; or will meet alternative requirements for waste classification and characterization as DOE may authorize.

(b) Will be managed as transuranic waste and meet the following criteria:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and
2. Will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and
3. Are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate."

Events that led to development of these criteria make it clear that citation process waste streams were so identified because of the ease of determining up front that they do not pose the long-term hazards associated with HLW. Evaluation process wastes, on the other hand, generally require a case-by-case evaluation and determination. (DOE Guide 435.1-1, II-17)

Basis for DOE Manual 435.1-1 Requirements

Both the citation and evaluation processes are based on policies initiated by the U.S. Atomic Energy Commission (AEC 1969) and later adopted by the NRC (NRC 1987). Those policies identified spent nuclear fuel reprocessing-related wastes that are not included within the definition of HLW either:

(1) Because of the intrinsic nature of the waste (e.g., not a highly radioactive material that originated during spent nuclear fuel reprocessing) or

(2) Because of the effectiveness of treatment(s) used to remove key radionuclides from waste that meets both disposal site performance objectives and the radionuclide concentration limits of 10 CFR Part 61 (i.e., no longer highly radioactive by virtue of treatment).

These NRC criteria were adopted by DOE for the evaluation process described in DOE Manual 435.1-1.

1.5 Background

As a result of its nuclear materials production mission, SRS generated large quantities of HLW. Much of this waste resulted from spent nuclear fuel reprocessing, that is, dissolving spent reactor fuel and nuclear targets (uranium-based fuel slugs irradiated in the site's nuclear reactors) in acid to recover the valuable isotopes. This waste was stored in 51 underground waste tanks in F-Tank Farm and H-Tank Farm. HLW is still being produced during operation of the H-Canyon reprocessing facility.

The HLW in the underground waste tanks exists mainly in three physical forms: sludge, salt, and liquid. Sludge is the solid material that precipitates and settles at the bottom of the tanks. The salt is made up of salt compounds that crystallize as liquid is concentrated by evaporation. The liquid consists of a highly concentrated salt solution. Some tanks contain all three forms of HLW. Others are considered to be mainly sludge tanks and some are considered to be salt tanks because those waste forms are dominant.

Preparation of this waste for disposal – a key part of the site's nuclear materials management mission – involves many complex processes. These processes include various types of treatment, such as volume reduction by evaporation. The high-activity portion of the HLW is prepared for eventual geologic disposal by vitrification in borosilicate glass, a process that takes place in the Defense Waste Processing Facility (DWPF).

During management and processing of HLW, a variety of tools, equipment, and materials come into contact with the waste in some fashion. Through this incidental contact, these items become contaminated to varying extent with radionuclides in the HLW. The waste-incidental-to-reprocessing process in DOE Manual 435.1-1 was established to determine whether such equipment and material can be managed as LLW or TRU waste instead of HLW.

1.6 Organization of this Procedure

This procedure has six major sections and three attachments.

- Section 1 provides introductory information necessary to help place the information that follows into context.
- Section 2 describes the specific responsibilities of the organizations involved in carrying out the provisions of this procedure.
- Section 3 describes how radioactive waste is managed at SRS, with separate discussions about HLW, LLW, and TRU waste. This section also describes in summary fashion the waste treatment processes and the waste characterization protocols that are relevant to waste determinations by the citation process, along with waste acceptance criteria for the disposal sites of interest.
- Section 4 identifies those waste streams that have been determined not to be HLW by the citation process by referring to Attachment 1. This section describes in detail the citation process for waste-incidental-to-reprocessing determinations. It also specifically identifies waste materials at SRS that are HLW.
- Section 5 describes quality assurance, training, and documentation requirements.
- Section 6 lists references cited in the other sections.
- Attachment 1 is the citation determination. It identifies each secondary waste stream that has been determined not to be HLW by the citation process. It identifies the basis for each determination and the DOE official who made the determination.
- Attachment 2 provides a checklist based on the provisions of this procedure that is to be followed in applying the citation process to other secondary waste streams. The

completed checklist with the associated verification signatures, including the DOE official, is intended to serve as the primary documentation for a citation determination.

- Attachment 3 describes the technical basis for using the citation process for certain equipment that became contaminated by radionuclides from HLW but does not contain a significant amount of waste.

2.0 RESPONSIBILITIES

2.1 U.S. Department of Energy – Savannah River

The Assistant Manager for Waste Disposition Project is responsible for ensuring that a Site-Wide Radioactive Waste Management Program is developed, documented, implemented, and maintained. This individual is also the responsible technical authority for all matters pertaining to HLW, TRU waste, LLW, and mixed waste. (DOE 2005)

Consistent with these responsibilities, the Assistant Manager for Waste Disposition Project has the following specific responsibilities related to this procedure:

- Overall responsibility for its implementation, and
- Approval of citation determinations.

2.2 Site Contractors

The Waste Program Lead for the liquid waste contractor (LWO Waste Program Lead) has overall responsibility for this procedure. The individual in this position is also responsible for providing guidance to waste generators for implementation of this procedure, for assigning numbers for additional citation determinations, and for reviewing additional citation determinations.

The Manager, Environmental Compliance for the liquid waste contractor (LWO, Manager, Environmental Compliance) is responsible for reviewing and approving each additional citation determination.

The Manager, Closure & Waste Disposal Authority for the liquid waste contractor (LWO, Manager, Closure & Waste Disposal Authority) is also responsible for reviewing and approving each additional citation determination.

The Chairman, DOE Order 435.1 Working Group, is responsible for oversight of the implementation of this procedure and coordination of DOE-SR approval of additional citation determinations.

Organizations that generate secondary waste within the scope of this procedure are responsible for compliance with this procedure, including:

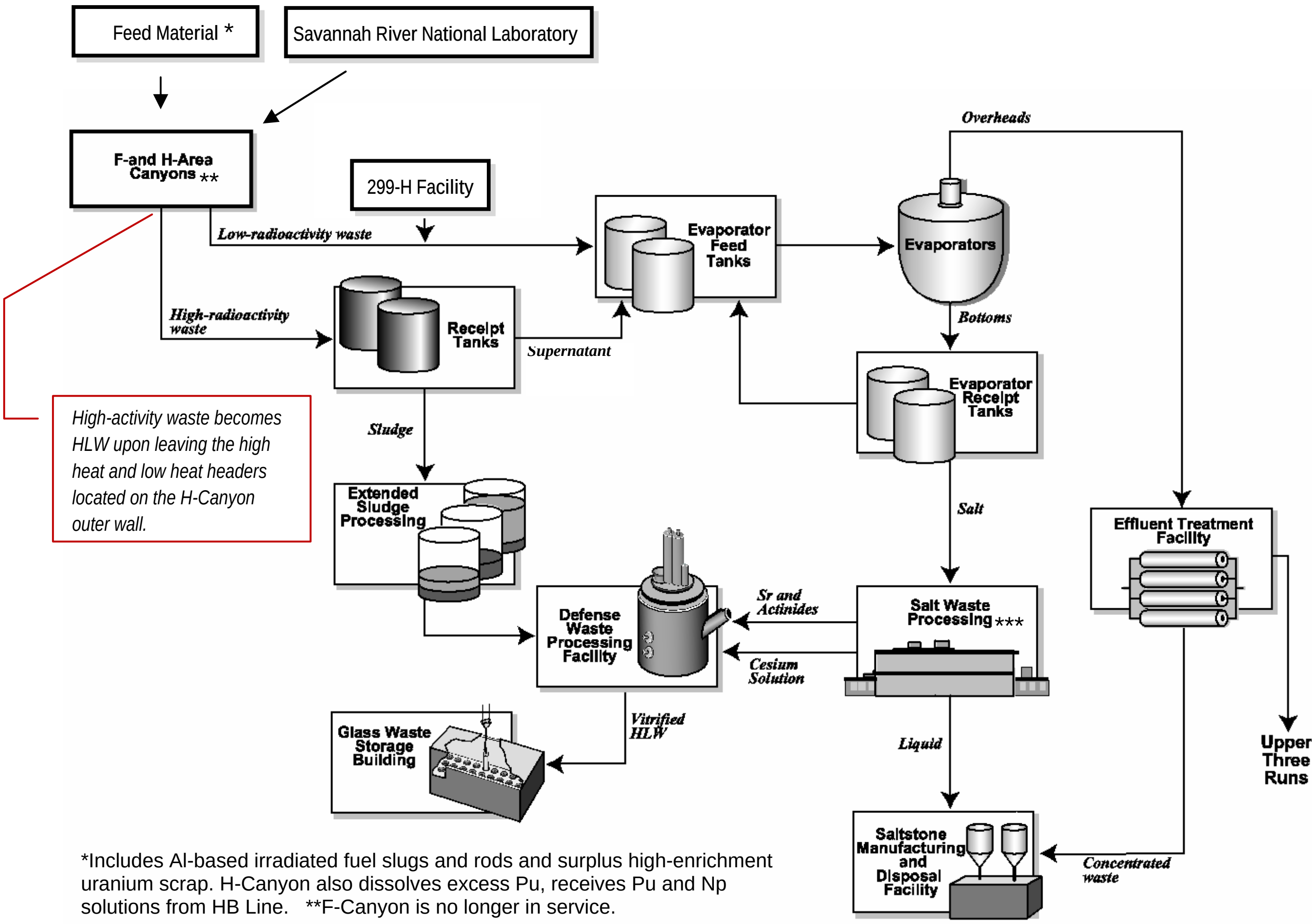
- Initiating the citation determination checklist for secondary waste streams not identified in Attachment 1 to facilitate their disposal;
- Completing Part I of the checklist, completing Part II to the extent practical, and providing for an independent review by the responsible official in the organization that generated the waste;
- Providing the completed, signed Part I checklist to the LWO Waste Program Lead; and
- When information is available to complete Part II of the checklist, completing Part II and providing the completed checklist to the LWO Waste Program Lead.

Maintenance of records related to citation waste determinations is addressed in Section 5.

3.0 WASTE MANAGEMENT AT SRS

3.1 The Radioactive Liquid Waste System

Figure 1 illustrates the general process for HLW management at SRS.



*Includes Al-based irradiated fuel slugs and rods and surplus high-enrichment uranium scrap. H-Canyon also dissolves excess Pu, receives Pu and Np solutions from HB Line. **F-Canyon is no longer in service.

***Full-scale salt waste processing at the Salt Waste Processing Facility is expected to begin in the near future.

Figure 1. Simplified Process Flow for Radioactive Liquid Waste

The SRS Liquid Waste (LW) System consists of an integrated series of facilities for storage, evaporation, waste removal, pretreatment, vitrification, and disposal of waste in the underground HLW tanks. The LW system is used to process and manage this waste to the point where the high-activity waste has been vitrified at DWPF and stored for eventual geologic disposal, and the low activity waste has been incorporated into a grout matrix in the Saltstone Disposal Facility.

Most of the tank waste inventory is a complex mixture of chemical and radioactive waste generated during acid-side separation of special nuclear materials and enriched uranium from irradiated targets and spent fuel. Waste generated from the recovery of Pu-238 in H-Canyon for the production of heat sources is also included. This waste was converted to an alkaline solution where metal oxides settled into a sludge and a soluble supernatant fraction. The soluble supernatant is processed by evaporation to minimize tank volume. The evaporator overheads are sent to the Effluent Treatment Facility for further processing prior to release. (The evaporator overheads are considered to be LLW and are not subject to the waste-incidental-to-reprocessing process in accordance with DOE Guide 435-1, II.B, pages II-20 and II-21.) The evaporator concentrate is cooled to form saltcake, which goes back to the tank farm.

Reprocessing Operations

The production mission of F-Canyon ended in 2002. Historically, F-Canyon operations recovered Pu-239 and U-238 by a chemical separation process (PUREX) after dissolving aluminum-based irradiated fuel slugs or rods from the site's production reactors and other test and research reactors. Pu-239 was produced to support the nuclear weapons stockpile. Depleted uranium (U-238) was recovered in an oxide (solid) form as a by-product and remains stored at SRS pending disposition offsite.

H-Canyon remains in operation with the primary mission to dissolve, purify, and blend-down surplus highly enriched uranium scrap and aluminum-clad highly enriched uranium fuel to produce a low enriched uranium solution suitable for conversion to commercial reactor fuel. H-Canyon has the capability to process irradiated aluminum-clad reactor fuel as well as unirradiated scrap materials from around the DOE complex utilizing the modified PUREX process (the HM or H-Modified process). A secondary mission for H-Canyon is to dissolve excess Pu, receive Pu and Np solutions from HB-Line, and store, neutralize and discard plutonium and neptunium solutions to waste.

Historically, both canyons produced two liquid radioactive waste streams described as high heat waste (high-activity waste) and low heat waste (low-activity waste) generated from the first cycle and the second uranium cycle, respectively. When these streams were neutralized with caustic material, the resulting precipitate settled into four distinct sludges currently found in the tanks where they were originally deposited.

Fission product concentrations are about three orders of magnitude higher in both PUREX and HM high activity waste sludges than the corresponding low activity waste sludges. H-Canyon continues to generate both high-activity waste and low-activity waste, as well as low level liquid waste from processing of unirradiated material.

Waste Removal From Tanks

During waste removal, water treated with corrosion inhibiting chemicals (inhibited water) is added to the waste tanks and agitated by slurry pumps. If the tank contains salt, inhibited water and agitation re-dissolves the saltcake. If the tank contains sludge, inhibited water agitation suspends the insoluble sludge particles. In either case, the resulting liquid slurry, which now contains the dissolved salt or suspended sludge can be pumped out of the tanks and transferred to waste treatment tanks.

Waste removal is a multiyear process. First, each waste tank is retrofitted with slurry and transfer pumps, along with infrastructure to support the pumps, and various service upgrades (power, water, air, and steam). These retrofits take between two and four years to complete. Then, the pumps are operated to slurry the waste. Initially, the pumps operate near the surface of the liquid and are lowered sequentially to the proper depths as waste is slurried and transferred out of the tanks.

Salt Processing

Two different processes are currently being used for processing salt waste:

> ***Actinide Removal Process.*** For salt in selected tanks, even though extraction of the interstitial liquid reduces Cs-137 and soluble actinide concentrations, the Cs-137 or actinide concentrations of the resulting salt are too high to meet the Saltstone Disposal Facility waste acceptance criteria. Salt from these tanks first will be sent to the actinide removal process (ARP). In ARP, actinides are sorbed on mono-sodium titanate particles and filtered out of the liquid to produce a low-level waste stream that is sent to the Modular Caustic Side Solvent Extraction Unit (MCU). If the soluble actinides in the original salt solution are sufficiently low, then the stream will not require the mono-sodium titanate strike and will only be filtered prior to being sent to the MCU.
>
> ***Modular CSSX Unit.*** For tanks with salt that is too high in activity for deliquification to sufficiently reduce Cs-137 concentrations, the salt in these tanks must be further treated to reduce the concentration of Cs-137 using the caustic side solvent extraction (CSSX) process. Salt to be processed will first be processed through ARP and then through the modular CSSX unit.

The Salt Waste Processing Facility incorporates the full-scale CSSX process, making use of both the ARP and CSSX processes in a full-scale shielded facility capable of handling salt with high levels of radioactivity. When hot operations of the Salt Waste Processing Facility begin, all remaining salt waste will be processed through this facility.

Sludge Processing

Sludge is “washed” to reduce the amount of non-radioactive soluble salts remaining in the sludge slurry that would interfere with the vitrification process. The processed sludge is called “washed sludge.” During sludge processing, large volumes of wash water are generated and must be volume-reduced by evaporation. Over the life of the waste removal program, the sludge currently stored in tanks at SRS will be blended into separate sludge batches to be processed and fed to DWPF for vitrification.

DWPF Vitrification

Final processing of the washed sludge and salt waste occurs at DWPF. This waste includes monosodium titanate /sludge from ARP or the Salt Waste Processing Facility, the cesium strip effluent from MCU or the Salt Waste Processing Facility, and the washed sludge slurry. This waste is blended with glass frit and melted to vitrify it into a borosilicate glass form.

The resulting molten glass is poured into stainless steel canisters. After the canisters have cooled, they are permanently sealed and the external surfaces are decontaminated. The canisters are stored on an interim basis onsite in a Glass Waste Storage Building, pending shipment to a federal repository for permanent disposal. A low-activity recycle waste stream from DWPF is returned to the Tank Farms.

Saltstone Onsite Disposal of LLW

The Saltstone Facility consists of two facility segments: the Saltstone Production Facility and the Saltstone Disposal Facility. The Saltstone Production Facility receives and treats the decontaminated salt solution to produce grout by mixing the LLW liquid stream with cementitious materials (cement, flyash, and slag). A slurry of the components is pumped into the disposal vaults, located in the Saltstone Disposal Facility, where the saltstone grout solidifies into a monolithic, non-hazardous, solid LLW form. The Saltstone Disposal Facility is permitted as an industrial solid waste landfill site.

The LW System and HLW

As noted previously, HLW is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation. This material includes:

- The contents of the underground waste tanks prior to treatment and processing;
- Washed sludge removed from the underground waste tanks that is transferred to DWPF for vitrification;
- The waste stream containing cesium, strontium, and actinides removed from salt waste during treatment that is transferred to DWPF for vitrification; and
- The resulting canisters of vitrified HLW.

Equipment and material that has come in contact with this waste are subject to the citation process described in this procedure or the evaluation process per DOE Order 435.1 or Section 3116. Any equipment or material that has come in contact with HLW that does not satisfy criteria of this citation or the evaluation process will be classified and managed as HLW.

Exposure of Tools, Equipment, and Materials to HLW

Tools, equipment, and materials may be contaminated with radionuclides from HLW at certain points in the process, mainly in the underground HLW tanks, in the evaporation process, at DWPF, and at Savannah River National Laboratory (SRNL) where samples of HLW are analyzed or used for additional research and development activities. Examples of such materials and equipment include:

- Pumps used in HLW tanks,
- Piping jumpers used in transfer of HLW,
- Equipment used in DWPF, such as the vitrification melter;
- Laboratory equipment used in analysis of samples or used for additional research and development activities; and
- Unused sample aliquots from sample analysis or research and development activities.

Such items become secondary waste when they are no longer being used for their intended purpose and cannot be used in another application or recycled. At this point, items are rejected to waste and must be classified as HLW or determined not to be HLW by the citation or evaluation process.

The canyons are production facilities that do not process waste. Therefore the equipment in the canyons is not subject to the waste-incidental-to-reprocessing process because the canyons do not contain HLW. Equipment in the canyons that is no longer usable and cannot be recycled is classified as either LLW or TRU waste depending on the concentrations of transuranic radionuclides.

3.2 Low-Level Waste

SRS produces LLW in a variety of activities, including decontamination and decommissioning and environmental remediation work. This LLW is disposed of onsite, at other DOE facilities, or at commercial disposal facilities. A more detailed discussion of LLW disposal facilities used by SRS, their waste acceptance criteria, and their performance assessments can be found in Attachment 3.

Onsite Disposal of LLW

In addition to disposal of LLW in the Saltstone Disposal Facility, disposal of LLW onsite to takes place at the E-Area Low-Level Waste Facility. This facility contains various disposal units: the Slit Trenches, Engineered Trenches, Component-in-Grout Trenches, the Low-Activity Waste Vault, the Intermediate-Level Vault, and the Naval Reactors Component Disposal Area. Waste acceptance criteria for the E-Area Low-Level Waste Facility are found in the 1S Manual, Procedure WAC 3.17 (SRNS 2009a).

The performance objectives for DOE LLW disposal facilities are identified in DOE Manual 435.1-1. A detailed performance assessment (WSRC 2008) demonstrates that the E-Area Low-Level Waste Facility will perform as required after it is closed.

Offsite Disposal of LLW

SRS disposes of some LLW offsite. Two offsite facilities that have been used for this purpose are the Nevada Test Site and the Energy*Solutions* disposal facility at Clive, Utah.

Procedure WAC 3.17 (SRNS 2009a) identifies the Nevada Test Site as a disposal facility for LLW that cannot be disposed of at SRS. The Nevada Test Site provides specific radionuclide waste acceptance criteria for LLW (DOE 2008). These waste acceptance criteria are based on a performance assessment that provides reasonable expectation that DOE's performance objectives will be achieved and that the predicted potential doses to representative members of the public will be much less than the performance objective dose limits.

The Energy*Solutions* Clive, Utah facility is licensed by the State of Utah to dispose of Class A LLW and mixed waste, including radioactively contaminated soil and large components. Procedure WAC 3.17 (SRNS 2009a) identifies the Clive, Utah Energy*Solutions* disposal facility as an acceptable disposal facility for LLW that cannot be disposed of at SRS.

Energy*Solutions* specifies waste acceptance criteria for its Bulk Waste Disposal and Treatment Facilities (Energy*Solutions* 2006) and separately for its Containerized Waste Facility

(Energy*Solutions* 2008). The waste acceptance process involves developing a radioactive waste profile record that is approved by the facility prior to waste shipment.

Waste Acceptance Criteria and Disposal Site Performance

Because of the established relationship between the waste acceptance criteria and performance assessments of the waste disposal sites, satisfying the waste acceptance criteria ensures compliance with the disposal site performance assessment and, hence, with the performance objectives. That is, implementation of the waste acceptance criteria provides assurance that inventories in different parts of the disposal facility comply with performance assessment requirements.

3.3 Transuranic Waste

Like other DOE sites, SRS sends TRU waste to DOE's Waste Isolation Pilot Plant (WIPP) for geologic disposal. This waste is typically shipped in vented Department of Transportation Type A 55-gallon drums that meet the WIPP waste acceptance criteria, which are contained within Type-B shipping casks such as TRUPACT-II containers.

3.4 Mixed Waste

Mixed waste is not disposed of onsite at the Savannah River Site. It is shipped to the Nevada Test Site, to the Energy*Solutions* Clive, Utah facility, or to another suitable facility for any necessary treatment and offsite disposal.

3.5 Decontamination

It is a requirement and a standard practice at SRS to decontaminate equipment contaminated by HLW. This practice is required to minimize worker radiation exposure consistent with the ALARA (as low as reasonably achievable) principle. (10 CFR 835.101, DOE Policy 441.1, DOE Order 5400.5).

Equipment contaminated by HLW is decontaminated prior to removal from service, during the removal process, or after removal, and in some cases, by a combination of these processes. The first two decontamination processes are considered to be field decontamination processes. The third process takes place at the Building 299-H Maintenance Facility or at DWPF.

Field decontamination involves activities such as flushing equipment connected to working systems and rinsing equipment removed from underground waste tanks with water until there is no visible sign of salt or sludge. Decontamination performed at Building 299-H and DWPF makes use of more robust processes such as acid soaking and spraying with high pressure steam or decontamination solutions.

Details on implementation of the ALARA process at SRS and the related decontamination processes are provided in Attachment 3. Experience has shown that the standard decontamination processes remove key radionuclides from equipment that comprise secondary waste to the maximum extent technically and economically practical.

3.6 Waste Characterization

SRS requirements for characterization of LLW, TRU waste, mixed waste, and PCB waste are described in 1S Manual, Procedure WAC 2.02 (SRNS 2008a). This procedure describes methods to be used to determine the characteristics of a waste stream, including its predominant radionuclide content and distribution. The contents of each waste package are required to be quantified in terms of the physical, chemical, and radiological characteristics.

Attachment 3 provides additional information on waste characterization.

4.0 CITATION DETERMINATION AND CITATION PROCESS

Lessons learned at SRS and other DOE sites that manage HLW (as detailed in Attachment 3) were used in developing this procedure.

4.1 Lessons Learned

DOE Guide 435.1-1 provides examples that are useful in implementing the requirements for citation determinations. Experience at DOE sites in implementing these requirements has led to the following lessons learned that have been applied in following the citation process:

> ***Make use of the concept of secondary waste***. Secondary waste consists of waste by-products resulting from the management, retrieval, treatment, storage, handling, analysis, and/or disposal of HLW that have become radioactively contaminated by such waste. Therefore, secondary waste comprises the materials and equipment of potential interest in citation determinations.
>
> ***Consider the limited potential for residual waste in many components and pieces of equipment that have been contacted by HLW***. DOE manual 435.1-1 states on page II-20:
>
>> ". . . review of available supporting documentation has concluded that although contaminated components and equipment are not high-level waste, they can, and often do, retain significant amounts of residual waste even after extensive decontamination efforts. Therefore, it is considered inappropriate for such components and equipment to qualify under the citation process."
>
> Experience has shown that most components and equipment that have been contacted by HLW have a limited potential for retaining significant amounts of residual waste. Some by virtue of their configuration have no hidden surfaces where waste could accumulate. In most cases, residual waste is readily removed by standard decontamination processes, which are required for ALARA purposes to support further management of the components or equipment. Consequently, it is not appropriate to apply the guidance in DOE Guide 435.1-1 in a blanket fashion since it does not apply to those components and pieces of equipment where use of the citation process can be shown to be justified because of the low potential for containing a significant amount of residual waste and/or the effectiveness of the decontamination process.
>
> ***Consider the effects of decontamination processes***. As explained previously, it is a requirement and standard practice to decontaminate tools and equipment removed from underground waste tanks and other equipment contaminated with radionuclides from HLW for worker protection and ALARA purposes. Experience has shown that such decontamination is effective in removing residual waste, for example:
>
> - All tank farm equipment contaminated with supernatant, which is soluble in water, can be effectively decontaminated by rinsing the internals and flushing the exterior with water, unless the equipment is plugged with waste;
> - All tank farm equipment contaminated with sludge, which is relatively insoluble in water, can be effectively decontaminated by the same processes, except for

equipment plugged with waste and the volutes of slurry pumps which by design tend to trap sludge;

- The robust decontamination processes used at the Building 299-H facility have proven to be very effective in removing residual waste in tank farm equipment with complex internal configurations that can trap waste; and
- The robust decontamination processes used for DWPF equipment at that facility have also proven very effective in removing residual waste.

The amounts of residual waste in laboratory equipment are usually insignificant. As indicated above, DOE Manual 435.1-1 states that laboratory equipment is among the radioactive wastes resulting from reprocessing plant operations appropriate for the citation process. Small amounts of residual liquid associated with spent nuclear fuel reprocessing contained in laboratory equipment, such as sample aliquots, are appropriately treated in the same fashion. At SRS, larger amounts of residual liquid are routinely returned to the tank farm by use of the SRNL High Activity Drain System.

4.2 Citation Determination

Procedure HLW-SUP-99-0060 (WSRC 2000) identifies materials and equipment that had been determined not to be HLW by the citation process in Attachment 4. This procedure includes these materials and equipment in Attachment 1. This procedure also identifies in Attachment 1 additional materials and equipment that have been determined to not be HLW by the citation process since Procedure HLW-SUP-99-0060 (WSRC 2000) was issued.

Attachment 1 identifies the basis for the determination that the material or equipment is not HLW, citing both the documentation and the name of the DOE official who approved the determination. Attachment 3 provides additional information on the basis for certain material and equipment not included in Procedure HLW-SUP-99-0060 (WSRC 2000) not being HLW.

As stated previously, F-Canyon and H-Canyon do not and have not contained HLW. By-products of the canyons do not become HLW until they leave the high heat and low heat headers, i.e., the point of rejection as waste. Consequently, equipment and material in the canyons or removed from the canyons are not within the scope of the waste-incidental-to-reprocessing process and are to be classified as either LLW or TRU waste depending on transuranic radionuclide concentrations, or their mixed waste counterparts, as noted previously.

4.3 Process for Additional Determinations by Citation

Section 1.4 of this procedure describes the requirements of DOE Manual 435.1-1 for the citation process. The key portion of the requirements reads as follows:

> “Waste incidental to reprocessing by citation includes spent nuclear fuel reprocessing plant wastes that meet the description included in the Notice of Proposed Rulemaking (AEC 1969) for proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not limited to: contaminated job wastes including laboratory items such as clothing, tools, and equipment.”

The citation process is intended to produce an *a priori* determination that the secondary waste stream of interest is not HLW. That is, consideration of the source of the waste, process knowledge, and typical characterization data would make it obvious and self evident that the waste stream:

(1) Was not produced during spent nuclear fuel reprocessing;

(2) Is not highly radioactive (that is, meets waste disposal criteria for LLW or TRU waste); and

(3) Does not contain fission products in sufficient concentrations to require permanent isolation.

The citation process is primarily intended for secondary waste streams that will be managed in the same way every time, that is, for repetitive type situations. However, this limitation does not mean that it cannot be used for a unique waste stream that would clearly meet other conditions for the citation process. Note that the size of the component or equipment is not a factor in whether the citation process is appropriate.

Use of the Evaluation Criteria

In some cases, consideration of the waste-incidental-to-reprocessing evaluation criteria specified in Section 1.4 was useful to inform the decision on the citation determination. Utilization of this approach depended on the complexity of the secondary waste stream and its potential for retaining residual waste. In such cases, consideration will be given to these criteria as part of the citation determination on an informal basis.

Use of the Attachment 2 Checklist

The checklist contained in Attachment 2 has been developed to facilitate use of the citation process. It addresses each key point to be considered in making the determination about whether a particular secondary waste stream can be managed as LLW or TRU waste or their mixed waste counterparts.

Note that the checklist is divided into two parts. The first part focuses on making sure that the use of the citation process is appropriate for the subject secondary waste stream.

This part of the checklist involves consideration of the nature of the secondary waste stream, how it came to be associated with HLW, and whether it is clear without detailed analysis that it could not contain a significant amount of waste due to its design, its use, or its decontamination, or due to some combination of these factors.

The second part of the checklist focuses on how the secondary waste stream will be managed as LLW or TRU waste (or their mixed waste counterparts). Completion of this part of the checklist confirms that the subject waste package(s) meets disposal site waste acceptance criteria and therefore will not impact disposal site performance.

The two parts of the checklist together establish the technical basis for managing the subject secondary waste stream as LLW or TRU waste (or their mixed waste counterparts) in a manner consistent with DOE requirements and guidance. The completed signed checklist, along with the cited supporting material, documents the completion of the citation determination process.

Figure 2 illustrates the checklist process. The objective and application of each checklist topic are discussed below.

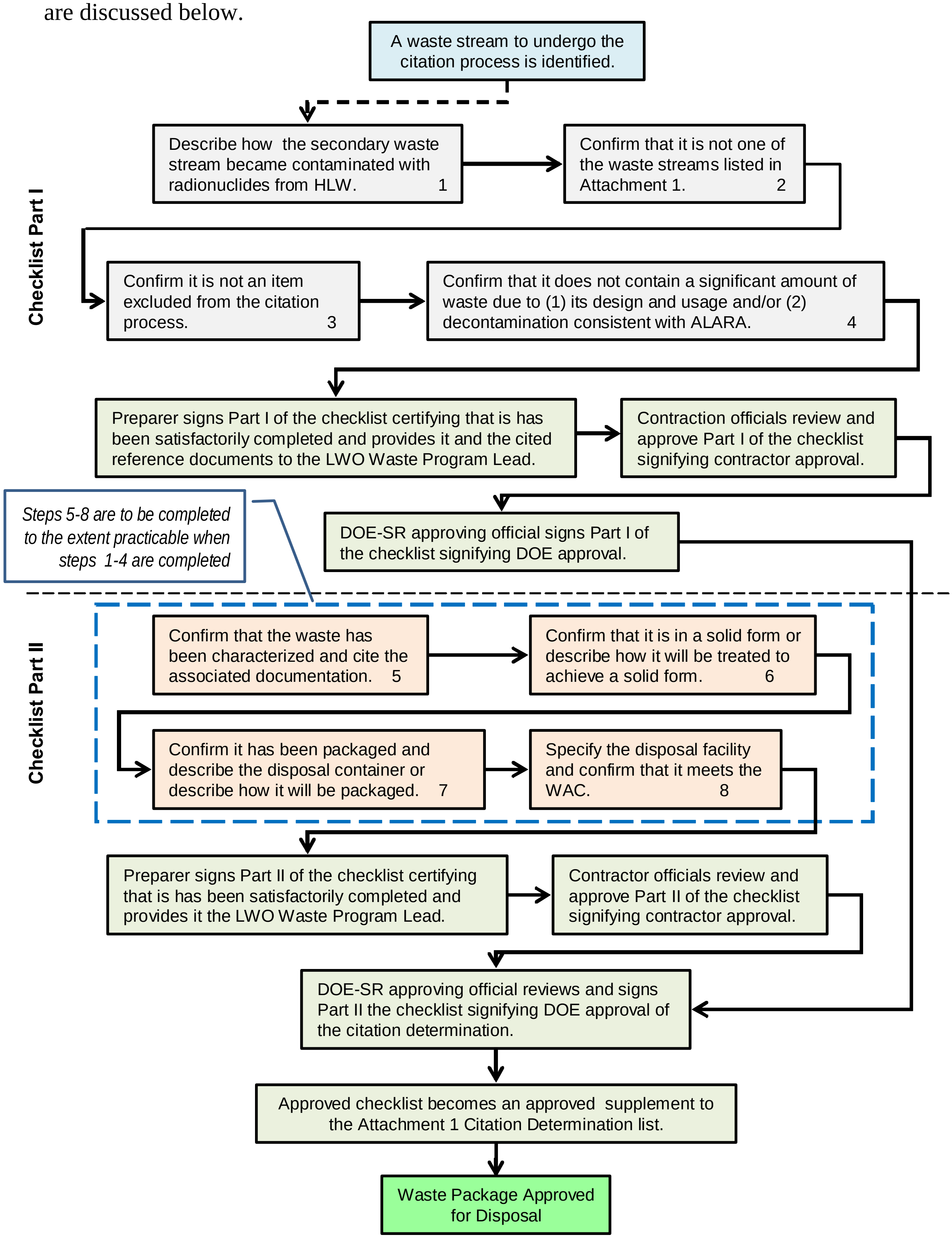


Figure 2. Citation Determination Process

As noted previously, the checklist is divided into two parts, with Part I focusing on ensuring that the waste stream is appropriate for the citation process and Part II focusing on how the waste stream will be managed.

The checklist is to be completed for a new secondary waste stream as indicated using an electronic copy of Attachment 2 as explained below. The preparer will obtain a citation number from the Waste Program Lead. The preparer is to place an "x" or check mark in the check (third) column to signify completion of each topic. The "Remarks" column is to be used for clarifying information. Where appropriate, illustrations (figures) or other documents are to be included with the checklist to ensure that the waste stream description is clear.

NOTE

In many cases, it will not be practical to complete each topic in Part II of the checklist at the time Part I is completed. To accommodate this situation, the checklist cover in Attachment 2 provides signature blocks for both Part I and Part II.

Part I (Criteria that must be satisfied to declare the secondary waste to be non-HLW)

(1) *Describe how the secondary waste stream became contaminated by HLW:* ________________________________.

Objective: To ensure that those involved in the citation process understand how the subject waste became contaminated by HLW and that this matter is clearly documented.

Application: Provide a brief, clear explanation in the checklist.

(2) *Confirm that the secondary waste stream is not one of the waste streams listed in Attachment 1 for which a citation determination has already been made.*

Objective: To help avoid duplication.

Application: Check the approved citation in Attachment 1 and the approved supplements to the Attachment 1 list. If the subject material or equipment is already covered, then no additional citation determination is needed.

(3) *Confirm that the secondary waste stream is not one of the following items that are excluded from the citation process: ion exchange beds, sludges, or process filter media.*

Objective: To help ensure that the citation process is not used improperly.

Application: Confirm that the subject material or equipment is not one of these excluded items. If it is not, then proceed with the subsequent checklist topics.

(4) *Confirm that the secondary waste stream does not contain a significant amount of waste due to (1) its design and usage and/or (2) decontamination consistent with ALARA based on* __________________________.

Objective: To document the basis for the secondary waste stream not containing a significant amount of residual waste to help ensure that the citation process is not used improperly.

Application: Describe why it is evident that the component or piece of equipment could not contain a significant amount of waste because of its design and usage, if this is the case. Also, identify the method used for decontamination and cite the applicable work instruction or other document.

As discussed above, one of the lessons learned in application of the waste-incidental-to-reprocessing process is that certain components and equipment contaminated by HLW could not retain significant amounts of waste and/or can be easily decontaminated. The citation process can be applied to such equipment if it is evident without detailed analysis (1) that it could not contain a significant amount of waste because of its design or use, or (2) it has been decontaminated to remove key radionuclides consistent with ALARA requirements. Note that decontamination would not be necessary for ALARA purposes for some components or equipment which could have only low levels of contamination.

The conclusion as to whether any residual waste represents a "significant amount" is based on observational factors such as (1) the absence of visual evidence of waste, such as saltcake adhering to a tool; (2) radiation levels being much lower than those associated with HLW; and (3) the use of a proven decontamination process is cases where decontamination is necessary consistent with the ALARA principle.

Part II (Criteria that must be satisfied to dispose of the secondary waste)

(5) *Confirm that the secondary waste stream has been characterized and cite the associated calculation or other documentation.*

Objective: To document that characterization of the waste has been accomplished.

Application: Identify the characterization documentation such as the calculation. Note that the secondary waste stream does not have to be individually characterized; it is acceptable to simply place it into a waste package with other similar waste and characterize that waste package. (If characterization is to be accomplished later, note this plan in the remarks.)

(6) *The secondary waste stream will be treated prior to disposal to incorporate it into a solid physical form (if this has not already been done) as follows: __________________.*

Objective: To document that the secondary waste is or will be in a solid physical form prior to disposal.

Application: In a case where the secondary waste stream is already in a solid form, so indicate in the remarks and insert "not applicable" in the blank space in the "criterion" column. In a case where the secondary waste stream is not in a solid form, briefly describe how it will be solidified, such as by incorporation into a cement matrix within the waste container.

(7) *Confirm that the secondary waste stream has been packaged for disposal and describe the disposal container or describe how it will be packaged:* ______________________.

Objective: To document how the waste is packaged and the type of container used.

Application: Verify that the waste has been packaged for disposal and specify the type of waste container. In cases where the secondary waste will not fill a standard waste container, it may be placed in a waste container with other waste having similar characteristics. (If packaging is to be accomplished later, identify the planned disposal container in the remarks column.)

(8) *Specify the disposal facility and confirm that the secondary waste stream meets the waste acceptance criteria.*

Objective: To document this key information, which also serves to confirm that the waste package will not adversely impact performance of the waste disposal facility.

Application: Provide the indicated information. Including the waste package in the Waste Information Tracking System (WITS) ensures that LLW and TRU waste meets the applicable waste acceptance criteria. In the case of mixed waste, including the waste package in the E-14 program ensures that applicable waste acceptance criteria are met. (If confirmation of meeting the waste acceptance criteria is to be accomplished later, so indicate and identify the planned disposal facility in the remarks column.)

Checklist Review and Approval

After completion of Part I, the checklist and any associated documentation will be provided to the LWO Waste Program lead who will perform a review to ensure that the checklist has been appropriately completed in accordance with this procedure and that the associated documentation supports the determination that the secondary waste stream is not HLW.

The site contractor LWO Manager, Environmental Compliance, will then review and sign to document approval of Part I of the checklist.

The site contractor LWO Manager, Closure & Waste Disposal Authority, will then review and sign to document approval of Part I of the checklist.

The contractor-approved Part I checklist will then be provided to the DOE-SR official for approval of the determination.

A similar process will be followed for review and approval of Part II of the checklist.

After both parts of the checklist have been approved by DOE-SR, the checklist will be distributed to interested parties and controlled and maintained as specified in Section 5.3.

4.4 Required Documentation

Attachment 1 to this procedure as approved by DOE serves as the documentation for the citation determination for those items listed in Attachment 1, as supported by the documents listed in the Basis for Non-HLW column in Table 1. The documentation for additional citation determinations (supplements to this procedure) will consist of the approved Attachment 2 checklist along with the associated supporting documents cited in the checklist.

Each approved checklist will be assigned a supplement number and will become an approved supplement to this procedure. These approved supplements will be maintained with controlled copies of this procedure. Section 5.3 provides requirements for control of these records.

5.0 QUALITY ASSURANCE AND DOCUMENTATION

5.1 Controls to Assure Quality in Waste Determinations Made by the Citation Process

The persons preparing, reviewing, and approving additional waste determinations made by the citation process are responsible for following the procedures of the site 1Q Manual, *Quality Assurance* (SRNS 2009b), as they apply to the activities involved. These procedures include:

QAP 1-1	Organization
QAP 2-1	Quality Assurance Program
QAP 2-2	Personnel Training and Qualification
QAP 6-1	Document Control
QAP 17-1	Quality Assurance Records Management
QAP 19-2	Quality Improvement

Each individual is responsible for the quality of his or her own work.

5.2 Training

The persons who prepare information for additional waste determination made by the citation process by completing the Attachment 2 checklist shall be knowledgeable of the contents of this procedure and the key technical standards on which it is based, DOE Manual 435.1-1 and DOE Guide 435.1-1. This knowledge may be gained by self study or by briefings or a combination of both. Briefings on these matters can be provided by the Waste Program Lead for the liquid waste contractor.

5.3 Records Control and Maintenance

Copies of the approved additional waste determinations made by the citation process become supplements to this procedure. This procedure and the associated supplements become QA records after they are authenticated by being signed and dated.

The signed and dated procedure and the associated supplements are to be maintained in accordance with Procedure Manual 1B, MRP 3.31, *Records Management* (WSRC 2006). Copies will also be provided to onsite LLW disposal facility personnel.

6.0 REFERENCES

Federal Statutes

Atomic Energy Act of 1954, as amended

Code of Federal Regulations

10 CFR 50, *Domestic Licensing of Production and Utilization Facilities.*

10 CFR 61, *Licensing Requirements for Land Disposal of Radioactive Waste.*

10 CFR 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes.*

10 CFR 835, *Occupational Radiation Protection.*

DOE Orders, Policies, and Technical Standards

DOE Order 435.1, *Radioactive Waste Management.*

DOE Order 5400.5, Change 2, *Radiation Protection of the Public and the Environment*. U.S. Department of Energy, Washington, D.C., January 7, 1993.

DOE Policy 441.1, *Department of Energy Radiological Health and Safety Policy*. U.S. Department of Energy, Washington, D.C., April 26, 1996.

DOE Manual 435.1-1, *Radioactive Waste Management Manual*.

DOE Guide 435.1-1, *Implementation Guide for use with DOE M 435.1-1, Chapter II, High-Level Waste Requirements.*

Other References

AEC 1969, *Proposed Policy (Appendix D to 10 CFR Part 50) on the Siting of Commercial Fuel Reprocessing Plants and Related Waste Management Facilities; Statement of Proposed Policy*, 34 FR 8712, U.S. Atomic Energy Commission, Washington, D.C, June 3, 1969).

DOE 2005, *Radioactive Waste Management Manual*, SRM 435.1B. U.S. Department of Energy, Savannah River, Aiken, South Carolina, July 1, 2005.

DOE 2006a, *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, DOE-WD-2005-001. U.S. Department of Energy, Savannah River, Aiken, South Carolina, January 2006.

DOE 2006b, *Program Execution Plan For Making Determinations that Certain Wastes from Spent Fuel Reprocessing are Not High-Level Waste*. U.S. Department of Energy, Office of Environmental Management, Washington, D.C., June 2006.

DOE 2008, *Nevada Test Site Waste Acceptance Criteria*, DOE/NV-325-Rev. 7 (or later revision). U.S. Department of Energy, National Nuclear Security Administration, Nevada Site Office, Waste Management Project, Las Vegas, Nevada, June 2008.

Energy*Solutions* 2006, *EnergySolutions Bulk Waste Disposal and Treatment Facilities Waste Acceptance Criteria*, Revision 7 (or later revision). EnergySolutions, Salt Lake City, Utah, March 15, 2006.

Energy*Solutions* 2008, *EnergySolutions Containerized Waste Facility Waste Acceptance Criteria*, TSC-2.0, Revision 7 (or later revision). EnergySolutions, Salt Lake City, Utah, November 2008.

Hanford 2008, *Waste Incidental to Reprocessing (WIR) Determinations*, Procedure ESQ-EM-IP-M435.1-1-01, Revision 0. Office of River Protection. U.S. Department of Energy, Richland, Washington, September 11, 2008.

INTEC 2001, *Waste-Incidental-to-Reprocessing (WIR) Citation Determination Report for Contaminated Job Waste at the Idaho Nuclear Technology and Engineering Center*, DOE/ID-10832, Revision 0. U.S. Department of Energy Idaho Operations Office, Richland, Idaho, October 2001.

NRC 1987, *Proposed Rulemaking, 10 CFR Part 60, Definition of "High-Level Radioactive Waste"*, 52 FR 5993, U.S. Nuclear Regulatory Commission, Washington, D.C., February 27, 1987.

NRC 1993, *Letter from R.M. Bernero (NRC) to J. Lytle (DOE) describing Commission review of a rulemaking partition from the states of Washington and Oregon on Hanford tank wastes*. U.S. Nuclear Regulatory Commission, Washington, D.C., dated March 2, 1993.

SRNS 2008a, *Low-Level, Hazardous, TRU, Mixed, and PCB Waste Characterization Requirements*, Procedure WAC 2.02, Revision 12 (or later revision), Savannah River Site Waste Acceptance Criteria Manual, Manual 1S. Savannah River Nuclear Solutions, Aiken, South Carolina, October 31, 2008.

SRNS 2008b, *Waste Acceptance Criteria, Program Requirements for Radioactive Waste*, Procedure WAC 1.02, Revision 8 (or later revision), Savannah River Site Waste Acceptance Criteria Manual, Manual 1S. Savannah River Nuclear Solutions, Aiken, South Carolina, December 31, 2008.

SRR 2009, *Liquid Waste Disposition System Plan*, SRR-LWP-2009-00001, Revision 15. Savannah River Remediation LLC, Aiken, S.C., September 24, 2009.

SRNS 2009a, *Low-Level Radioactive Waste Acceptance Criteria*, Procedure WAC 3.17, Revision 11 (or later revision), Savannah River Site Waste Acceptance Criteria Manual, Manual 1S. Savannah River Nuclear Solutions, Aiken, South Carolina, January 15, 2009.

SRNS 2009b, *Quality Assurance Manual*, Procedure Manual 1Q. Savannah River Nuclear Solutions, Aiken, South Carolina, December 3, 2009 (or later revision).

U.S. Congress 1992, *The Waste Isolation Pilot Plant Land Withdrawal Act, Public Law 102-57*, as amended by Public Law 104-201 (H.R. 3230). 104th United States Congress, Washington, D.C., 1992.

U.S. Congress 2004**,** *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*, Public Law 108-375, 118 Stat. 1811. 108th United States Congress, Washington, D.C., October 28, 2004.

WSRC 2000, *Citation Determination and Evaluation of Waste Incidental to Reprocessing*, Procedure HLW-SUP-99-0060, Revision 0. Westinghouse Savannah River Company, Aiken, South Carolina, April 1, 2000.

WSRC 2006, *Records Management*, Procedure Manual 1B, MRP 3.31, Revision 8 (or later revision). Westinghouse Savannah River Company, Aiken, South Carolina, December 15, 2006.

WSRC 2008, *E-Area Low-Level Waste Facility DOE 435.1 Performance Assessment*, WSRC-STI-2007-00306, Revision 0 (or later revision). Washington Savannah River Company, Aiken, S.C., July 2008.

WVNSCO 2007, *Waste Incidental to Reprocessing Determination*, WV-929, Revision 7. West Valley Nuclear Services Company, West Valley, New York, March 27, 2007.

ATTACHMENTS

1. Citation Determination
2. Citation Process Checklist and Determination Documentation
3. Basis for Use of the Citation Process for Key Secondary Waste Streams

SUPPLEMENTS

Copies of additional citation waste determinations made in accordance with the process described in Section 4.3 will be maintained with controlled copies of this procedure.

ATTACHMENT 1 – CITATION DETERMINATION

The purpose of this attachment is to document citation determinations that have been made as of the date of this procedure. These determinations have been made by the DOE-SR Assistant Manager, Waste Disposition Project or by other designated DOE officials under the authority described below.

1.0 Authority

DOE is responsible for determining the classification of radioactive wastes managed pursuant to its authority under the Atomic Energy Act of 1954, as amended, and DOE policy as set forth in DOE Order 435.1 and DOE Manual 435.1-1. DOE Manual 435.1-1, Chapter I.2.F(18) authorizes DOE field element managers to make citation process waste determinations on their own authority.

At the Savannah River Site, this authority has been delegated by the Manager, DOE-SR (the field element manager) to the Assistant Manager for the Waste Disposition Project. Delegation of this responsibility is consistent with DOE Manual 435.1-1 and with DOE Guide 435.1-1, which states that field element managers are responsible for the "identification of the site organizations that are responsible for formulating and approving the determinations..." (DOE Guide 435.1-1, Chapter I, page I-174).

2.0 Approval

The equipment and materials listed in Table 1 have been determined not to be HLW by the citation process based on documentation identified in Table 1 and additional information provided in Attachment 3. They are not HLW based on their origin and characteristics, that is, they were not produced during reprocessing of spent nuclear fuel, are not highly radioactive (i.e., will meet waste acceptance criteria for disposal as LLW of TRU waste), and do not contain fission products in sufficient concentrations so as to require permanent isolation. They are to be managed and disposed of as LLW or TRU waste, or as mixed LLW or mixed TRU waste when appropriate.

[signature] 4-27-10

DOE-SR, Assistant Manager for Waste Disposition Project — Date

General Categories of Equipment and Material

Table 1 identifies the following categories of equipment and materials:

(1) Contaminated job waste;

(2) Sample media;

(3) Measuring and Monitoring Equipment;

(4) Laboratory Clothing, Tools, and Equipment;

(5) Decontamination Media and Decontamination Solutions;

(6) Remote Handling Devices and Processing Support Equipment;

(7) Decontaminated Tank Farm Equipment, Including Equipment Removed from HLW Tanks

(8) Decontaminated DWPF equipment; and

(9) Other Materials and Equipment.

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
1	**Contaminated job waste of any type** (protective clothing, personal protective equipment, work tools, ventilation filter media, and other job-related materials necessary to complete HLW management). This waste includes but is not limited to: • Hand tools (e.g., screw drivers, wrenches, hammers, etc.) • Electrical tools (e.g., drills, grinders, etc.) • Job control wastes (e.g., paper, plastic, rubber, metal, cloth items, tape, survey media, postings/signs, step-off-pads, ropes, and barricades) • Temporary containment materials (e.g., huts, windbreaks, glove bags, drip containment) • Ventilation system HEPA filters • Personnel protective equipment (e.g., clothing, respiratory equipment) • Hoses • Electrical cords • Radiological monitoring equipment including wipes, smears, filters, probes, etc.	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann).
2	**Sample Media** (e.g., sampling vials, crucibles, and other hardware). This waste includes but is not limited to: • Lab ware (e.g., funnels, beakers, cylinders, stir bars, flasks, sample bombs)	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann).

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
	• Thermometers • Sample vials, vessels, and bottles • Sample carriers • Tongs • Syringes and needles • Planchets, crucibles and crucible lids	
3	**Measuring and Monitoring Equipment**. This waste includes but is not limited to: • Reel tapes • Steel tapes • Instruments and gages • Level indicators • Pressure indicators • Temperature indicators, thermocouples in wells • Density/specific gravity indicators • Conductivity probes • In-line monitors	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann).
4	**Laboratory Clothing, Tools, and Equipment**. This waste includes but is not limited to: • Lab coats, gloves, tape, hoods, shoe covers, coveralls • Wipes, swabs, absorbent materials, towels • Laboratory balances and scales • Centrifuges • Grinding equipment for solid samples and lab ware • Electronic chemical and radioactivity measuring equipment and probes/detectors • Cables and cords • Heating equipment (e.g., hot plates, ovens, furnaces, microwave ovens) • Weighing equipment (e.g., balances and scales) • Laboratory instrumentation with associated wiring, plumbing, tubing, etc. • Laboratory quantities of contaminated resins, reagents, aliquots • Empty laboratory containers (e.g., leach buckets, mixing containers, digestion vessels) • Glove-boxes, hoods, and associated equipment • Empty (HLW drained, emptied, flushed, or otherwise removed) laboratory scale research melters • Refractory pieces from SRNL pilot scale melter	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann). DOE-SR letter from T.J. Spears to William Tadlock of SRNL dated 4/15/08 specifically approved a citation determination for liquid in two 10 mL vials consisting of aliquots of pretreated materials generated during Hanford treatability studies in 2000. Attachment 3 provides the basis for

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
	• Remote cameras and support equipment • Shield windows and temporary and permanent shielding • Laboratory associated operations equipment and operations media (e.g., HEPA and HEME filters) • Sampling and analytical evaporators and condensers	using the citation process for 4 pieces of refractory from dismantled pilot-scale melter used for a 1986 demonstration run with HLW slurry.
5	**Decontamination Media and Decontamination Solutions** (e.g., swabs, other decon related materials). This waste includes but is not limited to: • Swabs, mops, masslin cloths, buckets, milers, brushes • Craft paper, surface coverings, wrappings • Strippable coatings and application equipment • CO_2 decontamination equipment (tanks, hoses, nozzles) • Acids, bases, and cleaning solutions • Liquid, chemical, and steam spray nozzles, hoses, and piping • Scabbing equipment • Canister decontamination chambers and support equipment	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann).
6	**Remote Handling Devices and Processing Support Equipment**. This waste includes but is not limited to: • Tele-Robotic Manipulators • Electro-Mechanical Manipulators • Manually Operated Manipulators (commonly referred to as MSMs) • Process cranes (including motors, rigging equipment, switches, cables, and remote tools) • Rigging cables, hooks, and pulleys • Remotely operated crane tools (e.g., hooks, impact wrenches) • Decontamination equipment including hoses and nozzles • Lifting yokes and other lifting assemblies • Equipment stands • Reach rods and extension tools • Electrical components for rigging equipment • Robotic equipment • Remote monitoring equipment such as video cameras, video cabling, viewing screens, etc. • Canister welding components and portable/fixed welding equipment	DOE Manual 435.1-1, Procedure HLW-SUP-99-0060 as approved by DOE-SR (H. Gnann).

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
	• Shielding (temporary and permanent) • Structural material, decking, supports, platforms, cell covers • Ventilation filter and separation media – HEME and HEPA (e.g., sand, metallic, or other mediums) • Motors, blowers, fans, and ventilation systems components, dampers, and duct work • Ventilation system demisters, reheater coils, and coalescer filters • Piping, tubing, valves, pumps, and monitoring equipment from support systems not carrying HLW • Piping, tubing, valves, pumps, and monitoring equipment from small diameter HLW systems (e.g., from sampling systems, process instrumentation systems, and offgas/ventilation systems) • Electrical components, cables, wiring, and switch gear	The demister in the Tank 30 purge ventilation system (was located within tank riser) was evaluated in 2008. WSRC (W.T Goldston) 4/29/08 e-mail provides rationale developed by Bob Petras that demonstrated similarity to "motors, blowers, fans, and ventilation systems components" listed in Procedure HLW-SUP-99-0060. Approved by DOE-SR (L. Ling) in 7/14/08 e-mail.
7	**Decontaminated Tank Farm Equipment, Including Equipment Removed from HLW Tanks**. Such equipment includes, but is not limited, to: • agitators • caissons • centrifuges/contactors • conductivity probes • cranes • cross flow filters and rotary screen filters • dip tubes • downcomers • drill guides • drill strings • dummy connector headers • eductors • evaporator feed pumps • evaporator pots • filtrate tanks • inspection port plugs • interstitial liquid pumps • instrumentation (all types) • jets • jumpers • lances	Attachment 3. Approved by DOE-SR by approval of this attachment.

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
	• mailboxes (short downcomers) • mining tools, pineapple heads • neutralization equipment • piping (lines of various types) • pumps (other types not listed) • riser plugs • riser plugs containing equipment or piping • sample tools • scrubbers • slurry pumps • spray chambers • spray nozzles • spray wash tools • submersible mixer pumps • sump pumps • tanks (other types not excluded) • telescoping transfer jets • thermowells • transfer pumps • transfer piping and transfer lines • valves (all types) • ventilation equipment, including HEPA filters • vessels (other types) • waste retrieval equipment (other types not listed) • well screens In addition, other tank farm equipment not listed above is not HLW if (1) it has been decontaminated using routine site processes, when such decontamination is consistent with ALARA requirements, and (2) it meets disposal facility waste acceptance criteria.	
8	**Decontaminated DWPF Equipment**. This equipment includes: • agitators • cooling and steam coils • cross flow filters • cranes • dip tubes • headers • instrumentation (all types) • jumpers • lifting and handling equipment	Attachment 3. Approved by DOE-SR by approval of this attachment.

Table 1. Waste Determined Not to be HLW by the Citation Process

No.	Waste	Basis for Non-HLW
	• piping • pumps • sample tools • Sludge Receipt and Adjustment Tank • Slurry Mix Evaporator • tanks • telerobotic manipulator tools • valves • vessels (other types not listed) • ventilation equipment, including HEPA filters In addition, other DWPF equipment not listed above (except for vitrification melters) is not HLW if (1) it has been decontaminated using routine site processes, when such decontamination is consistent with the ALARA principle, and (2) it meets disposal facility waste acceptance criteria.	
9	**Other Materials and Equipment**. Material in this category is identified below.	
	• Tritium Extraction Facility waste stream consisting of irradiated tritium-producing burnable absorber rods and associated job-control and spent process equipment wastes	WSRC (W.T Goldston) interoffice memorandum OBU-GSE-2004-00159 of 10/18/04 demonstrates that this waste stream is generated by a DOE activity, is not the result of spent nuclear fuel reprocessing, and is properly classified as LLW. Approved by DOE-SR (C.H. Ramsey).
	• Canned evaporator feed pump metal remnants (electric motor windings, electric wiring, and metal fines) generated in the 299-H Maintenance Facility during decontamination of feed pumps by dissolving components such as the volute and impeller in nitric acid.	Citation determination ESH-WPG-2006-00140, Revision 0 of 3/9/07 demonstrates that the remnants cannot contain HLW since the acid solution that removes the HLW is transferred into Tank 43. Approved by DOE-SR (T.J. Spears) in 12/8/08 email.
	• Soil and debris.	Attachment 3.

ATTACHMENT 2 – CITATION PROCESS CHECKLIST AND DETERMINATION DOCUMENTATION

Description of subject secondary waste stream:	**Citation No:**
Point of generation (location) and process of generation:	

CITATION BASIS

The basis for this citation determination is as follows: (1) all applicable criteria listed in the checklist below have been satisfied, (2) the blank spaces related to these criteria have been filled in appropriately; and (3) the basis for any listed criteria determined not to apply has been described in the remarks column.

This information, coupled with the cited reference documents, provides sufficient evidence that the subject secondary waste stream is not HLW by its origin or characteristics; that is, it was not produced in reprocessing of spent nuclear fuel and it does not require permanent geologic isolation. The subject secondary waste stream has been determined not to be HLW by the citation process based on these considerations.

Part I of the Checklist

Printed name, signature, and title of site contractor person completing this form — Date

LWO, Manager, Environmental Compliance — Date

LWO, Manager, Closure & Waste Disposal Authority — Date

DOE-SR, Assistant Manager for Waste Disposition Project — Date

Part II of the Checklist

Printed name, signature, and title of site contractor person completing this form — Date

LWO, Manager, Environmental Compliance — Date

LWO, Manager, Closure & Waste Disposal Authority — Date

DOE-SR, Assistant Manager for Waste Disposition Project — Date

CITATION PROCESS CHECKLIST[9]

No.	Criterion That Must Be Satisfied to Declare Non-HLW (Part I)	√	Remarks
1	Describe how the secondary waste stream became contaminated by HLW: ________________________________.		
2	Confirm that it is not one of the waste streams listed in Attachment 1 for which a citation determination has already been made.		
3	Confirm it is not one of the following items excluded from the citation process: ion exchange beds, sludges, or process filter media.		
4	Confirm that it does not contain a significant amount of waste due to (1) its design and usage and/or (2) decontamination consistent with ALARA based on __________________________.		

No.	Criterion That Must Be Satisfied for Disposal (Part II)	√	Remarks
5	Confirm that the secondary waste stream has been characterized and cite the associated documentation.		
6	Confirm that it is in a solid form or describe how it will be treated to achieve a solid form as follows: ___________________________.		
7	Confirm it has been packaged for disposal and identify the type of disposal container or describe how it will be packaged: _________.		
8	Specify the disposal facility and confirm that the secondary waste stream meets the waste acceptance criteria.		

[9] Guidance for completing the checklist appears in Section 4.3 of this procedure.

ATTACHMENT 3

BASIS FOR USE OF THE CITATION PROCESS FOR KEY SECONDARY WASTE STREAMS

1.0 INTRODUCTION

1.1 Purpose

The purpose of this attachment is to demonstrate that certain equipment and material contaminated by HLW are not HLW. The information in this attachment thereby serves as the basis for the DOE-SR waste-incidental-to-reprocessing determination by the citation process that this equipment and material is not HLW and can be disposed of as LLW or TRU waste or their mixed waste counterparts when no longer of use.

Note that references for this attachment are listed in Section 8.0 below.

1.2 Scope

This technical basis document applies to the following equipment contaminated by HLW:

- Equipment that has been installed in an underground waste tank for use in managing the HLW, such as pumps, conductivity probes, and waste retrieval tools;
- Other tank farm equipment such as jumpers, valves, and dip tubes; and
- DWPF equipment such as agitators, jumpers, and vessels (except for DWPF vitrification melters and melter parts, for which evaluation determinations are required).

This technical basis document also applies to certain other secondary waste streams such as SRNL pilot scale melter refractory pieces and soil and debris.

1.3 Background

As a result of its nuclear materials production mission, SRS manages large quantities of HLW from spent nuclear fuel reprocessing. This waste was stored in 51 underground waste tanks in F-Tank Farm and H-Tank Farm; 49 of these tanks remain in active service.

1.3.1 Liquid Waste System Status and Plans

The general conditions in the Liquid Waste System and plans for continued operation of this system are as follows[10]:

- F-Tank Farm and H-Tank Farm together contain approximately 36 million gallons of HLW with approximately 400 million curies of radioactivity;
- The H-Canyon production facility continues to generate HLW;
- Three evaporators (2F, 2H, and 3H) are operating to reduce the overall waste volume;

[10] As of June 30, 2009 based on Revision 15 to the Liquid Waste System Plan (SRR 2009a).

- The available space in the underground tanks for waste storage and processing remains limited;
- Limited salt waste processing continues using the Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit process;
- Full-scale salt waste processing at the Salt Waste Processing Facility is expected to begin in the near future; and
- A total of 2,739 canisters of vitrified HLW have been produced at DWPF with a projected final total of approximately 7,200.

The strategy for operation of the Liquid Waste System takes into account the provisions of DOE Order 435.1-1 and DOE Manual 435.1-1, along with various regulatory drivers, including South Carolina environmental laws, the Site Treatment Plan, the Federal Facilities Agreement, the National Environmental Policy Act, and the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (SRR 2009a).

1.3.2 Secondary Waste

As noted previously, secondary waste consists of waste byproducts resulting from the management, retrieval, treatment, storage, handling, analysis, and/or disposal of HLW that have become radioactively contaminated by HLW, and therefore may contain small amounts of this waste. Given the broad scope of the site Liquid Waste Program, and the complexities of managing and processing HLW, a large amount of secondary waste has been produced and more will be produced in the coming years.

As of early 2010, hundreds of containers filled with secondary waste were awaiting disposition. Effective use of the citation waste-incidental-to-reprocessing determination process can help eliminate this backlog and minimize accumulations of secondary waste in the future, measures that will improve health and safety consistent with the ALARA principle by reducing radiation exposure to workers involved with monitoring stored radioactive waste.

1.3.3 Waste-Incidental-to-Reprocessing Requirements

As noted previously, the waste-incidental-to-reprocessing process in DOE Manual 435.1-1 was established to determine whether equipment and material contaminated by HLW can be managed as LLW or TRU waste instead of HLW. Chapter 2 of DOE Manual 435.1-1 specifies the applicable requirements as follows:

> "Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not high-level waste, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate. When determining whether spent nuclear fuel reprocessing plant wastes shall be managed as another waste type or as high-level waste, either the citation or evaluation process described below shall be used:
>
> (1) **Citation**. Waste incidental to reprocessing by citation includes spent nuclear fuel reprocessing plant wastes that meet the description included in the Notice of Proposed Rulemaking (AEC 1969) for proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not

limited to: contaminated job wastes including laboratory items such as clothing, tools, and equipment.

(2) **Evaluation**. Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that:

(a) Will be managed as low-level waste and meet the following criteria:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical[11]; and

2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, *Performance Objectives*; and

3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, *Waste Classification*; or will meet alternative requirements for waste classification and characterization as DOE may authorize.

(b) Will be managed as transuranic waste and meet the following criteria:

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

2. Will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and

3. Are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate."

1.4 Information Provided in this Attachment

Section 2 describes lessons learned in application of the waste-incidental-to-reprocessing criteria, addressing (1) general DOE site experience, (2) experience at DOE's Hanford site that led to broader use of the citation process at that site, and (3) two SRS waste-incidental-to-reprocessing evaluations completed in 2001 that provide perspective on application of the citation process at SRS.

[11] Removal to the maximum extent "technically and economically practical" is not removal to the extent practicable or theoretically possible. The term "practical" is intended to convey its usual meaning, such as "fitting the needs of a particular situation in a helpful way, helping to solve a problem or difficulty, effective, or suitable" (Cambridge 2009). The conclusion as to whether a particular key radionuclide has been or will be removed to the "maximum extent that is technically and economically practical" may vary from situation to situation, based not only on reasonably available technologies but also on the overall costs and benefits of deploying a technology for decontamination of a particular waste stream. Comparing costs (monetary, societal, etc.) to benefits (primarily reduced radiation dose) is an inherent part of the ALARA process, which is discussed in Section 3.0 below.

Section 3 describes DOE's ALARA policy and explains how this policy is implemented at SRS to ensure that key radionuclides in equipment and material that comprise secondary waste are removed to the maximum extent technically and economically practical.

Section 4 summarizes decontamination processes used in the field, in the Building 299-F maintenance facility, and at DWPF. This section also describes the controls used for decontamination of equipment and materials that comprise secondary waste.

Section 5 summarizes waste characterization protocols, describes the link between waste acceptance criteria and disposal site performance, and discusses controls used to evaluate cases where disposal of a particular secondary waste stream might have some impact on disposal site performance.

Section 6 summarizes information provided in Sections 2 through 5 and describes the conclusions from consideration of this information.

Section 7 identifies the secondary waste streams that this technical basis document shows can be managed as non-HLW.

Section 8 lists references cited in the text.

2.0 LESSONS LEARNED IN APPLICATION OF THE CRITERIA

As noted previously, events that led to development of the waste-incidental-to-reprocessing criteria make it clear that citation process waste streams were so identified because of the ease of determining up front that they do not pose the long-term hazards associated with HLW. Experience has shown that it is indeed easy to determine that most secondary waste streams do not pose such long-term hazards.

2.1 General DOE Site Experience

Experience at the four sites that have followed DOE waste-incidental-to-reprocessing requirements and guidance since they were issued in 1999 – Hanford, Idaho, Savannah River, and the West Valley Demonstration Project – shows that the citation process can be widely applied to secondary waste because it can be established with ease that most secondary waste streams are not HLW by their origin or characteristics. That is, it is readily evident that most secondary waste streams (1) are not the actual liquid or solid waste from reprocessing of spent nuclear fuel, but became contaminated by this waste, (2) are not highly radioactive (i.e., will meet waste acceptance criteria for disposal as LLW of TRU waste), and (3) do not require long-term geologic isolation.

This conclusion is based on consideration of eight key points:

(1) Most secondary waste streams consist of equipment used in some aspect of management of HLW that was not produced in reprocessing of spent nuclear fuel;

(2) Most of this equipment has a low potential for retaining significant amounts of waste due to its configuration and use;

(3) Sites managing HLW are required by DOE policies and technical standards to implement the ALARA principle to decontaminate equipment that becomes contaminated by HLW;

(4) Decontamination performed in the field effectively removes residual waste from most equipment by simple processes such as flushing and rinsing with water;

(5) Decontamination performed in maintenance facilities makes use of more robust processes such as acid soaking that more effectively remove waste from equipment with complex internal surfaces that tend to trap waste;

(6) Characterization data typically show that radionuclide concentrations in waste packages containing the decontaminated equipment meet waste acceptance criteria for disposal as LLW;

(7) Meeting the waste acceptance criteria for disposal in an LLW disposal facility ensures that the equipment does not require geologic isolation; and

(8) Meeting these waste acceptance criteria ensures that disposal of the secondary waste stream will not impact performance of the disposal site.

Such factors make it clear without detailed analysis that most secondary waste streams are not HLW. It follows that the evaluation determination process should be reserved for the most complex secondary waste streams that have a potential for containing significant amounts of residual waste, such as vitrification melters used to solidify HLW for geologic disposal.

2.2 Hanford Experience

Consideration was given to waste-incidental-to-reprocessing procedures used at the other DOE sites that manage HLW. Only one site (Hanford) has updated its procedure to reflect the lessons learned in implementation of the DOE Manual 435.1-1 requirements and the DOE Guide 435.1-1 guidance.

In 2008, the DOE Office of River Protection issued an integrating procedure for waste-incidental-to-reprocessing determinations (Hanford 2008). This procedure identified a broad category of materials under the citation process that routinely will meet the criteria for disposal as non-HLW. It used the evaluation process to demonstrate the technical basis for use of the citation process for these materials.

The Hanford procedure provides a citation waste list in Attachment 10.1 that identifies three categories of materials: (1) solid waste items/materials contaminated or assumed to be contaminated, (2) liquid secondary waste, and (3) tank farm soil and debris. The first category of materials is discussed below because it is especially applicable to SRS.

2.2.1 Solid Waste Items/Materials Contaminated or Assumed to be Contaminated

Among the items in this category are:

- In-tank retrieval or sampling equipment of any type including pumps, crawlers, mantises[12], salt well screens, sluicing equipment, drill case, and other equipment placed in tanks to facilitate the retrieval, interim stabilization, or sampling of tank wastes that are drained, rinsed, and surveyed in accordance with tank farm practices; and

[12] A mantis is remote-controlled waste retrieval device.

- Any item or material not specifically identified elsewhere in the list that is contact handled (<200 mR/h) without reliance on shielding applied for the sole purpose of reducing the surface dose rate to contact handled levels.[13]

Attachment 10.2 of the Hanford procedure describes a decision analysis that was considered by the DOE Office of River Protection in making the citation determination included with the procedure. Key points discussed in this decision analysis with regard to the first category of materials include:

- These secondary waste streams can be readily determined not to be HLW because they were not produced during the reprocessing of spent nuclear fuel,
- Equipment wetted by tank waste is drained, rinsed, and surveyed in accordance with tank farm requirements and procedures, and
- Tank farm cleaning [decontamination] practices reduce contamination levels orders of magnitude below those associated with HLW.

Hanford concluded that the citation process was more appropriate for this material for two reasons: (1) the radionuclide inventories associated with this waste are inconsequential and (2) the non-HLW characteristics of the waste are based on obvious or readily available information. To inform this decision, Hanford considered whether this type of waste would meet the evaluation process criteria, as discussed below.

2.2.2 Inconsequential Radionuclide Inventories

To demonstrate that the radionuclide inventories associated with this waste are inconsequential, Hanford used its waste disposal database, which dates to 1989. This evaluation showed that all secondary waste from the tank farms disposed of in the onsite Low Level Burial Ground since 1989 contained less than 500 curies of residual radioactivity. This amount is less than 0.01 percent of the total amount of radioactivity of approximately 6.4 million curies disposed of in this facility during that period. Comparison of waste forecasts showed that future waste disposal would follow a similar pattern.

2.2.3 Non-HLW Characteristic Based on Readily Available Information

To demonstrate the non-HLW characteristics of this waste, Hanford used readily available information consisting of three metrics: (1) disposal site inventory, (2) estimated radionuclide concentrations in the waste, and (3) measured dose rates on the waste. Hanford noted that the tank farm secondary wastes exhibit radiation dose rates well below those for the tanks, with site experience showing that surface dose rates on equipment removed from tanks following draining and rinsing are typically tens or hundreds of mrem/hr, compared to tens or hundreds of rem/hr associated with actual tank waste.

The key points for demonstrating that the tank secondary waste is not HLW were:

- The residual radioactivity in tank secondary waste makes up a small fraction of the disposal site inventory,

[13] The <200 mrem/hr criterion was based on the waste acceptance criteria for the Hanford LLW disposal facility.

- All tank farm secondary waste meets disposal site waste acceptance criteria, and
- All tank farm secondary waste will be less than Class C concentration requirements based on characterization of representative equipment.

2.2.4 Comparison of Wetted Waste to Evaluation Process Criteria

As recommended by DOE Guide 435.1-1, Hanford considered the evaluation process criteria for two representative pieces of equipment used in the tanks, including the C-109 saltwell screen.

One of the most contaminated pieces of equipment removed from the tanks in the previous 12 years, the saltwell screen was a 35-foot long pipe with a screened section at the bottom that was used for removing interstitial liquid from tanks containing mostly saltcake. This particular saltwell screen was much more contaminated than other similar tools used in the tanks.

The evaluation performed may be briefly summarized as follows:

Criterion 1. *[The waste] has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically possible.* This criterion was met by using a process that involved:

- Lifting the tool from the tank slowly to allow liquid to drain back into the tank,
- Spraying the tool with water during removal using a spray ring installed in the tank riser,
- Spraying the tool again when radiation level measurements indicated hot spots to reduce the radiation levels to values consistent with the decontaminated portions of the tool, and
- Allowing remaining water to drip back into the tank before closing the plastic sleeve used to contain the tool as it was removed.

The removed tool was characterized using the dose-to-curie method, with the total estimated activity being 25.9 curies. The tool had one localized 12 rem/hr hot spot, although the levels on the rest of the tool were substantially lower. Only one piece of equipment removed from the tanks in the previous 12 years contained more residual radioactivity, a heel jet pump containing an estimated 29.9 curies.

This decontamination process is used for all equipment removed from Hanford waste tanks. Equipment wetted with HLW in locations other than in the tanks – such as waste transfer lines – is decontaminated by rinsing and/or flushing in the tank farms, with the removed tank waste being returned to the tanks.

One alternative to the decontamination processes used on the saltwell screen was evaluated. This alternative method involved construction of a new permanent decontamination facility, or refurbishing and setting up an existing site facility for this purpose. This alternative was not considered to be technically or economically practical because of the high cost and because radiation exposure to facility workers would far exceed the potential reduction in long-term dose to the public from disposal of the waste without additional decontamination.

These factors – coupled with the inconsequential increase in the disposal facility inventory from disposal of tank secondary wastes – led to the conclusion that the decontamination practices in place remove key radionuclides to the maximum extent technically and economically practical.

Criterion 2. *[The waste] will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, Performance Objectives.* This criterion was met based on the following considerations:

- The tank farm secondary waste meets the Hanford disposal site waste acceptance criteria,
- These criteria are established to ensure that the disposal site performs within the performance assessment projections, and
- The performance assessment indicates that the projected waste inventory to be disposed of meets performance objectives comparable to those in 10 CFR Part 61, Subpart C.

Criterion 3. *[The wastes] are to be managed pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, and in accordance with provisions of Chapter IV [of DOE Manual 435.1-1], provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR Part 61, Waste Classification; or will meet alternative requirement for waste classification and characterization as DOE may authorize.* This criterion was met by showing that the subject tool met Class C limits with a maximum sum of fractions of 0.3 and that it is obviously in a solid physical form.

The evaluation included discussion to the effect that the waste acceptance criteria required the waste to be in a solid physical form. It also provided information showing that four other pieces of typical tank farm equipment – another saltwell screen and three pumps – had maximum sums of fractions less than 0.3 and thus readily met Class C limits. Based on these examples, and decades of site experience in disposing of similar tank farm equipment onsite, Hanford concluded that residual radionuclide concentrations in all similar tank farm equipment disposed of onsite in the future would be below Class C limits.

Hanford concluded that consideration of the evaluation criteria as just described supported the conclusion that a citation process determination for equipment wetted by HLW is appropriate for use at the site and protective of human health and the environment.

2.3 SRS Waste-Incidental-to-Reprocessing Evaluations

In 2001, SRS prepared waste-incidental evaluations for two types of equipment wetted by HLW in underground waste tanks. One evaluation involved three slurry pumps used in Tank 40 (WSRC 2001a). The other involved a telescoping transfer jet used in Tank 41 (WSRC 2001b). Both were approved by DOE-SR (DOE 2001) and therefore may be appropriately considered in support of the use of the citation determination process provided for in this procedure.

These two evaluations may be summarized as follows. Consideration of the results of these evaluations is consistent with guidance in DOE Guide 435.1-1 to consider the evaluation criteria in making waste-incidental-to-reprocessing determinations by the citation process.

2.3.1 Evaluation of Tank 40 Slurry Pumps

The three 45-foot long pumps were used in mixing sludge slurry in Tank 51. During use, they were partially submerged in the supernatant layer with the lower 10 feet in the sludge layer. All three pumps failed due to impeller imbalance causing a leak in the lower seal. The pumps were subsequently removed from Tank 51 and stored in Tank 40. They were removed from Tank 40 in the winter of 1999-2000.

During removal from Tank 40, each pump was separated into two sections to facilitate disposal in the E-Area LLW facility: a 30-foot upper section and a 15-foot lower section containing the volute. Each pump was decontaminated in the field. The lower sections were decontaminated further in the Building 299-H facility.

The evaluation focused on the lower sections of the pumps because the upper sections had been disposed of as LLW before SRS implemented DOE Order 435.1.

> ***Criterion 1.*** *[The waste] has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically possible.* This criterion was met by using a process that involved both decontamination in the field and additional decontamination in a maintenance facility.
>
> During removal, the exterior of each pump was flushed with water. Video cameras were used to inspect the pump exteriors to verify that they were free of visible waste. The lower sections were then moved to the Building 299-H Maintenance Facility for further decontamination. Prior to this additional decontamination, the maximum dose rates at one foot from the surface, which were on the pump volutes, ranged from 2000 to 9100 mrem/hr.
>
> For two of the pump sections, the additional decontamination consisted of soaking for two to three months in a tank containing a 10 percent nitric acid solution. These sections were then decontaminated further using an 80 psi steam lance with soap detergent, followed by brushing with an extended stiff bristle brush. This spray/brush process was repeated several times to reduce the dose rates.
>
> Because the decontamination tank was in use for other equipment, the third pump section was decontaminated by spraying it with a 50 percent nitric acid solution, which was allowed to remain in place for several days to loosen the sludge. This pump section then underwent the same repeated spray/brush process as the other two pump sections.
>
> The three waste boxes containing the lower pump sections were estimated to have the following approximate activities before and after decontamination in Building 299-H:

Waste Box	Contents[(1)]	Ci Before Decon	Ci After Decon
IT12000380	2 volutes, 4 column sections	184	4
IT12000381	1 volute, 4 column sections	207	4

Waste Box	Contents[(1)]	Ci Before Decon	Ci After Decon
IT12000367	1 column section	4	2

NOTE: (1) The columns were cut into pieces and each waste box also contained job control waste.

The actual cost of this decontamination was $1385 per curie removed.

Further removal of key radionuclides was considered. Alternate technologies were identified and analyzed for technical and economic feasibility for use in further key radionuclide removal; however, none of these alternate technologies was available.

A second round of decontamination in Building 299-H by the spray/brush process was evaluated. Cost estimates were prepared that showed a cost of $23,856 for each additional curie removed, with the conservative assumption that the removal efficiency would be the same as in the first round (approximately 98 percent). This additional decontamination would not have been cost-effective because of (1) its high cost, (2) site experience showing that such additional decontamination would result in only minimal further reduction in key radionuclide concentrations, and (3) it would not change the waste classification.

Based on these considerations, it was concluded that key radionuclides had been removed from the slurry pump lower sections to the maximum extent technically and economically practical.

Criterion 2. *[The waste] will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, Performance Objectives.* This criterion was met based on the following considerations:

- The waste in the three boxes met the waste acceptance criteria for the Intermediate-Level Vault; and
- A comparison of DOE and NRC requirements demonstrated that waste meeting the waste acceptance criteria for LLW disposal in the Intermediate-Level Vault will be managed to meet safety requirements comparable to the performance objectives in 10 CFR Part 61, Subpart C.[14]

Criterion 3. *[The wastes] are to be managed pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, and in accordance with provisions of Chapter IV [of DOE Manual 435.1-1], provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR Part 61, Waste Classification; or will meet alternative requirement for waste classification and characterization as DOE may authorize.* This criterion was met because the waste was in solid form, with absorbents included in the waste

[14] A 2001 analysis (Wilhite 2001) shows that DOE LLW disposal performance objectives in DOE Manual 435.1-1 are comparable to NRC LLW disposal performance objectives in 10 CFR Part 61. It follows that a waste package meeting waste disposal criteria for a DOE LLW disposal facility does not have to meet Class C concentration limits because it would fall within the performance assessment envelope. That is, the disposal facility would still meet performance objectives comparable to those specified in 10 CFR Part 61 after disposal of such a waste package. Section 5.2.1 below discusses these matters in more detail.

packages to absorb any incidental decontamination liquids, with radionuclide concentrations below Class C limits.

Note that evaluation showed that the waste packages met the criteria for disposal in the Slit Trenches.

2.3.2 Evaluation of Tank 41 Telescoping Transfer Jet

Transfer jets use steam to draw liquid through a suction strainer located at the lower end and transfer it through a discharge port located near the top of the jet. The telescoping feature allows the suction and discharge lines to be retracted or extended to accommodate varying liquid and solids levels in the underground waste tanks.

This particular transfer jet was used to transfer supernatant from Tank 41. It consisted of a 17-foot stainless steel pipe section, a four-foot end bell section, and a stiffener ring. It was removed from Tank 41 in 1996 so another telescoping transfer jet of modified design could be installed. It was decontaminated during removal, lifted into a special design stainless steel sleeve, and the ends of the sleeve capped. The sleeved transfer jet was later placed in a 27-foot-long steel box.

Criterion 1. *[The waste] has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically possible.* This criterion was met by using a process that involved:

- Flushing the internals of the steam side and discharge side with heated water prior to removal, and
- Using a lance to spray the outside to remove the saltcake and reduce the contamination levels.

It was estimated that approximately 15 pounds of saltcake adhered to the exterior of the tool before decontamination. The decontamination effectiveness in terms of total estimated activity removed was as follows:

Ci Before Decon	Ci After Decon	Decontamination Factor	Total Cost
52.9	7.4	7.2	$236,985

The key radionuclides were removed by this process at a unit cost of approximately $5208 per curie.

Further removal of key radionuclides was considered. Alternate technologies were identified and analyzed for technical and economic feasibility for use in further key radionuclide removal; however, none of these alternate technologies was available.

Additional decontamination in Building 299-F was considered. However, the tool was too long to handle in that facility or any other site facility without being sectioned. Performing this work in a containment hut was not considered to be safe. Efforts to make arrangements to perform this work offsite produced no bidders. Even though size reduction was determined not to be feasible, an estimate for additional decontamination after size reduction in the Building 299-F facility was prepared. This estimate, with the conservative assumption of a 98 percent decontamination factor, produced a unit cost of $14,608 per curie removed.

It was concluded after taking this information into account that key radionuclides had been removed by the field decontamination process to the maximum extent technically and economically practical.

Criterion 2. *[The waste] will be managed to meet safety requirements* . . . This criterion was met in the same manner as with the Tank 40 slurry pumps.

Criterion 3. *[The wastes] are to be managed pursuant to DOE's authority under the Atomic Energy Act* . . . This criterion was met in the same manner as with the Tank 40 slurry pumps.

2.3.3 Lessons Learned from these Evaluations

These two evaluations show that:

- Field decontamination processes used at SRS on equipment removed from underground waste tanks remove key radionuclides to the maximum extent technically and economically practical;
- The need for additional decontamination depends on the design of the equipment, that is, whether waste could be trapped in portions of the equipment beyond the reach of field decontamination processes;
- A single cycle of additional decontamination in a maintenance facility can remove residual key radionuclides to the maximum extent technically and economically practical in cases where additional decontamination is necessary;
- If size-reducing equipment in the field is necessary to facilitate additional decontamination, the associated hazards could outweigh the benefits of additional decontamination, so that additional decontamination would be inconsistent with the ALARA principle; and
- Equipment removed from underground waste tanks that is decontaminated by routine site processes can meet waste acceptance for onsite disposal as LLW, and meeting these criteria ensures that the waste will be managed to meet safety requirements comparable to the performance objectives in 10 CFR Part 61, Subpart C.

3.0 APPLICATION OF THE ALARA PRINCIPLE FOR SECONDARY WASTE

This section describes DOE's ALARA policy, explains how this policy is implemented at SRS, and shows how implementation of this policy ensures that equipment and material that comprise the various secondary waste streams are decontaminated to remove key radionuclides to the maximum extent technically and economically practical.

Work activities related to removal and decontamination of equipment and material that comprise secondary waste are treated as nonroutine work and this policy is a key factor in the controls that are applied.[15]

[15] Nonroutine work activities are those that are outside of normal work activities, including jobs performed under special written procedures, those that require special training, and those that have a high risk due to the inability to predict radiological events or control physical factors (WSRC 2008a). Note that decontamination performed remotely at DWPF is accomplished using Operations procedures rather than work packages because the workers cannot come in contact with the equipment being decontaminated.

3.1 DOE ALARA Requirements and Policy

The Department requires that radiation protection programs include formal plans and measures for applying the ALARA process to occupational radiation exposure (10 CFR 835.101). The Department defines ALARA in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, as follows:

> "[ALARA is] an approach to radiation protection to control or manage exposures (both individual and collective to the work force and the general public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. … ALARA is not a dose limit, but rather it is a process that has as its objective the attainment of dose levels as far below the applicable limits of the Order as practicable."

DOE's policy on ALARA is stated in DOE Policy 441.1, *Department of Energy Radiological Health and Safety Policy*, as follows:

> "It is the policy of the Department of Energy to conduct its radiological operations in a manner that ensures the health and safety of all its employees, contractors, and the general public. In achieving this objective, the Department shall ensure that radiation exposures to its workers and the public and releases of radioactivity to the environment are maintained below regulatory limits and deliberate efforts are taken to further reduce exposures and releases as low as reasonably achievable. The Department is fully committed to implementing a radiological control program of the highest quality that consistently reflects this policy."

DOE field managers are responsible for ensuring that ALARA principles for radiation protection are incorporated when reviewing and approving radioactive waste management activities (DOE Manual 435.1-1, page I-9).

3.2 SRS ALARA Program

SRS maintains a multi-faceted ALARA program consistent with DOE requirements and guidance as described in the site ALARA Manual (WSRC 2007). This program is an integral part of all site activities involving radioactive materials. Components of this program include:

(1) *Policy* for commitment and participation of all management and workforce levels,

(2) *Training* for management and workers,

(3) *Design* of equipment and facilities,

(4) *Procedures* providing direction for maintaining occupational exposure ALARA,

(5) *Radiological work/planning* that implements controls and uses optimum methods to ensure occupational doses are ALARA,

(6) *Audits* conducted periodically to help ensure that policy and requirements are effectively implemented, and

(7) *Records* that document compliance and demonstrate that the program is effectively carried out.

SRS maintains an online ALARA Center (www.srs.gov/general/programs/alara/link/htm) to facilitate implementation of the program. The ALARA Center and other key elements of the ALARA program as defined in the site ALARA Manual are briefly described below.

3.2.1 The ALARA Center

Management commitment to DOE's ALARA policy is demonstrated in the existence of the ALARA Center. The ALARA Center is staffed by experienced radiation protection professionals who provide support to various SRS organizations in implementation of the ALARA principle to reduce worker exposure to hazards in the workplace, especially those that are associated with radioactivity.

The ALARA Center staff keeps abreast of new technologies and methods that can be used to improve safety in radiological work and reduce radiation exposure to workers and to the public. Staff members consult with planners and engineers to help ensure that the best available methods to support the ALARA principle are incorporated into the radiological work planning process.

3.2.2 Radiological Work Planning

Removal of equipment that has been contaminated by HLW from underground waste tanks and from other tank farm systems and decontamination of this equipment are treated as non-routine work and are subject to all requirements of the site radiological work planning process.

The site Work Planning and Control procedure (WSRC 2008c) requires adherence to the guiding principles and core functions of Integrated Safety Management System described in DOE Policy 450.4, *Safety Management System Policy*, in work planning and the performance of radiological work. The seven guiding principles are:

(1) Line management responsibility for safety,

(2) Clear roles and responsibilities,

(3) Competence commensurate with responsibilities,

(4) Balanced priorities,

(5) Identification of safety standards and requirements,

(6) Hazard controls tailored to work being performed, and

(7) Operations authorization.

The core functions involve (1) defining the scope of work, (2) analyzing the hazards involved, (3) developing controls, (4) performing work within these controls, and (5) providing feedback that is used to improve the work process.

The primary hazard related to equipment that has been contaminated by HLW is radioactivity. This radioactivity includes Cs-137 with its high energy gamma radiation. Such gamma radiation poses a direct exposure hazard to workers who remove the equipment from the tank or other system and those who are involved with managing the packaged waste.

Beta radiation from Sr-90 and other radionuclides must also be considered. In many cases, extremity dose due to beta radiation is more limiting to workers than whole body dose due to gamma radiation.

One of the key controls (that is, ALARA measures) to reduce this hazard is decontamination. Such decontamination is accomplished to reduce radiation exposure to workers involved in handling, management, and disposal of the waste.

Decontamination of equipment and material that comprises secondary waste is therefore a key product of the SRS ALARA program and the site work planning process. Provisions for this decontamination are incorporated into the procedures (work instructions) used in accomplishment of the work. This decontamination effectively removes key radionuclides, including Cs-137 that provides the primary gamma exposure hazard and Sr-90 that provides the primary beta exposure hazard.

3.2.3 Work Packages

Equipment removal and decontamination are the subject of detailed written instructions generally provided in the form of work packages. These work packages provide administrative and engineering controls to ensure that the work is accomplished safely and efficiently. Input is provided by key subject matter experts, including the Generator Certification Official and representatives of the Radiological Control Operations group and the liquid waste contractor Waste Characterization Engineering group, who ensure that the decontamination specified will remove key radionuclides from the secondary waste stream to the maximum extent technically and economically practical consistent with the ALARA principle.

3.2.4 DWPF Operations Procedures

Standard procedures are used for decontamination at DWPF because the work is performed remotely as described in Section 4.3 below. The DWPF equipment decontamination protocol (DWPF 2009) provides specific requirements for decontamination of pumps, jumpers, agitators, coils, and o-ring flanges.

The DWPF decontamination processes and protocols were designed and developed to be consistent with the ALARA principle in that they can reduce radiation and contamination levels on equipment that requires contact maintenance to levels low enough to minimize worker dose. The acceptable post-decontamination radiation levels are generally specified in the Radiological Work Permits included with the maintenance work packages, as discussed below.

3.2.5 ALARA Reviews

ALARA reviews are performed to ensure that appropriate radiation exposure and contamination controls are incorporated as part of the work planning process and performance of work (WSRC 2008a).

Formal ALARA pre-job reviews are performed for nonroutine work activities that meet one of a set of criteria based on factors such as estimated worker radiation exposure, expected radiation levels, or expected removable contamination levels. In most cases, work activities for removal and decontamination of equipment and material that comprise secondary waste meet conditions for a pre-job ALARA review. Such reviews entail use of a checklist to ensure that all relevant factors have been considered in establishing hazard controls for the work. The source reduction topic on this checklist requires consideration of decontamination by an interior flush, by use of a decon tank, and by an exterior flush.

3.3 In Summary

The site maintains programs to ensure full compliance with DOE requirements and policies on ALARA in radiological work and in management of radioactive waste. Compliance with these requirements and policies results in decontamination of equipment and materials that comprise the various secondary waste streams in those cases where such decontamination is consistent with the ALARA principle. Experience shows that the decontamination processes used are effective in removing key radionuclides to the maximum extent that is technically and economically practical**.**

The validity of the conclusion on the effectiveness of the site decontamination processes can be demonstrated by considering the relatively small amount of activity in secondary waste disposed of onsite in the E-Area LLW facilities compared to the total activity of LLW that has been disposed of in those facilities.

Since 1995, the total amount of LLW disposed of in the E-Area LLW facilities has contained approximately three million curies. The secondary waste from the tank farms and DWPF disposed of during this same period contained approximately 1,800 curies of activity, approximately 0.06 percent of the total amount. This comparison not only demonstrates the effectiveness of site decontamination processes used to comply with the ALARA principle, but it shows that secondary waste disposal has an insignificant impact on performance of the onsite LLW disposal facility.

While the secondary waste percentage is somewhat higher than the equivalent Hanford percentage discussed previously, this difference is at least partially accounted for by disposal of DWPF secondary waste at SRS, given that Hanford does not produce secondary waste from a vitrification process.

4.0 DECONTAMINATION

As has been discussed, it is standard practice at the SRS HLW management facilities, in compliance with ALARA requirements, to decontaminate equipment contaminated by HLW prior to removal from service, during the removal process, after removal, and in some cases, by a combination of these processes. The first two decontamination processes are considered to be field decontamination processes. The third process generally takes place at the Building 299-H Maintenance Facility or at DWPF. (DWPF currently handles, decontaminates, and works on only DWPF equipment and transfer pumps from H-Tank Farm Diversion Box 8.) Decontamination practices and the capabilities in the different facilities are summarized below.

Note that while this discussion focuses on key radionuclides, the decontamination processes routinely used at the site remove all radionuclides present to essentially the same extent.

4.1 Field Decontamination

Decontamination performed in the field effectively removes key radionuclides from most tank farm equipment to the extent technically and economically practical.

4.1.1 Field Decontamination Processes

The following standard field decontamination processes are used at SRS consistent with ALARA requirements:

- Equipment connected to working systems – such as pumps, jets, and jumpers – is flushed internally with water prior to removal.
- Evaporator pots may be further decontaminated before removal with chemicals such as potassium permanganate, if required.
- Equipment removed from underground waste tanks is partially dismantled to separate the portion exposed to only the tank vapor space from the portion contacted by HLW, in cases where this is practical.
- Equipment removed from underground waste tanks is decontaminated by rinsing external surfaces with cold or warm water until there is no visible sign of salt or sludge and drained of liquid to the extent practicable.
- Where practical, the internals of equipment that has been out of service and is to be removed from underground waste tanks are also flushed with water.
- Radiation surveys are performed during equipment removal within the limitations imposed by the particular containment configuration to provide information on the effectiveness of decontamination.

4.1.2 Cases Where Further Decontamination May Be Required

Sections 2.3.1 and 2.3.2 above describes how three slurry pumps used in Tank 51 and the telescoping transfer jet used in Tank 41 were decontaminated in the field during removal from the tanks. Note that the slurry pumps were decontaminated further in Building 299-H while the telescoping transfer jet was not. This difference was mainly due to the differences in the characteristics of the HLW to which the pumps were exposed.

The lower portions of the slurry pumps operated within the sludge layer in Tank 51. The telescoping transfer jet was exposed only to supernatant and to saltcake, which are more soluble and readily removed by water spray.

As a general rule, field decontamination processes are very effective for equipment that has come into contact with supernatant and saltcake, and this equipment will easily meet waste disposal criteria for onsite disposal as LLW after field decontamination. Tank farm equipment that has come into contact with sludge will meet these criteria in some cases; in other cases additional decontamination may be necessary consistent with ALARA requirements and to meet the onsite waste acceptance criteria for LLW disposal. The difference between these cases depends on the equipment design and use. The failed slurry pumps from Tank 40 are examples of a case where further decontamination was necessary due to an equipment design that could trap waste in areas difficult to decontaminate in the field.

EXAMPLE OF FIELD DECONTAMINATION

Another example of tank farm equipment decontamination involved a submersible mixer pump (SMP) that was removed from Tank 5 in December 2009. This type of pump is nuclear hardened and designed for nuclear tank service to replace the slurry pumps from the mining industry, and is one of the most difficult pieces of tank equipment to decontaminate. An SMP is approximately 51 feet long with the diameter at the suction screen and discharge nozzle being 22.5 inches.

This pump was decontaminated during removal using the standard protocols. However, owing to its immersion in the sludge layer, relatively high contamination levels remained after field decontamination. The pump was removed in one piece since, due to its design, it was not practicable to cut it into sections working in the radiological enclosure (containment hut) during removal.

The pump was placed directly into a steel transport container. Measurements made on this waste package after the pump was removed showed levels up to 200 R/hr (extremity, i.e., β-γ at 5 cm) and 150 mrem/hr (whole body, i.e., γ at 30 cm). The dose rate in the cab of the truck used to move the waste package to its temporary storage location was 8 mrem/hr whole body. (SRR 2009b)

The process followed in such cases, consistent with ALARA requirements, includes:

(1) Characterizing the waste package to determine the residual radioactivity,

(2) Establishing whether the waste package meets the waste acceptance criteria for onsite disposal as LLW,

(3) Determining the potential impact, if any, of its disposal in the most appropriate disposal unit, such as the Engineered Trench, and

(4) Making an engineering judgment about whether size reduction and further decontamination in Building 299-H can be justified under the particular circumstances.

This decision on further decontamination weighs such factors as whether a special analysis would be required for disposal and the radiation exposure to workers who would be involved in cutting the pump into sections to facilitate decontamination and decontaminating the pump in Building 299-H to further reduce the residual radioactivity. In cases where the component meets the waste acceptance criteria, disposal without further decontamination is usually the approach consistent with the ALARA principle. This was the case for the SMP removed from Tank 5.

4.2 Decontamination at Building 299-H

The Building 299-H Maintenance Facility provides additional decontamination capabilities. The decontamination capabilities in this facility include soaking in a 25 percent nitric acid bath, steam cleaning, and wands that can spray water and nitric acid.

Building 299-H contains a Decon Cell that is 25 feet long, 25 feet wide, and 25 feet high. The cell contains a decon tank that is 10 feet long, four feet wide, and 10 feet high with a working volume of 1200 gallons. The area is serviced by a bridge crane with a maximum capacity of 15 tons. The service area outside of the cell where trucks are unloaded (known as the truckwell) has a 15-ton capacity bridge crane with a maximum hook height of 22 feet.

The largest pieces of equipment decontaminated in this facility are pumps and agitators, which range up to 40 feet long and four feet wide. Jumpers can be up to 20 feet long. Equipment longer than 25 feet must be size reduced in the field to fit into the Decon Cell in cases where such size reduction is consistent with the ALARA process[16]. The decon tank is used mostly for feed pumps, but an agitator will also fit inside the tank.

The facility operates under the following guidelines:

- All equipment received in the facility is decontaminated until there is no visible contamination and the whole body dose rate is < 50 mR/hr. After decontamination, maintenance personnel can evaluate the equipment and determine if it can be repaired and returned to service.
- Equipment that is to be repaired and reused is further decontaminated to the following criteria: removable contamination levels on accessible surfaces of < 100,000 dpm/100 cm^2 beta-gamma and <2,000 dpm/100 cm^2 alpha and a whole body dose rate of < 10 mR/hr.

These guidelines are specified in the applicable work packages.

Section 2.3.1 above described how slurry pump volutes from Tank 40 were effectively decontaminated at Building 299-H by two different processes that used nitric acid solutions.

EXAMPLE OF DECONTAMINATION IN BUILDING 299-H

Work Order 00926821-01 issued on November 3, 2009 provided maintenance instructions for decontamination and repair of a backflush valve for Tank 38. These maintenance instructions provided for:

- Performing radiation surveys before decontamination;
- Placing the valve in the decon tank to soak in acid;
- Performing radiation surveys to ensure that dose rates after decontamination are <50 mrem/hr; and
- Performing removable contamination surveys to ensure that levels on the accessible outer surfaces of the valve are less than 100,000 dpm/100 cm^2 beta-gamma and <2,000 dpm/100 cm^2 alpha, performing additional decontamination if necessary to achieve these criteria.

4.3 Decontamination at DWPF

DWPF provides capabilities for decontamination of equipment with high radiation levels in its Remote Equipment Decon Cell (REDC). The REDC is 30 feet long, 26 feet wide, and 41 feet high. It contains shielded viewing windows and master-slave manipulators for remote operations.

[16] Whether size reduction in the field to facilitate additional decontamination is consistent with ALARA requirements depends on factors such as the radiation and contamination levels on the equipment and the capabilities of the radiological containment being used. In some cases, the risks of size reduction in the field will outweigh the potential benefits that might result in additional decontamination in a maintenance facility. Such was determined to be the case for the Tank 41 telescoping transfer jet discussed previously.

The REDC contains a vertical cylindrical soak tank that is 19.5 feet high and four feet in diameter with a working volume of 1500 gallons. Equipment is routinely soaked in a 12 percent nitric acid solution in that tank. The REDC also provides capabilities for CO_2 pellet blasting, steam cleaning, and 3000-psi pressure washing. The area is serviced by the main process cell bridge crane, which has a maximum capacity of 117 tons.

Any DWPF equipment that will fit inside the REDC can be decontaminated in that area. This equipment includes tanks, coils, and agitators, which range in size up to 25 feet long and eight feet wide, as well as jumpers up to 15 feet long. The soak tank is used mostly for pumps, but will also accommodate an agitator.

As noted previously, the DWPF equipment decontamination protocol (DWPF 2009) provides requirements for decontamination of various equipment that is performed remotely in the REDC. The requirements for pumps used for sludge mixtures, for example, involve soaking them in nitric acid solution for one to two weeks, flushing the internals with nitric acid solution, decontaminating the lower external surface using a technique such as pressure washing, and using the CO_2 pellet blasting system to decontaminate the pump motor.

Equipment is decontaminated in the REDC by the specified decontamination protocols as soon as it is removed from service. In cases where required maintenance or repairs cannot be performed remotely, further decontamination is performed using the steam and/or CO_2 systems to reduce contamination levels sufficiently to allow transfer into the adjoining Contact Decon and Maintenance Cell (CDMC). The acceptable radiation levels after decontamination depend largely on the scope of the planned maintenance work.

After completion of decontamination in the REDC, the equipment is moved to the CDMC where surveys are performed to determine the accessible beta and gamma radiation levels. The nature of the radioactivity is such that beta radiation may be more limiting than gamma radiation due to potential extremity doses exceeding potential whole body doses.

If necessary, the equipment is returned to the REDC for additional decontamination to ensure that the radiation levels are consistent with the ALARA principle. Maintenance personnel evaluate the equipment to determine if it is to be repaired or discarded as waste. The necessary maintenance and repairs are performed where this is appropriate.

Work packages are used for repairs and maintenance work performed in the CDMC and ALARA reviews are performed for such work. The Radiological Work Permit included with the work package specifies the maximum radiation level acceptable for the work. The specified radiation levels depend on factors such as the scope of the work to be performed and the feasibility of reducing the radiation levels further by additional decontamination in the REDC. Radiological Control management involvement with the process helps ensure that the radiation levels are consistent with the ALARA principle for the work involved.

EXAMPLE OF DECONTAMINATION AT DWPF

One of the most complex pieces of equipment related to the vitrification process is the Slurry Mix Evaporator, which is used to prepare sludge for vitrification by mixing treated waste with borosilicate glass frit to form a sludge-frit slurry.

This stainless steel vessel is 12 feet in diameter and stands approximately 18 feet high. It is designed with a removable top head so it can be serviced remotely. It contains removable internal heating and cooling coils and a removable agitator. The vessel contains various nozzles to support provisions for sampling and pumping, along with dip tubes for measuring the slurry level. The working capacity is 10,800 gallons.

In 2002, a leak developed during an air sparging evolution. The Slurry Mix Evaporator was removed from service and was moved into the REDC for decontamination. Gamma radiation levels measured on October 21, 2002 prior to decontamination by the two in-cell radiation detectors positioned approximately 30 cm from the vessel surface were 272 mR/hr and 438 mR/hr, respectively.

In the REDC, the leak was temporarily sealed and the vessel was filled with 12 percent nitric acid solution, which was allowed to soak the internal surfaces for approximately three months. The gamma radiation levels approximately 30 cm from the vessel surface following completion of this decontamination as measured by the two in-cell radiation detectors were 185 mR/hr and 261 mR/hr, respectively.

Additional decontamination was performed on the outside of the vessel with a high-pressure spray lance using nitric acid. The gamma radiation levels approximately 30 cm from the vessel surface following completion of decontamination as measured by the two in-cell radiation detectors were 30 mR/hr and 70 mR/hr, respectively, indicating an overall decontamination factor of approximately six to nine.

Evaluation after the Slurry Mix Evaporator was moved into the CDMC showed that it could be repaired. This was done and it was returned to service.

The Slurry Mix Evaporator failed again in 2007 due to a leak in a steam coil. It was moved to the REDC and decontaminated. Evaluation in the CDMC showed that tabs holding the removable coil guide had eroded leaving the guide stuck in place. This condition could not readily be resolved and led to replacement of the Slurry Mix Evaporator with a new unit. The failed Slurry Mix Evaporator remains in storage at DWPF awaiting possible repair. Additional decontamination would be performed if repairs were to be undertaken.

Consideration of the design and use of this equipment and the effectiveness of the decontamination processes used at DWPF make it obvious that the failed Slurry Mix Evaporator is not HLW after decontamination is completed. This same rationale also applies to the removable component parts of the Slurry Mix Evaporator, such as the heating and cooling coils and the agitator shaft and paddles, which are decontaminated using the same processes.

5.0 SECONDARY WASTE AND DISPOSAL SITE PERFORMANCE

This section summarizes the waste characterization process, describes radioactive waste disposal facilities used by the site, identifies the waste disposal criteria for these facilities, discusses the link between the waste acceptance criteria and disposal site performance, and discusses the relationship between waste acceptance criteria for LLW and the NRC waste classifications.

5.1 Characterization of Secondary Waste

SRS requirements for characterization of LLW, TRU waste, mixed waste, and PCB waste are described in the 1S Manual, Procedure WAC 2.02 (SRNS 2008a). This procedure describes methods to be used to determine the characteristics of a waste stream, including its predominant radionuclide content and distribution. The characterization approach for each waste stream considers the following factors:

- Its source,
- Its use prior to being declared a waste,
- Its association with radioactive material management areas,
- Its predominant radionuclide content and distribution,
- Its physical properties and chemical constituents,
- The type of disposal container used, and
- The feasibility of quantifying the radionuclide or chemical content of a waste package directly or indirectly using emitted radiation.

Characterization is performed on waste packages, and not equipment or material before it is placed into the waste package.

The contents of each waste package are required to be quantified in terms of the physical, chemical, and radiological characteristics. Radiological characterization methods may include a combination of process knowledge, sample analytical data, measured gamma radiation levels, and scaling factors that relate the concentration of an easy-to-measure radionuclide such as Cs-137 to the concentrations of other radionuclides present in the waste (dose to curie), and relating measured surface contamination to activity (smear to curie). Samples used for characterization purposes must be representative of the waste stream. An appropriate range of radionuclides is considered in characterization, including those important in the performance assessment and safety authorization basis for the treatment, storage, and/or disposal facility.

TRU waste characterization prior to shipment offsite also includes radiological assay of each container, X-ray of each container to ensure that the physical contents are consistent with the waste acceptance criteria, and sampling of each container to ensure the absence of hydrogen, methane, and other volatile organic compounds.

5.2. Waste Acceptance Criteria and Disposal Site Performance

Waste acceptance criteria for DOE LLW disposal facilities are established to ensure that the facilities perform as required. The performance objectives for a DOE LLW facility include dose limits for a member of the public and for a hypothetical person who, unaware of the buried radioactive material, might inadvertently drill a well into the buried waste, referred to as the post-drilling scenario, or establish a farm on the site, known as the intruder-agriculture scenario. The performance objectives for DOE LLW disposal facilities are identified in DOE Manual 435.1-1.[17]

To help place the link between waste acceptance criteria and disposal site performance into context, this section discusses onsite and offsite LLW disposal. It addresses the facilities involved, their waste acceptance criteria, and, for DOE-owned facilities, the performance assessments used to demonstrate that the closed facility will meet its performance objectives.

5.2.1 Low-Level Waste Disposal

SRS produces LLW in a variety of activities, including decontamination and decommissioning and environmental remediation work. This LLW is disposed of onsite, at other DOE facilities, or at commercial disposal facilities. With the exception of the saltstone waste stream, onsite disposal takes place at the E-Area Low-Level Waste Facility.

E-Area Low-Level Waste Facility

The E-Area Low-Level Waste Facility is located in the General Separations Area. It is comprised of 200 acres set aside for waste disposal with a surrounding buffer zone. Disposal units include the Slit Trenches, Engineered Trenches, Component-in-Grout Trenches, the Low-Activity Waste Vault, the Intermediate-Level Vault, and the Naval Reactors Component Disposal Area. Typical waste packages disposed of at this facility are B-25 boxes and intermodal containers (commonly referred to as Sealand containers), although a variety of other waste containers are approved for use.

Radioactive waste disposal operations at the E-Area Low-Level Waste Facility began in 1995. The operational period is assumed to last for 30 years for the Slit and Engineered Trenches and for 25 years for all other units. The operational period is therefore assumed to end in 2025. Plans then call for a 100-year institutional control period followed by final closure of the entire facility.

[17] Low-level waste disposal facilities shall be sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives will be met for waste disposed of after September 26, 1988:

(a) Dose to representative members of the public shall not exceed 25 mrem in a year total effective dose equivalent from all exposure pathways, excluding the dose from radon and its progeny in air.
(b) Dose to representative members of the public via the air pathway shall not exceed 10 mrem in a year total effective dose equivalent, excluding the dose from radon and its progeny.
(c) Release of radon shall be less than an average flux of 20 pCi/m^2/s (0.74 Bq/m^2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/L (0.0185 Bq/L) of air may be applied at the boundary of the facility.

The facility performance assessment is also required to include an assessment of impacts to a hypothetical intruder with performance measures of 100 mrem in a year for chronic exposure and 500 mrem in a year for acute exposure, excluding radon dose (DOE manual 435.1-1, IV). In addition, for purposes of establishing limits on radionuclides that may be disposed of near-surface, the performance assessment is required to include an assessment of impacts to water resources.

Waste Acceptance Criteria for the E-Area Low-Level Waste Facility

For its LLW disposal facilities, DOE provides formal waste acceptance criteria that comprise the technical and administrative requirements that a waste must meet in order for it to be accepted at the disposal facility (DOE Manual 435.1-1, Chapter IV). Waste acceptance criteria for the E-Area Low-Level Waste Facility are found in the 1S Manual, Procedure WAC 3.17 (SRNS 2009).

The radionuclide inventory limits calculated in the disposal facility performance assessment and documented safety analysis are implemented by the SRS waste acceptance criteria. The computerized Waste Information Tracking System (WITS) is used to manage waste disposal at this facility consistent with these criteria and within the limitations of the facility performance assessment and the documented safety analysis. Before a waste package is shipped to the facility for disposal, the waste generator enters the waste package contents into the WITS and performs a limit check of the waste package for acceptance into the planned disposal unit.

E-Area Low-Level Waste Facility Performance Assessment

A LLW disposal facility performance assessment involves detailed analyses of potential radiation doses to future members of the public and inadvertent intruders to ensure that the closed facility will meet its performance objectives. A LLW disposal facility performance assessment makes use of two basic types of models. One or more conceptual models are used to describe all of the relevant properties of the disposal site. Mathematical models are used with the conceptual models to calculate potential doses under different scenarios.

The projected inventory at closure is a key factor in disposal site performance. For a complex disposal facility, such as the E-Area LLW Facility, projected inventory is expressed for individual disposal units. Given this situation, a waste package that could have a significant impact on the performance of one disposal unit (e.g., the Slit Trenches) might have no impact on the performance of another disposal unit (e.g., the Intermediate-Level Vault).

The E-Area LLW Facility performance assessment was prepared by SRNL to meet requirements of Chapter IV of DOE Manual 435.1-1 (WSRC 2008b). It shows that there is reasonable expectation that the closed facility will meet its performance objectives.

Controls to Ensure Required Disposal Site Performance

The SRS waste acceptance process incorporates various administrative controls including screening limits that help provide a defense in depth to ensure that disposal site performance could not be comprised by disposal of a particular waste package. Two examples are provided below.

If WITS were to identify that a particular waste package would exceed 0.5 percent of the performance assessment limit for the disposal unit of interest, Solid Waste Engineering is required to evaluate the acceptability of the waste package and determine that it could be disposed of as planned. This package screening limit identifies waste containers with a significant inventory contribution for a given disposal location. Among the factors considered in the evaluation are the affected performance assessment exposure pathway isotope group and the current disposal inventory for the subject disposal location. (SRNS 2009, Attachment 2)

If WITS were to identify that a particular waste package would have a performance assessment impact on the planned disposal unit greater than five percent, it could not be disposed of in the planned disposal unit without a formal evaluation to ensure that the disposal unit performance envelope is not exceeded using the unreviewed disposal question process or by preparing a special analysis. A five percent limit failure indicates the potential presence of a point source in the disposal unit, a condition which is prohibited without additional analysis. (SRNS 2009, Attachment 2)

The unreviewed disposal question process involves a screening evaluation to determine whether the subject change could impact disposal site performance, that is, whether the change would be outside of the performance envelope[18]. Changes that would be outside of the performance envelope require a special analysis. A special analysis is a supplemental analysis performed using the same methodology as the disposal facility performance assessment, but the conceptual model takes into account the pertinent features of the waste stream of interest and the radioactivity associated with this waste, as well as the final disposal inventory used in the original performance assessment. Because a special analysis constitutes a change to the performance assessment it must be approved by DOE.

Note that a five-percent performance assessment impact issue might be resolved by making use of another disposal unit. For example, a waste package with greater than five percent impact on the Slit Trenches may be able to be disposed of in the Intermediate-Level Vault with no performance assessment impact.

As of December 2009, WITS was not being used for mixed waste. An equivalent process was being used for mixed waste that involves similar controls and screening of waste packages by Radioactive Waste Engineering in preparation of waste profile documentation for offsite disposal of the waste as described in Section 5.2.2 below.

Waste Acceptance Criteria and Disposal Site Performance

Because of the established relationship between the waste acceptance criteria and performance assessments of the waste disposal sites, satisfying the waste acceptance criteria ensures compliance with the disposal site performance assessment and, hence, with the performance objectives. The rationale for this conclusion may be summarized as follows:

- DOE performance objectives for its LLW disposal facilities are comparable with those of 10 CFR 61, Subpart C (Wilhite 2001);
- Disposal site performance in compliance with the performance objectives is determined by a performance assessment of the facility;
- This performance assessment is based on a projected total radionuclide inventory for the full, closed disposal site;
- This projected total inventory is based on the waste acceptance criteria, thus linking these criteria directly to the calculated disposal site performance; and

[18] The unreviewed disposal question process is similar to the unreviewed safety question process for DOE nuclear facilities defined in 10 CFR 830.203.

- Meeting the waste acceptance criteria will therefore ensure that the performance objectives will be achieved, because waste meeting these criteria would not increase the assumed waste inventory used in the performance assessment analyses.

Implementation of the waste acceptance criteria therefore provides assurance that inventories in disposal units comply with performance assessment requirements. The waste acceptance criteria serve as the principal means of communicating performance assessment assumptions, radionuclide limits for performance assessment and documented safety analysis, waste form requirements, and waste packaging requirements to waste generators (WSRC 2008b).

The radionuclide inventory limits calculated in the performance assessment and documented safety analysis and implemented by the waste acceptance criteria are managed through WITS. The WITS compares the waste package contents with the waste acceptance criteria container limits, calculates the cell/facility inventory to ensure compliance with the cell criticality and safety-based limits, and calculates the total inventory for each radionuclide to ensure compliance with the limits derived for all pathways in the performance assessment. (WSRC 2008b)

Waste Acceptance Criteria and Highly Radioactive Waste

For SRS, waste that meets the waste acceptance criteria for the E-Area LLW disposal facilities is not highly radioactive for reasons such as the following:

- The waste acceptance criteria are established to ensure that disposal site performance meets DOE performance objectives for LLW disposal, which are comparable to NRC performance objectives for LLW disposal in 10 CFR Part 61, Subpart C, as just discussed.
- Because the DOE performance objectives are comparable to these NRC performance objectives – which apply to land disposal of radioactive waste and specifically not to a geologic repository – it follows that waste meeting the waste acceptance criteria does not require geologic disposal.

Consideration of such matters leads to the conclusion that meeting NRC Class C concentration limits is not a factor in disposal of secondary waste that has been determined not to be HLW by the citation process as LLW.

5.2.2 Offsite Low-Level Waste Disposal

In the following discussion, the Nevada Test Site is used as an example of another DOE facility where SRS LLW may be disposed of, and the Energy*Solutions* disposal facility at Clive, Utah as an example of a commercial radioactive waste facility that may be utilized by SRS for LLW disposal.[19]

LLW Disposal at the Nevada Test Site

This DOE facility maintains two separate LLW disposal facilities known as the Area 3 and the Area 5 Radioactive Waste Management Sites. The Area 3 site has three disposal units located in shallow depressions in the ground created by underground nuclear weapons detonations. Waste

[19] Use of these examples is not intended to imply that they are the only DOE and commercial radioactive waste disposal facilities that may be used for offsite disposal of LLW.

in the Area 5 site is generally disposed of in trenches approximately 22 feet deep. Waste in both facilities is covered with soil.

Offsite disposal of SRS LLW at the Nevada Test Site is consistent with DOE's February 25, 2000 Amended Record of Decision for the Nevada Test Site (Federal Register 65 FR 38) related to the *Waste Management Programmatic Environmental Impact Statement* (DOE 1997). Procedure WAC 3.17 (SRNS 2009) identifies the Nevada Test Site as a disposal facility for LLW that cannot be disposed of at SRS.

Nevada Test Site Waste Acceptance Criteria

The Nevada Test Site provides specific radionuclide waste acceptance criteria for LLW (DOE 2008) that are expressed primarily in terms of waste package activity limitations based on Pu-239 equivalent grams (PE-g). This quantity relates the amount of a particular radionuclide to Pu-239.

The Nevada Test Site waste package limit for a single Department of Transportation Type A drum is 300 PE-g total. The limit for a strong-tight container such as an intermodal shipping container is also 300 PE-g total. An additional limitation of 2000 PE-g per individual shipment also applies, except for Type B shipping containers in cases where the containers themselves are to be disposed of. (DOE 2008)

The waste acceptance criteria are based on a performance assessment that provides reasonable expectation that DOE's performance objectives will be achieved and that the predicted potential doses to representative members of the public will be much less than the performance objective dose limits. The Nevada Test Site waste acceptance requirements incorporate various controls to ensure that waste packages could not affect disposal site performance, including a Waste Acceptance Review Panel, a group of waste management specialists who review new and revised waste streams planned for disposal at the site.

Energy*Solutions* Disposal Facility at Clive, Utah

This commercial radioactive waste disposal facility is located in an isolated area approximately 75 miles west Salt Lake City. It is licensed by the State of Utah to dispose of Class A LLW and mixed waste, including radioactively contaminated soil and large components. Offsite disposal of SRS LLW at this facility is consistent with the *Waste Management Programmatic Environmental Impact Statement* (DOE 1997). Procedure WAC 3.17 (SRNS 2009) identifies the Clive, Utah Energy*Solutions* disposal facility as an acceptable disposal facility for LLW that cannot be disposed of at SRS. (It is also an acceptable disposal facility for mixed LLW as indicated below.)

Waste Acceptance Criteria for the Energy*Solutions* Clive, Utah Facility

Energy*Solutions* specifies waste acceptance criteria for its Bulk Waste Disposal and Treatment Facilities (Energy*Solutions* 2006) and separately for its Containerized Waste Facility (Energy*Solutions* 2008). Acceptable radioactive wastes are:

- Class A LLW;
- Naturally occurring or accelerator produce radioactive material (NORM/NARM);

- Mixed LLW;
- Uranium and thorium mill tailings byproduct material;
- Special nuclear material in limited concentrations; and
- Polychlorinated biphenyl (PCB) radioactive waste, and PCB mixed waste

The waste acceptance process involves developing a radioactive waste profile record that is approved by the facility prior to waste shipment.

The acceptability of disposal of a particular SRS waste stream at the Energy*Solutions* Clive, Utah Facility is based on compliance with the waste acceptance criteria. If the waste meets the waste acceptance criteria, it is not necessary for SRS to consider the potential impact of the waste stream on disposal site performance.

5.2.3 Transuranic Waste

Like other DOE sites, SRS sends TRU waste to DOE's Waste Isolation Pilot Plant (WIPP) for geologic disposal. Shipments to WIPP began in 2001. This waste is typically shipped in vented Department of Transportation Type A 55-gallon drums that meet the WIPP waste acceptance criteria. The drums are transported within Type-B shipping casks such as TRUPACT-II containers. As with DOE LLW disposal facilities, meeting the waste acceptance criteria ensures that waste packages could not impact the performance of WIPP.

5.2.4 Mixed Waste

Mixed waste is not disposed of onsite. It is shipped to the Nevada Test Site, to the Energy*Solutions* Clive, Utah facility, or to another suitable facility for any necessary treatment and offsite disposal. For SRS mixed waste, the waste profile documentation will show that the waste packages meet the facility waste acceptance criteria, thus ensuring that there will be no adverse impact on disposal facility performance.

6.0 SUMMARY AND CONCLUSIONS

Sections 2 through 5 provide the following information:

- Section 2.1 describes lessons learned in application of waste-incidental-to-reprocessing criteria at SRS and other sites that manage HLW which make it clear that most secondary waste streams were not produced in reprocessing of spent nuclear fuel, are not highly radioactive (i.e., will meet waste acceptance criteria for disposal as LLW of TRU waste), and do not require long-term geologic isolation and are therefore not HLW.
- Section 2.2 describes evaluations performed at Hanford that led to a decision by the DOE Office of River Protection to use the citation process for all equipment used in underground waste tanks for activities such as removing and sampling waste.
- Section 2.2 explains that this decision was based on factors such as the effectiveness of routine decontamination processes, the resulting inconsequential radionuclide inventories, and the packaged waste meeting waste acceptance criteria for onsite disposal as LLW.

- Section 2.2 also explains how use of the citation process for the Hanford equipment was supported by consideration of the evaluation criteria of DOE Manual 435.1-1.
- Section 2.3 describes SRS waste-incidental-to-reprocessing evaluations performed in accordance with DOE Manual 435.1-1 which showed that slurry pumps removed from Tank 40 and a telescoping transfer jet removed from Tank 41 were not HLW and could be disposed of onsite as LLW, reinforcing the Hanford conclusions that it is obvious that equipment removed from underground waste tanks and decontaminated by routine site processes is not HLW.
- Section 3 describes DOE ALARA requirements and discusses how it is applied at the site.
- Section 4 describes decontamination routinely performed by the site in accordance with ALARA requirements and demonstrates that this decontamination removes key radionuclides from equipment used in the tank farms and at DWPF to the maximum extent technically and economically practical.
- Section 5 describes how waste packages are characterized at the site, discusses disposal facility waste acceptance criteria, describes controls over the waste acceptance process, and shows that there will be no negative impact on disposal facility performance from disposal of any waste package that meets the waste acceptance criteria.

This information demonstrates that SRS tank farm and DWPF equipment decontaminated by routine site processes when such decontamination is consistent with the ALARA process is not HLW and that use of the citation process for this equipment is appropriate.

7.0 SECONDARY WASTE STREAMS THAT CAN BE MANAGED AS NON-HLW

Based on the foregoing discussions, the following secondary waste streams are not HLW and can be managed as LLW, mixed LLW, TRU waste, or mixed TRU waste as applicable when they (1) have been decontaminated using routine site processes, when such decontamination is consistent with the ALARA principle, and (2) meet disposal facility[20] waste acceptance criteria.

DECONTAMINATION CONSISTENT WITH THE ALARA PRINCIPLE
Decontamination consistent with the ALARA principle means decontamination performed by proven site processes where performing decontamination is necessary to comply with DOE and site policies on ALARA. In some cases, no decontamination will be necessary based on the ALARA principle because the amount of radioactivity associated with the equipment is small or because the potential risks associated with decontamination and the related activities such as size reduction would outweigh the potential benefits.

7.1 Decontaminated Tank Farm Equipment

Decontaminated tank farm equipment including, but not limited to, the following, along with any parts of such equipment:

[20] Disposal facilities include onsite and offsite LLW disposal facilities, offsite disposal facilities for mixed LLW, and WIPP for TRU waste or mixed TRU waste.

- agitators
- caissons
- centrifuges/contactors
- conductivity probes
- cranes
- cross flow filters and rotary screen filters
- dip tubes
- drill guides
- drill strings
- downcomers
- dummy connector headers
- eductors
- evaporator feed pumps
- evaporator pots
- filtrate tanks
- inspection port plugs
- interstitial liquid pumps
- instrumentation (all types)
- jets
- jumpers
- lances
- mailboxes (short downcomers)
- mining tools, pineapple heads
- neutralization equipment
- piping (lines of various types)
- pumps (other types not listed)
- riser plugs
- riser plugs containing equipment or piping
- sample tools
- scrubbers
- slurry pumps
- spray chambers
- spray nozzles
- spray wash tools
- submersible mixer pumps
- sump pumps
- tanks (other types not listed)
- telescoping transfer jets
- thermowells
- transfer pumps
- transfer piping and transfer lines
- valves (all types)
- ventilation equipment, including HEPA filters
- vessels (other types)
- waste retrieval equipment (other types not listed)
- well screens

In addition, other tank farm equipment not listed above is not HLW if (1) it has been decontaminated using routine site processes, when such decontamination is consistent with the ALARA principle, and (2) it meets disposal facility waste acceptance criteria.

7.2 DWPF Equipment

DWPF equipment including, but not limited to, the following, along with any parts of such equipment:

- agitators
- cooling and steam coils
- cross flow filters
- cranes
- dip tubes
- headers
- instrumentation (all types)
- pumps
- sample tools
- Sludge Receipt and Adjustment Tank
- Slurry Mix Evaporator
- tanks
- telerobotic manipulator tools
- valves

- jumpers
- lifting and handling equipment
- piping
- vessels (other types not listed)
- ventilation equipment, including HEPA filters

In addition, other DWPF equipment not listed above (except for vitrification melters) is not HLW if (1) it has been decontaminated using routine site processes, when such decontamination is consistent with the ALARA principle, and (2) it meets disposal facility waste acceptance criteria.

7.3 Other Secondary Waste Streams

The following additional secondary waste streams are not HLW. The basis for this conclusion is described below.

- laboratory-scale melter refractory pieces
- soil and debris

7.3.1 Laboratory Pilot Scale Melter Refractory

The subject material consists of four pieces of K3 chrome aluminum refractory material weighing approximately 1.1 kg that came from a small, pilot-scale vitrification melter that was used in Building 773-A at SRNL in 1985 and 1986 for two testing campaigns. The subject pieces formed the bottom and sides of the melter cavity, which was eight inches in diameter and six inches high. They became contaminated with HLW when slurry from Tank 8/12 was heated in the melter during the 1986 testing campaign. The melter failed and was subsequently dismantled.

The refractory pieces were decontaminated in the laboratory by mechanically removing the residual glass. Removal of the glass was verified by visual inspection.

The refractory pieces are parts from an “empty (HLW drained, emptied, flushed, or otherwise removed) laboratory-scale research melter,” which is among the laboratory equipment listed in Procedure HLW-SUP-99-0060 (WSRC 2000a) that has been determined not to be HLW by the citation process. (See Attachment 1 to this procedure.) Procedure HLW-SUP-99-0060 contained the following note: “An engineering calculation note must be provided to document WIR requirements are met.” This calculation was completed for the melter itself, which was found to meet waste acceptance criteria for onsite disposal as LLW (WSRC 2000b). The refractory pieces, which are being managed separately, are clearly not HLW without the need for an additional calculation because they are not HLW by virtue of their origin (i.e., they were part of the laboratory-scale melter), have been effectively decontaminated, and have no hidden surfaces that could trap waste.

7.3.2 Soil and Debris

Soil and debris (such as gravel) become contaminated by HLW from time to time, such as by supernatant spills and leaks from transfer lines. Such spills generally occur in unsaturated soil. The resulting radioactive material becomes dispersed due to various transport mechanisms at rates depending on factors such as the chemical properties of the elements involved and the characteristics of the soil or other media.

This contaminated material is not HLW due to its origin and characteristics. The soil or debris did not originate in spent fuel reprocessing. It became contaminated by incidental contact with liquid HLW. The resulting contaminated material contains much lower radionuclide concentrations than HLW and will generally meet waste acceptance criteria for disposal as LLW. It therefore can be managed as LLW, or if transuranic radionuclide concentrations warrant, as TRU waste.

8.0 REFERENCES

Federal Statutes

Atomic Energy Act of 1954, as amended.

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10 CFR Part 61, Subpart C, *Licensing Requirements for Land Disposal of Radioactive Waste, Performance Objectives*.

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