U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY DRAFT WASTE INCIDENTAL TO REPROCESSING DETERMINATION FOR SODIUM-BEARING WASTE

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INTRODUCTION

Background - History of Reprocessing Activities at the Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), an 2300-square kilometer (890-square mile) site, located in Eastern Idaho, was initially established to develop civilian and defense nuclear reactor technologies. The Idaho Nuclear Technology and Engineering Center (INTEC) at the INEEL was established in 1953 to recover fissile uranium by reprocessing spent nuclear fuel (see Figure 1). The spent fuel was dissolved, producing an acidic aqueous solution, which was processed through a first-cycle extraction system to separate uranium from the bulk of the fission products (or first-cycle extraction waste). The separated uranium was processed through a second- and third- cycle extraction system to remove carry-over radioactive material, which included plutonium and transuranic radionuclides. In 1992, the U.S. Department of Energy (DOE) Idaho Operations Office (ID) ceased reprocessing activities at INTEC.

The waste from spent fuel reprocessing was stored in the Tank Farm Facility [consisting of eleven 1000 cubic meter (m^3) (300,000 gallon) and four 100 m^3 (30,000 gallon) underground storage tanks], where first-cycle solvent extraction waste was initially stored separately from other reprocessing wastes (see Figure 2). Other reprocessing wastes include decontamination solutions from maintenance and closure activities and second- and third-cycle reprocessing extraction wastes. The decontamination solutions contain large quantities of sodium salts, and since “other reprocessing waste” mainly consists of decontamination solutions, it is designated “sodium-bearing waste” (SBW).

Beginning in 1963, INEEL began to stabilize the first-cycle and most of the second- and third-cycle extraction wastes in a solid form through calcination. In addition to stabilization, calcination resulted in reduction of waste volume. In 1978, the sodium-bearing wastes were blended with calciner feed to help further reduce the inventory in the tank farm. In January 1990, the U.S. Environmental Protection Agency (EPA) issued a Notice of Noncompliance [1], since the 1000 m^3 (300,000 gallon) tanks did not meet the secondary containment requirements of the Resource Conservation and Recovery Act. The Notice of Noncompliance resulted in a Consent Order from the Idaho Department of Health and Welfare [2] that required INEEL to upgrade the tank system or permanently cease use of all 1000 m^3 (300,000 gallon) tanks before the end of calendar year 2012. As of March 1998, INEEL completed calcination of the first-cycle extraction waste and most of the second and third-cycle extraction waste. Small heels (liquid and settled solids remaining in the bottom of the tank after emptying to the maximum extent possible by using existing transfer equipment) remain in eight of the 1000 m^3 (300,000 gallon) tanks. The tanks were also used to store additional SBW. Therefore, the SBW consists of decontamination solutions from reprocessing activities, second- and third-cycle reprocessing extraction wastes, contamination from first-cycle reprocessing extraction wastes, settled solids in the tanks, and liquid wastes from ongoing and future maintenance and closure activities at the INTEC (called newly generated liquid waste). DOE-ID continued to calcine the SBW until May 2000, when the waste calcining facility at INEEL was placed on standby as a result of the Consent Order.

FIGURE 1

FIGURE 2

Incidental Waste/Waste Incidental to Reprocessing Criteria

Since 1969, the U.S. Nuclear Regulatory Commission (NRC) has recognized the concept of incidental waste or waste incidental to reprocessing (WIR). Certain material that otherwise would be classified as high-level radioactive waste (HLW) need not be disposed of as HLW and sent to a geologic repository because the residual radioactive contamination after decommissioning is sufficiently low as not to represent a hazard to the public health and safety. Consequently, incidental waste is not considered HLW.

Incidental waste criteria were previously developed for management of certain wastes removed from tanks at DOE's Hanford site. These criteria were approved by the Commission in a Staff Requirements Memorandum dated February 16, 1993, in response to SECY-92-391, "Denial of PRM 60-4 - Petition for Rulemaking from the States of Washington and Oregon Regarding Classification of Radioactive Waste at Hanford," and are described in a letter from R. Bernero/NRC, to J. Lytle/DOE, dated March 2, 1993 [3]. More recently, the criteria, as modified, were included in the Final Policy Statement for the Decommissioning Criteria for the West Valley Demonstration Project at the West Valley Site, dated February 1, 2002 [4]. In the Policy Statement, the Commission noted the criteria that should be applied to the incidental waste determinations at West Valley: (1) the waste should be processed (or should be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical; and (2) the waste should be managed so that safety requirements comparable to the performance objectives in 10 CFR Part 61, Subpart C, are satisfied.

On July 9, 1999, DOE issued DOE Order 435.1, "Radioactive Waste Management" [5]. The DOE Order 435.1 and its associated manual and guidance [6,7] require that all DOE radioactive waste be managed as HLW, transuranic (TRU) waste, or low-level radioactive waste (LLW). The Order states that waste, determined to be incidental to reprocessing, is not HLW and shall be managed in accordance with the requirements for TRU waste or LLW, if it meets appropriate criteria. The Order discusses the WIR evaluation process, stating that incidental waste may be managed as TRU waste if the wastes: "...(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 ["Transuranic Waste Requirements"], as appropriate."

Review Approach

DOE-ID and NRC developed a Memorandum of Understanding (MOU) [8] that establishes the framework for NRC to provide technical assistance to DOE-ID in regard to the incidental waste determinations. An Interagency Agreement [9] implements the MOU, which establishes that all costs incurred by NRC, including contractor support, will be reimbursed by DOE-ID. In addition, the MOU establishes that NRC's activities under the MOU are carried out in an advisory capacity, and that any advice given to DOE-ID under the MOU does not constitute regulatory approval, authorization, or license for DOE activities.

The guidance document for DOE Order 435.1 recommends consultation with NRC for WIR determinations. NRC's review focused on Criterion 1, assessing whether the waste has been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical. NRC's incidental waste guidance does not include a TRU disposal option, and NRC staff considers it inappropriate to assess whether the TRU disposal option provides safety equivalent to the performance objectives of 10 CFR Part 61, since the Waste Isolation Pilot Plant (WIPP) is regulated by EPA and is outside of NRC's jurisdiction. Therefore, although the WIR determination addresses all three criteria in DOE Order 435.1, NRC did not provide conclusions and recommendations for the TRU disposal portion of the determination (Criteria 2 and 3). Rather, NRC only provided comments and observations on the methodology for meeting Criteria 2 and 3, that were identified during the review.

DOE-ID submitted the SBW WIR determination on September 25, 2001 [10,11]. After initial review of the determination, NRC provided DOE-ID with a list of questions and comments in a request for additional information (RAI) [12]. As a result of NRC observations and a change in direction on the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (IHLW&FD EIS) [13], DOE-ID decided to revise its approach taken in the WIR determination. DOE-ID responded to NRC's RAI on January 29, 2002, providing the additional information requested and summarizing the revised approach for the determination [14]. On March 8, 2002, DOE-ID submitted the revised determination for NRC review [15, 16, 17, 18, 19, and 20]. Unresolved or additional NRC concerns have been resolved through informal communications with DOE-ID and/or are documented in the text of this report.

CRITERION ONE

> *The waste must have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical.*

Original SBW WIR Determination (Draft A)

DOE-ID's original SBW WIR determination focused on cesium (Cs)-137, strontium (Sr)-90, technetium-99, and the transuranic radionuclides as key radionuclides, since they accounted for 99.96 percent of the initial INTEC spent fuel reprocessing radionuclide curie inventory [11]. Cs-137 and Sr-90 are the greatest contributors, alone accounting for 99.6 percent of the initial curie inventory.

DOE-ID considered a number of options for treating SBW, including alternatives assessed in the IHLW&FD EIS, recommendations from the National Research Council [21], and INTEC evaluations. The original determination analyzed precipitation, ion exchange, and solvent extraction methods to determine whether it was technically and economically practical to remove additional key radionuclides from the SBW. Direct vitrification of SBW with disposal as TRU waste at WIPP was used as the base case for economic evaluations of additional key radionuclide removal options, since it was determined to be the most preferred of the technically viable non-separations options by the DOE Decision Management Team (DMT) for the IHLW&FD EIS.

One of the key arguments supporting the fulfillment of Criterion 1 was that the INTEC segregated, removed, and converted the first-cycle extraction waste and most of the second- and third-cycle extraction waste (representing 98.3 percent of the key radionuclide inventory from reprocessing) to a stable solid waste form (calcine), which will eventually be disposed of as HLW. Additional removal of key radionuclides from the SBW would incur an additional $77 to $225 million and remove only 1.3 to 1.7 percent of the original reprocessing curies, resulting in a cost of $129 to $290/curie above the cost of the baseline option (direct vitrification). DOE-ID determined that it was not economically practical to remove additional key radionuclides from the SBW since their removal does not provide any additional protection to the public and the environment.

After initial review of the SBW determination, NRC requested additional information on the rationale for the DMT's decision to use direct vitrification as the preferred alternative, rather than one of the other waste form options (such as grouting, calcining, or steam reforming). It was not clear to NRC that all the technically practical options had been evaluated in the context of Criterion 1.

NRC also observed that the WIR determination process, laid out in DOE Order 435.1, should allow flexibility in identifying the key radionuclides, so that a risk-informed approach could be used to determine what radionuclides are "key" (i.e., the key radionuclides are those that contribute most to risk and are the most significant for protection of public health and safety). NRC also noted that Cs-137 and Sr-90 (and other relatively short-lived radionuclides) may dominate occupational exposure, but it was not apparent that these radionuclides would be significant contributors to expected future risks associated with WIPP.

In response to NRC's observations, and based on a shift in direction for a preferred alternative for SBW treatment in the development of the IHLW&FD EIS, DOE-ID decided to revise its approach initially taken in the SBW WIR, and submitted a revised determination for NRC review.

Revised SBW WIR Determination (Draft B)

The revised determination states that DOE Order 435.1 provides flexibility for each site to identify key radionuclides as those that significantly impact disposal site performance objectives. This allows DOE-ID to identify the key radionuclides considered for SBW treatment and disposal and focus the technical and economic analysis on those radionuclides that are important for meeting disposal performance objectives at WIPP. The performance objectives require reasonable assurance that exposure to humans is within established limits. DOE-ID determined that americium (Am)-241, plutonium (Pu)-238, Pu-239, and Pu-240 are the key radionuclides, since they account for most of the calculated future risk in WIPP's performance assessment [22,23]. In addition, DOE-ID noted that 96 percent of the key radionuclides and 99 percent of all radionuclides generated from spent fuel reprocessing have been removed from INTEC tank farm waste.

Because of the shift in DOE-ID's assumptions while developing the IHLW&FD EIS, DOE-ID decided to evaluate SBW treatment independent of calcine treatment, and in turn, no longer assumed that a vitrification facility would be necessary at INEEL, as considered in the original determination. Therefore, the revised determination presents a range of SBW direct stabilization options as a base case (rather than choosing direct vitrification as the base case), with an evaluation of the technical and economic practicality of additional key radionuclide removal prior to disposal.

The revised determination treats SBW liquid and solids independently, by assuming (for all options) that SBW solids are filtered from the process feed stream and treated separately. Solids separation is a required process step for the contact-handled (CH) TRU grout and the universal solvent extraction (UNEX) and TRU solvent extraction (TRUEX) separation options. It may also be required for the other options, to improve process control and reduce final product variability. The large quantity of heel solids recovered during tank closure operations may require separate handling and additional treatment equipment. Therefore, there would still be costs for solid handling, but it should be less than front-end filtration costs for the treatment processes, so the cost estimates for calcination, steam reforming, and vitrification should be conservative in the SBW WIR economic evaluation. The filtered solids (including those from the tank heel removal) would be dried and packaged to meet WIPP waste acceptance criteria (WAC) as remote-handled (RH) TRU waste.

DOE-ID's economic evaluation (of direct stabilization options and options for removing additional key radionuclides) only considers discriminatory costs, so the costs presented in the WIR determination do not represent total costs and therefore, would not be used for life-cycle budget planning. Discriminatory costs include costs to build and operate the facilities needed for the specific treatment option, facility decontamination and demolition costs, interim storage costs (for HLW storage needed for the additional key radionuclide removal options), and waste disposal costs. Costs that were considered to be essentially the same for each alternative were not incorporated in the cost analysis; such costs include utility costs, costs for facilities common to all options, analytical support costs, management costs, maintenance costs, and the cost of inflation.

Base Case

The revised approach uses direct stabilization as a base case, resulting in a TRU waste stream that would be disposed of at WIPP and secondary waste streams that would be stabilized for appropriate disposal. Characterization of the projected SBW forms is based on feasibility-level studies for solidification processes and the SBW radionuclide inventory and mass balance. The direct stabilization options considered in the determination were CH-TRU grout, calcination, steam reforming, and direct vitrification. A brief description of each alternative, as well as its cost estimate, follows.

CH-TRU Grout

For this option, SBW would be transferred to a surge storage tank using in-tank steam jets, existing transfer piping, and new transfer piping that would be installed as part of this alternative. The undissolved solids would be filtered from the waste, dried, and packaged for disposal as RH-TRU waste at WIPP. The clarified liquid would then be passed through a fixed bed ion-exchange system to remove cesium. The cesium-loaded ion-exchange resin, estimated to be contaminated with TRU radionuclides in concentrations greater than 3700 becquerels (Bq) per gram (100 nanocuries per gram), would be treated and packaged for disposal as RH-TRU waste at WIPP. The bulk liquid would be neutralized with calcium oxide, and then combined with cement, fly-ash, blast furnace slag, and additional calcium oxide to form a stable grout material that meets the WIPP waste acceptance criteria for CH-TRU waste.

The total project cost estimates for this option are based on the design and construction of a new facility for treatment of the SBW; the estimate is $242 million (refer to Tables 1 and 2). Other costs associated with this option are operating costs of $89 million, decontamination and demolition costs of $67 million, CH-TRU disposal costs of $105 million [assuming 4600 m^3 ($1.6x10^5$ cubic feet (ft^3) of CH-TRU waste], and RH-TRU disposal costs of $63 million [assuming 249 m^3 (8790 ft^3) of RH-TRU waste], for a total discriminatory cost estimate of $566 million.

Table 1: SBW Treatment Alternative Costs

	Direct Stabilization Alternatives (Cost x millions)				Key-Radionuclide Separation Alternatives	
Alternative	CH-TRU Grout *	Calcination	Steam Reforming	Direct Vitrification	UNEX* *	TRUEX **
Total Project Cost	$242	$301	$485	$746	$989	$1,663
Operations	$89	$212	$163	$189	$416	$399
DD&D	67	84	136	209	277	466
Transportation & Disposal						
Class-A Disposal at Hanford					$15	
Class-C Disposal at Hanford		$0.1	$0.1	$0.3		$87
CH-TRU Disposal at WIPP	$105					
RH TRU disposal at WIPP	$63	$325	$270	$215	$21	$21
HLW Disposal at National Rep.					$14	$143
Total	$566	$922	$1,054	$1,359	$1,732	$2,779
	*Includes up-front removal of Cs to allow disposal as CH grout. (Total cost for grouting without Cs removal would be greater than $1 billion, including disposal costs for over 5,000 m^3 of RH grouted product.)				**Includes the cost of vitrification & HLW disposal.	

DD&D - decommissioning, decontamination, and demolition costs

Table 2: Waste Generation Quantities for SBW Disposal Options (dose rates in July 1999)

Option	Solids RH TRU (m^3)	RH TRU (m^3)	CH TRU (m^3)	CH-Mixed LLW (m^3)	RH-Mixed LLW (m^3)	HLW (m^3)
Direct stabilization						
CH-TRU grout	81 (130 R/hr)	168[a] (251 R/hr)	4600 (190 mR/hr)			
Calcination	81 (130 R/hr)	1,201 (46 R/hr)		50[b] (<5 mR/hr)		
Steam reforming	81 (130 R/hr)	981 (57 R/hr)		50[b] (<5 mR/hr)		
Direct vitrification	81 (130 R/hr)	764[a] (35 R/hr)		110[b] (<5 mR/hr)		
Separation of key radionuclides						
TRUEX	81 (130 R/hr)				6,763 (8 R/hr)	210 (36 R/hr)
UNEX	81 (130 R/hr)			6,664 (93 mR/hr)		20 (1,130 R/hr)

a. Volumes increased to meet shipping requirements.

b. Secondary waste streams.

Calcination with Maximum Achievable Control Technology Upgrade

This option involves upgrading the existing New Waste Calcining Facility (NWCF) with off-gas treatment equipment, to comply with the Maximum Achievable Control Technology (MACT) requirements for incinerators in 40 CFR Part 63.

After filtration of the solids, which will be packaged for disposal as RH-TRU waste at WIPP, the filtered SBW liquid is blended with chemicals to prevent agglomeration during the calcination process and fed to the calciner bed. In the calciner vessel, kerosene is combusted to evaporate liquid in the SBW and produce a dry granular product (calcine). The calcine will be packaged for disposal as RH-TRU waste at WIPP. The secondary wastes from the off-gas treatment are expected to be disposed of as CH-LLW.

The cost estimate for this option is based on costs of constructing new facilities to house the MACT control equipment and for managing calcined solids. The discriminatory cost for this alternative is estimated at $922 million (refer to Tables 1 and 2).

Steam Reforming

This process is similar to the NWCF calciner in that both are fluidized bed devices. In this process, the SBW is treated with additives and sent to a steam reforming system reactor, where steam is used as the fluidizing gas and a refractory oxide material is used as the bed media. Water in the waste is vaporized into superheated steam, while the nitrates are reduced to nitrogen and oxygen. A fine solid inorganic salt is produced and packaged as RH-TRU waste for disposal at WIPP. A secondary waste stream from off-gas treatment is expected to be disposed of as Class C mixed LLW. In addition, an interim storage facility is needed to store the waste, since the production rate of the stabilized waste exceeds the rate that it can be removed and disposed of off-site.

The cost estimates are based on the design and construction of a new facility for treatment of SBW. The estimate was based on the costs to construct the NWCF, which was considered to be a similar facility. Additional costs were added for those features not considered in the NWCF estimate (e.g., the remote operated waste packaging system, interim storage facility, solids processing), based on cost estimates from other similar feasibility studies. The estimated total discriminatory cost of this alternative is $1054 million (refer to Tables 1 and 2).

Direct Vitrification

This process begins with the solids filtration step, with solids disposal at WIPP as RH-TRU waste. The clarified liquid is mixed with glass formers and various additives that will control the reducing properties of the glass, aid in denitrification of the waste, and control glass viscosity. This feed is injected into the melter as a slurry. First, the liquid is evaporated, then the solid material is melted into a vitreous form. The glass is poured into storage canisters, transferred to the interim storage facility, and ultimately disposed of at WIPP as RH-TRU waste. Gas and vapors generated during the process are passed through the off-gas treatment system, producing a secondary waste stream that is expected to be disposed of as Class C LLW. In addition, an interim storage facility is needed to store the waste, since the production rate of the waste exceeds the rate that it can be removed and disposed of off-site. The discriminatory cost for this option is estimated at $1359 million (refer to Tables 1 and 2).

Waste Inventory and Characterization

The current inventory of SBW is a mixture that includes both liquid and solid components. The solid portion is assumed to result from incomplete fuel dissolution, chemical precipitation (formed during the unstable conditions caused when different waste types were added together in the tanks), and decontamination activities. It is primarily present as settled tank heel solids (in a fine particulate form), but can also be filtered from the liquid portion. The radiological composition of the solids is similar to that of the liquid SBW, with all four key radionuclides (Am-241, Pu-238, Pu-239, and Pu-240) occurring in both the solid and liquid portions. However, the solids tend to have higher concentrations of radionuclides compared to the liquids.

Technical Practicality of Further Key Radionuclide Removal

As noted above, the revised determination treats SBW liquid and solids independently, by assuming (for all options) that SBW solids are filtered from the process feed stream and treated separately.

Solids

Further dissolution of solids would be necessary to make chemical separation of key radionuclides possible. However, since the solids have had long-term exposure to the SBW liquid, which is $\geq$ 2 molar nitric acid solution, further dissolution would be difficult, if not impossible. It is possible that strong acid mixtures at elevated temperatures could dissolve some constituents in the SBW solids; however, no production-scale technologies exist, and because of the relatively small solids quantity and the severe conditions anticipated for dissolution, it was not technically practical to develop a dissolution process. Therefore, since no technologies have been demonstrated for dissolving SBW solids, additional key radionuclide removal is considered not technically practical.

Liquids

DOE-ID determined that it was technically possible to separate and remove additional key radionuclides from SBW liquids using various precipitation and solvent extraction options.

The precipitation options considered by DOE-ID included hydroxide precipitation, modified hydroxide precipitation, low-temperature precipitation, and high-temperature evaporation and precipitation. All these options use either chemical or temperature manipulation to precipitate metals and other constituents. These options were eliminated from further consideration (for performing further key radionuclide separation and removal) because of technical difficulties with maintaining an operational system under both normal and off-normal conditions.

Solvent extraction options were also considered as a method to remove additional key radionuclides from the SBW, using various organic solvents. The two solvent extraction methods considered were TRUEX and UNEX.

TRUEX removes actinides, including transuranics. The separation efficiency is 99.8 percent for Pu and 99.9 percent for Am. The separated actinides are combined, concentrated by evaporation, and vitrified for eventual disposal at the HLW geologic repository. Given the high separation efficiencies, DOE-ID estimates that TRUEX could remove 100 TBq [3000 curies (Ci)] of key radionuclides from the SBW liquid. The bulk waste from the process would be concentrated by evaporation and grouted to produce an RH low-activity waste, expected to be suitable for disposal as Class C LLW.

The UNEX process is very similar to the TRUEX process, and in addition, it removes Cs and Sr isotopes. The separation efficiency for key radionuclides is greater than 99.9 percent for both Pu and Am isotopes. The removal efficiency is 99.5 percent for Cs and 99.9 percent for Sr and europium. Since the UNEX process also removes Cs and Sr, the bulk waste from the process (after concentration and grouting) is expected to be suitable for Class A LLW disposal.

Economic Practicality of Further Key Radionuclide Removal

Only the methods of further key radionuclide removal that were considered technically practical were retained for further economic evaluation. Therefore, DOE-ID's economic evaluation focused on costs for removing additional key radionuclides using the TRUEX and UNEX processes. The economic practicality of removing additional key radionuclides from SBW liquid was evaluated by determining removal costs and considering the effect of removing additional key radionuclides on reducing radionuclide releases to the public at WIPP.

Costs of removing additional key radionuclides using TRUEX and UNEX

DOE-ID's economic analysis of further key radionuclide removal presents the cost per curie for additional key radionuclide removal. The high additional costs for these options (above that of the direct stabilization options) are attributable to the construction and operation of facilities needed to separate and treat the HLW fraction (key radionuclides removed) of the SBW. The total project costs for TRUEX and UNEX processes are based on the design and construction of a complex of new facilities at INTEC, which will include: a separations facility (for separating key radionuclides using TRUEX and UNEX processes); a vitrification facility (to vitrify separated key radionuclides for disposal at the HLW geologic repository); a low-activity waste treatment building (to treat bulk waste from TRUEX and UNEX processes); an interim storage facility (to store the HLW until a geologic repository is ready to accept it); and various small support facilities.

The total discriminatory cost estimate for UNEX is $1732 million (refer to Tables 1 and 2). This is $373 million to $1166 million above the cost of the direct stabilization options, or $124,000 to $389,000 per curie for additional key radionuclide removal (given that UNEX is expected to remove 3000 additional curies of key radionuclides).

The total discriminatory cost estimate for TRUEX is $2779 million (refer to Tables 1 and 2). This is $1420 million to $2213 million above the cost of direct stabilization options, or $473,000 to $738,000 per curie of additional key radionuclide removal (given that TRUEX is expected to remove 3000 additional curies of key radionuclides).

Effect of Further Key Radionuclide Removal on WIPP Repository Performance

The WIPP Land Withdrawal Act (LWA) provides capacity limits based on radiation doses for CH and RH TRU. The quantity of waste for some of the SBW treatment options may exceed the limit for $\geq$100 roentgens per hour (R/hr) RH waste. DOE-ID notes that the waste will be treated to meet the WAC of <100 R/hr, so as not to exceed the bounds of the LWA.

The WIPP Compliance Certification Application and supporting performance assessment modeled TRU components from all waste planned for disposal. The performance assessment for WIPP estimates that the source term of key radionuclides is 1.51×10^5 TBq (4,070,000 Ci) from all sources at closure [22,23]. The key radionuclide (Am-241, Pu-238, Pu-239, and Pu-240) source term from the SBW is estimated at 170 TBq (4500 Ci). It is estimated that the UNEX and TRUEX processes could remove an additional 100 TBq (3000 Ci) of key radionuclides from the SBW liquid, which is less than 0.1 percent of the total WIPP curies at closure. Since the large additional cost to remove 100 TBq (3000 Ci) of key radionuclides would not result in a significant reduction of the radionuclide inventory at WIPP, DOE-ID determined that it was not economically practical to remove additional key radionuclides from the SBW.

NRC REVIEW AND CONCLUSIONS

The following assumptions were made in assessing conformance with Criterion 1:

- NRC staff is providing technical assistance, only. NRC is not a regulatory authority for SBW stabilization and disposal.
- NRC staff focused its review on Criterion 1. Any comments made with regard to Criteria 2 and 3 were observed during the Criterion 1 review, and do not indicate a thorough review of Criteria 2 and 3.
- Cost estimates associated with the different options are reasonable.
- Identifying key radionuclides based on predicted performance is reasonable.
- The characterization of the radionuclide composition of the SBW liquids and solids is a reasonable representation of the actual composition.

The following conclusions are made with respect to Criterion 1:

- NRC staff agrees that it is not technically practical to remove additional key radionuclides from the SBW solids prior to disposal.
- NRC staff agrees that even though the technology exists to remove additional key radionuclides from SBW liquid, it is not economically practical, since removing additional key radionuclides for disposal at a HLW geologic repository would not significantly reduce the radionuclide inventory at WIPP.

The following recommendations are noted with respect to meeting Criterion 1:

- Although a significant amount of work has been completed in an attempt to develop the SBW liquid and solid radionuclide concentrations, limited information is available in some key areas or to support some key assumptions. The residual uncertainty can likely be reduced through the collection of additional information during future activities (e.g., solid and liquid sampling). For the SBW WIR determination, the residual uncertainty is not expected to be significant enough to invalidate DOE-ID’s conclusion that SBW is WIR, and therefore, can be managed as TRU waste. As additional information is collected, an impact assessment on the SBW WIR determination should be completed and any significant impacts communicated to NRC.

- NRC's RAI requested DOE-ID to provide a brief analysis describing impacts to workers resulting from the options evaluated. In the response to the RAI, DOE-ID noted that dose to the workers was generally found to be insignificant, and that allowable worker radiation exposures are set by DOE regulations. Additional shielding was added to facilities (that would be required for the various SBW treatment options) that handle more highly radioactive waste, so that the worker exposure is projected to be about the same for all options. Likewise, shipping, handling, and disposal facilities all have equipment and procedures to handle waste product safely. Therefore, increased radiation levels for various waste types were reflected in increased costs for additional shielding, shipping, and handling requirements. DOE-ID noted that this discussion would be included in the revised SBW WIR determination; however it appears that it was not included. DOE-ID should provide this discussion in the final WIR determination.

<u>Although NRC staff review of the SBW WIR determination focused on Criterion 1, the staff also noted the following during its review:</u>

- DOE-ID noted that WIPP is currently not permitted to accept RH-TRU waste, but it is expected to be permitted in 2003. DOE-ID also noted that the draft WAC for RH-TRU are not expected to change. NRC staff suggests that if there are changes to the plans to permit WIPP to accept RH-TRU waste or if the draft WAC for RH-TRU change, DOE-ID should revisit the WIR determination before final decisions regarding the SBW treatment process and final waste forms are made.

- The residual uncertainty regarding the radionuclide inventory is expected to have a greater impact on DOE-ID's WIR determination for tank closure. NRC plans to document its concerns regarding the current tank inventories in a future RAI on the tank closure WIR determination.

- NRC supports DOE-ID using the most economically efficient technology that will result in waste that meets the WIPP WAC.

REFERENCES

1. United States Environmental Protection Agency Notice of Noncompliance in the Matter of the United States Department of Energy Idaho Operations Office, January 29, 1990.

2. Idaho Department of Health and Welfare Consent Order in the Matter of United States Department of Energy, Idaho National Engineering Laboratory, Idaho Code § 39-4413, dated April 3, 1992, modifications dated March 17, 1994, August 18, 1998, and April 20, 1999.

3. Letter from R. Bernero/NRC, to J. Lytle/DOE, March 2, 1993.

4. U.S. Nuclear Regulatory Commission, "Decommissioning Criteria for the West Valley Demonstration Project (M-32) at the West Valley Site; Final Policy Statement," 67 FR 5003, February 1, 2002.

5. U.S. Department of Energy, "DOE Order 435.1: Radioactive Waste Management," July 9, 1999.

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LIST OF ABBREVIATIONS AND ACRONYMS

Am	americium
CFR	Code of Federal Regulations
CH	contact-handled
Cs	cesium
DD&D	decommissioning, decontamination, and demolition costs
DOE	U.S. Department of Energy
DMT	Decision Management Team
EPA	U.S. Environmental Protection Agency
HLW	high-level radioactive waste
ID	Idaho Operations Office
IHLW&FD EIS	Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LLW	low-level radioactive waste
LWA	WIPP Land Withdrawal Act
MACT	maximum achievable control technology
MOU	Memorandum of Understanding
NRC	U.S. Nuclear Regulatory Commission
NWCF	New Waste Calcining Facility
Pu	plutonium
R/hr	roentgen per hour
RAI	request for additional information
RH	remote-handled
SBW	sodium-bearing waste
Sr	strontium
TRU	transuranic
TRUEX	transuranic solvent extraction
UNEX	universal solvent extraction
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WIR	waste incidental to reprocessing