ANNEX D to ATTACHMENT F

PACKAGING MATERIALS

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DATA-F-D-1.0 INTRODUCTION

The calculations for the packaging material densities (also referred to as container material densities) for steel, plastic, or lead present in each type of transuranic (TRU) waste container that will to be shipped to the Waste Isolation Pilot Plant (WIPP) are based on packaging assumptions found in the Transuranic Waste Baseline Inventory Report (TWBIR), Revision 2, Chapter 1 (DOE 1995) on data documented in the TRUPACT-II Authorized Methods for Payload Control (NRC 2003), and a pending revision to the TRAMPAC (DOE 2002). Additional details concerning waste material parameters or packaging materials can be found in the documents listed in Attachment F, Table-DATA-F-1. This annex describes how packaging material densities are determined for sites where limited or no information was provided.

This annex consists of two parts. In the first part, the general packaging material densities are given for directly loaded containers including 55-gallon drums, 85-gallon drums, 100-gallon drums, and standard waste boxes (SWBs). This part also includes the methods used to determine the packaging material densities when waste containers are overpacked, such as four 55-gallon drums overpacked in an SWB or ten 55-gallon drums overpacked in a ten-drum overpack (TDOP). These general methods are based on TWBIR, Revision 2 and the TRAMPAC. The calculations to estimate the packaging material densities in kilograms per cubic meter (kg/m^3) are presented in Section DATA-F-D-2.0.

The second part of this annex summarizes the methods used to calculate and document packaging material densities that were done on a site-by-site basis. These summaries are based on several "Routine Calculations" that were developed and documented under Sandia National Laboratories (SNL) Nuclear Waste Management Program Procedure, NP 9-1, Analyses. These routine calculations were conducted after a thorough review of the inventory data revealed that some waste streams required modification to allow for shipping container volume. For example, some sites reported the current packaging configuration of their waste streams instead of the configuration that the waste would be in when shipped and disposed in the WIPP. Although this information was accurate and complete, the result was that the waste volumes reported did not truly reflect the volume the waste will occupy when disposed in the WIPP. Waste volume accuracy in this regard is vital for the Performance Assessment (PA) calculations in support of the Compliance Recertification Application (CRA). The routine calculations serve to repair this discrepancy in the volumes and apply the new volumes to the waste and packaging material densities and the radionuclide concentrations. The methods used to estimate the packaging material densities in kg/m^3 are summarized in Section DATA-F-D-3.0 below, with reference to the actual routine calculations by SNL WIPP Records Center, Electronic Records Management System (ERMS) number.

DATA-F-D-2.0 GENERAL PACKAGING MATERIAL DENSITIES

DATA-F-D-2.1 Packaging Material Densities for a Directly Loaded 55-Gallon Drum

DATA-F-D-2.1.1 Steel

A 55-gallon drum is made of steel and weighs 27 kg (60 lbs) (NRC 2003). The density of steel for the drum is calculated as follows:

$$\text{Density of Steel} = \frac{60 \text{ lbs} / (2.205 \text{ lbs/kg})}{0.208 \text{ m}^3 \text{ per drum}} = 131 \text{ kg/m}^3.$$

DATA-F-D-2.1.2 Plastic

The rigid liner in a 55-gallon drum weighs 7.7 kg (17 lb) (DOE 1995). The density of plastic packaging in a 55-gallon drum is calculated as follows:

$$\text{Density of Plastic} = \frac{7.7 \text{ kg}}{0.208 \text{ m}^3} = 37 \text{ kg/m}^3.$$

DATA-F-D-2.2 Packaging Material Densities for a Directly Loaded 85-Gallon Drum

Directly loaded 85-gallon drums are not compliant with the current TRAMPAC (NRC 2003), but are expected to be compliant with the next revision of the TRAMPAC. A request was submitted to the Nuclear Regulatory Commission (NRC) in October 2002 to approve directly loaded 85-gallon drums as payload containers as part of the CH TRAMPAC Revision 1 (DOE 2002). Therefore, the directly loaded 85-gallon drums will be considered here.

Additionally, the TRAMPAC, Revision 1 (DOE 2002) used the term "85-gallon drum" to refer to "drums with a range of dimensions yielding 75 to 88 gallons." Therefore, this calculation applies to all drums between 75 and 88 gallons.

DATA-F-D-2.2.1 Steel

The weight of the 85-gallon drum is 37 kg (81 lbs) (DOE 2002). The volume of an 85-gallon drum is 0.322 m^3. The density of steel for the 85-gallon drum is calculated as follows:

$$\text{Density of Steel} = \frac{81 \text{ lbs} /(2.205 \text{ lbs/kg})}{0.322 \text{ m}^3 \text{ per 85-gallon drum}} = 114 \text{ kg/m}^3.$$

DATA-F-D-2.2.2 Plastic

It is assumed that no plastic liners are used. Therefore, the value used for the plastic packaging material is 0.0 kg/m^3.

DATA-F-D-2.3 Packaging Material Densities for a Directly Loaded 100-Gallon Drum

The 100-gallon drum is currently authorized for shipment in the TRUPACT-II (NRC 2003) and will be added as an authorized payload container for the HalfPACT (DOE 2002).

DATA-F-D-2.3.1 Steel

The weight of a steel, 100-gallon drum is 43 kg (95 lbs) (NRC 2003). The volume of a 100-gallon drum is 0.379 m^3. The density of steel for the 100-gallon drum is calculated as follows:

$$\text{Density of Steel} = \frac{95 \text{ lbs} /(2.205 \text{ lbs/kg})}{0.379 \text{ m}^3 \text{ per 100-gallon drum}} = 114 \text{ kg/m}^3.$$

DATA-F-D-2.3.2 Plastic

It is assumed that no plastic liners are used. Therefore, the value used for the plastic packaging material is 0.0 kg/m^3.

DATA-F-D-2.4 Packaging Material Densities for a Directly Loaded Standard Waste Box

DATA-F-D-2.4.1 Steel

An SWB is made of steel and weighs 290 kg (640 lbs) (NRC 2003). The volume of an SWB is 1.89 m^3. The amount of steel is calculated as follows:

$$\text{Density of Steel} = \frac{640 \text{ lbs}/(2.205 \text{ lbs/kg})}{1.89 \text{ m}^3 \text{ per SWB}} = 154 \text{ kg/m}^3.$$

DATA-F-D-2.4.2 Plastic

The plastic liner in a directly loaded SWB weighs approximately 2.25 kg (5 lbs) (DOE 1995). The plastic packaging density in a directly loaded SWB is calculated as follows:

$$\text{Density of Plastic} = \frac{2.25 \text{ kg}}{1.89 \text{ m}^3} = 1.2 \text{ kg/m}^3.$$

DATA-F-D-2.5 Packaging Material Densities for a Directly Loaded Remote-Handled-Transuranic Waste Canister

There are two remote-handled (RH)-TRU waste canister designs available for use by the generator sites. One contains lead, the other does not. Since it is uncertain which canister will be used, this calculation uses the same assumption as that for the TWBIR Revision 2 (DOE 1995), and lead is included as packaging material for RH-TRU waste canisters.

DATA-F-D-2.5.1 Steel

The total weight of an empty RH-TRU waste canister is 799 kg (1,762 lbs), of which 386 kg (852 lbs) is steel and 413 kg (910 lbs) is lead (DOE 1995). This does not include the shield

plug (included in emplacement materials). The volume of the RH-TRU waste canister is 0.89 m^3.

The density of steel for the RH-TRU waste canister is:

$$\text{Density of Steel} = \frac{852\ \text{lbs}/(2.205\ \text{lbs/kg})}{0.89\ m^3\ \text{per RH-waste canister}} = 434\ kg/m^3.$$

DATA-F-D-2.5.2 Plastic

For a directly loaded RH-TRU waste canister, it is assumed there would be no plastic packaging involved. Therefore, the amount of plastic for this case is zero.

DATA-F-D-2.5.3 Lead

The weight of lead in the RH-TRU waste canister is 413 kg (910 lbs) (DOE 1995), and the volume is 0.89 m^3. The density of lead is calculated as follows:

$$\text{Density of Lead} = \frac{910\ \text{lbs} / (2.205\ \text{lbs/kg})}{0.89\ m^3\ \text{per RH-waste canister}} = 464\ kg/m^3.$$

DATA-F-D-2.6 Packaging Material Densities for a Standard Waste Box Used to Over-Pack Four 55-Gallon Drums

DATA-F-D-2.6.1 Steel

For the case of four 55-gallon drums overpacked in an SWB, the total weight of steel is a combination of the steel in the SWB and the steel in the 55-gallon drums. The weight of a 55-gallon drum is 27 kg (60 lbs) and the weight of an SWB is 290 kg (640 lbs) (NRC 2003). The density of steel for the SWB with four 55-gallon drums in it is calculated as follows:

$$\text{Density of Steel} = \frac{(4\ \text{drums x 60 lbs steel per drum} + 640\ \text{lbs})/(2.205\ \text{lbs/kg})}{1.89\ m^3\ \text{per SWB}} = 211\ kg/m^3.$$

DATA-F-D-2.6.2 Plastic

It is assumed that the plastic liner for the SWB will not be used when the drums are overpacked in the SWB. Thus, the plastic will be contributed entirely by the rigid liners in the four overpacked drums. The density of plastic packaging is:

$$\text{Density of Plastic} = \frac{4\ \text{drums x 7.7 kg of plastic per drum}}{1.89\ m^3\ \text{per SWB}} = 16\ kg/m^3.$$

DATA-F-D-2.7 Packaging Material Densities for a Remote-Handled TRU-Waste Canister Used to Over-Pack Three 55-Gallon Drums

DATA-F-D-2.7.1 Steel

For the case of three 55-gallon drums overpacked in an RH-TRU waste canister, the total weight of steel is a combination of the steel in the RH-TRU waste canister and steel in the three 55-gallon drums. The weight of a 55-gallon drum is 27 kg (60 lbs) (NRC 2003) and the weight of steel in an RH-TRU waste canister is 386 kg (852 lbs) (DOE 1995). The density of steel for the RH-TRU waste canister with three 55-gallon drums in it is calculated as follows:

$$\textit{Density of Steel} = \frac{(3 \text{ drums x } 60 \text{ lbs} + 852 \text{ lbs})/(2.205 \text{ lbs/kg})}{0.89 \text{ m}^3 \text{ per RH-TRU waste canister}} = 526 \text{ kg/m}^3.$$

DATA-F-D-2.7.2 Plastic

The plastic will be contributed entirely by the rigid liners in the three overpacked 55-gallon drums. The plastic liners weigh approximately 7.7 kg (17 lbs) each (DOE 1995) and are in the total volume of the RH-TRU waste canister. The density of plastic packaging is calculated as follows:

$$\textit{Density of Plastic} = \frac{3 \text{ drums x } 7.7 \text{ kg of plastic per drum}}{0.89 \text{ m}^3 \text{ per RH-TRU waste canister}} = 26 \text{ kg/m}^3.$$

DATA-F-D-2.7.3 Lead

Since the 55-gallon drums do not contribute any lead, the calculation for this case is the same as that of a directly loaded RH-TRU waste canister (464 kg/m^3), as calculated in Section DATA-F-D-2.5).

DATA-F-D-2.8 Packaging Material Densities for Ten 55-Gallon Drums in a Ten-Drum Overpack

DATA-F-D-2.8.1 Steel

For the case of ten 55-gallon drums overpacked in a TDOP, the total weight of steel is a combination of the steel in the TDOP and the ten 55-gallon drums. The weight of an empty TDOP is 771 kg (1,700 lbs) (NRC 2003). The volume of a TDOP is 4.79 m^3. The weight of a 55-gallon drum is 60 lbs. The density of steel packaging in the TDOP with 10 drums in it is:

$$\textit{Density of Steel} = \frac{(10 \text{ drums x } 60 \text{ lbs} + 1{,}700 \text{ lbs})/(2.205 \text{ lbs/kg})}{4.79 \text{ m}^3 \text{ per TDOP}} = 218 \text{ kg/m}^3.$$

DATA-F-D-2.8.2 Plastic

The plastic in the TDOP will be contributed entirely by the rigid liners in the 10-overpacked drums. The density of plastic packaging is calculated as follows:

$$\text{Density of Plastic} = \frac{10 \text{ drums x } 7.7 \text{ kg of plastic per drum}}{4.79 \text{ m}^3 \text{ per TDOP}} = 16 \text{ kg/m}^3.$$

DATA-F-D-3.0 GENERATOR SITE PACKAGING MATERIAL DENSITIES

Several generator sites originally reported data in a way that did not reflect the volume the waste would occupy when disposed in the WIPP. The volume of waste needed for the PA in support of the CRA is the volume that will be disposed in the WIPP. Therefore, all data and calculations were reviewed and adjusted as necessary to reflect the volume the waste would occupy once disposed in the WIPP. Table DATA-F-D-1 lists the large and small quantity TRU waste generator sites that required some adjustment of their packaging material, along with the ERMS reference number for the associated routine calculation.

Table DATA-F-D-1. TRU Waste Generator Sites and Associated ERMS Numbers for Routine Calculations Related to Packaging Material Densities

Generator Site	ERMS # for Routine Calculation
Hanford Richland Operations Office (Hanford RL)	530693
Hanford Office of River Protection (Hanford RP)	530675
Idaho National Engineering and Environmental Laboratory (INEEL)	530666 (IN-BN-510) 530688 (Non-Debris) 530679 (RH/Other)
Los Alamos National Laboratory (LANL)	530717
Argonne National Laboratories East (ANL-E)	530643
Argonne National Laboratories West (ANL-W)	530639
Battelle Columbus Laboratories (BCL)	530634
Energy Technology Engineering Center (ETEC)	530658
Knolls Atomic Power Laboratory (KAPL)	530648
Lawrence Livermore National Laboratory (LLNL)	530662
Paducah Gaseous Diffusion Plant (PGDP)	530670

Table DATA-F-D-2 contains a summary of the packaging configurations and packaging material densities for sites whose packaging required updating to obtain the volume needed for the PA in support of the CRA. The processes used to obtain these results are described in Sections DATA-F-D-3.1 through DATA-F-D-3.11.

1 ***Table DATA-F-D-2. Summary of Packaging Configurations and Packaging Material***
2 ***Densities***

Generator Site[1]	Packaging Configuration[2]	Steel Packaging Material Density (kg/m^3)[3]	Plastic Packaging Material Density (kg/m^3)[3]	Lead Packaging Material Density (kg/m^3)[3]
Hanford RL	Directly loaded 55-gallon drums.	131	37	0
	Directly loaded SWBs.	154	1.2	0
Hanford RP	Three 55-gallon drums overpacked in an RH-TRU-waste canister.	526	26	464
INEEL	Directly loaded 100-gallon drums.	119.7	0	0
	Ten 55-gallon drums overpacked in a TDOP.	208	24	0
	Four 55-gallon drums overpacked in an SWB.	211	16	0
	Three 55-gallon drums overpacked in an RH-TRU-waste canister.	526	26	464
	Three 30-gallon drums overpacked in an RH-TRU-waste canister.	498	0	464
LANL	Three 15-gallon drums overpacked in one 55-gallon drum.	262	37	0
	One 30-gallon drum overpacked in one 55-gallon drum.	207	37	0
	Other/unknown containers overpacked in 55-gallon drums.	131	37	0
	Crates, fiberglass-reinforced polyethylene (FRP) boxes, and other/unknown large containers into SWBs or standard large boxes (SLBs).	154	1.2	0
	Repackaging crates, FRP boxes, and other/unknown large containers into SWBs.	154	1.2	0
ANL-E	Three 30-gallon drums overpacked in an RH-TRU-waste canister.	481	15	464
ANL-W	Three 45-gallon drums overpacked in an RH-TRU-waste canister.	511	21	464
BCL	Three 55-gallon drums overpacked in an RH-TRU-waste canister.	770	17	464
ETEC	Three 55-gallon drums overpacked in an RH-TRU-waste canister.	526	26	464
KAPL	Three 55-gallon drums overpacked in an RH-TRU-waste canister.	526	26	464
LLNL	Repackaging large boxes into SWBs or SLBs.	154	0	0
PGDP	Four 55-gallon drums overpacked in an SWB.	212	17.5	0

[1] See Appendix DATA, Attachment F, page v for site acronym definitions.
[2] This is the packaging configuration determined to be acceptable for shipment to and disposal in the WIPP.
[3] These are the new packaging material densities as calculated, in the routine calculations listed in Table DATA-F-D-1.

DATA-F-D-3.1 Hanford Richland Packaging Material Densities

Hanford Richland (RL) originally reported 229 contact-handled (CH)-TRU and 119 RH-TRU waste streams (ERMS #526736). The site had misinterpreted the "R" in one of their database fields to mean RH-TRU waste when it actually indicated that the waste was "radioactive." The result was that Hanford RL actually had 306 CH-TRU waste streams and 42 RH-TRU waste streams. Therefore, 77 waste streams required a change in the shipping container from an RH-TRU waste canister to other packaging acceptable for CH-TRU waste shipment and disposal. As a result, the packaging material densities for the 77 CH-TRU waste streams were recalculated. Hanford RL submitted updated information indicating the appropriate shipping containers (ERMS #530628). The new shipping containers were directly loaded 55-gallon drums and SWBs. The packaging material densities for the 55-gallon drums and SWBs were determined as shown in Sections DATA-F-D-2.1 and DATA-F-D-2.4, respectively.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste Material Densities, Container Material Densities, and Radionuclide Concentrations for Corrected Hanford (RL) Waste Streams for the Compliance Recertification Application (ERMS #530693). The packaging material densities for these 77 waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.2 Hanford River Protection Packaging Material Densities

Hanford River Protection (RP) originally reported data for two of its waste streams in a way that did not reflect the volume that the waste will occupy when disposed in the WIPP (ERMS #526473). Specifically, Hanford RP intends to ship these waste streams in 55-gallon drums overpacked in RH-TRU waste canisters. However, the waste volume reported was determined using the internal volume of the three 55-gallon drums ($3 \times 0.21 = 0.63$ m^3) instead of the volume of the RH-TRU waste canister (0.89 m^3), which is representative of the volume of waste to be emplaced in WIPP. The waste stream volume and the packaging material densities were recalculated based on the volume of the RH-TRU waste canister (0.89 m^3), as shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for RP RH TRU Waste Streams RP-W013 and RP-W016 for the Compliance Recertification Application (ERMS #530675). The packaging material densities for these two RH-TRU waste streams were adjusted according to the results of this calculation.

DATA-F-D.3.3 Idaho National Engineering and Environmental Laboratory Packaging Material Densities

Idaho National Engineering and Environmental Laboratory (INEEL) originally reported data for several of its waste streams in a way that did not reflect the volume that the waste will occupy when disposed in the WIPP. Three routine calculations were developed for the INEEL waste streams. The first focuses on the super-compacted waste stream originating from the Advanced Mixed Waste Treatment Facility (AMWTF). The second routine calculation discusses the non-debris waste streams from the AMWTF. The third routine calculation covers 13 other INEEL waste streams for which the packaging configurations did not reflect the volume that the waste will occupy in the WIPP. These three routine calculations consistently estimate the packaging material densities for each of the disposal container types and are referenced and summarized below.

DATA-F-D-3.3.1 Super-Compacted Debris Waste Stream IN-BN-510

The INEEL reported one debris waste stream originating from the AMWTF that would be super-compacted (ERMS #528171). This data submission included the total volume of the waste stream (11,635 m^3), the intended shipping container type (100-gallon drums), and the packaging material densities (steel 308.9 kg/m^3, no plastic or lead). However, updated information (ERMS #530423) revealed that the waste would be packaged in the drums so that the drums were approximately 60 percent full. This resulted in a change to the number of 100-gallon drums and hence the waste stream volume to be received at the WIPP (19,875 m^3). Subsequently, the packaging material density for steel was calculated based on the new waste stream volume, yielding a new value of 119.7 kg/m^3.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volume, Waste and Container Material Densities, and Radionuclide Concentrations for INEEL Waste Stream IN-BN-510 for the Compliance Recertification Application (ERMS #530666). The packaging material densities for this waste stream were adjusted according to the results of this calculation.

DATA-F-D-3.3.2 Advanced Mixed Waste Treatment Facility Non-Debris Waste Streams

The INEEL reported 38 non-debris waste streams originating from the AMWTF (ERMS #528171). However, updated information from INEEL (ERMS #530423) revealed changes in the shipping container type and a resulting change in the volume of waste to be received at the WIPP. Specifically, INEEL originally reported only TDOPs as shipping containers, but its updated information identified both TDOPs and SWBs as shipping containers for each waste stream. There were therefore two cases considered regarding packaging material densities: Ten 55-gallon drums overpacked in a TDOP, and four 55-gallon drums overpacked in an SWB.

The steel packaging material densities reported in the original submittal from INEEL were calculated based on the original densities given by the site that were based on the total waste stream volumes, and the total volume of the TDOP (4.79 m^3). However, INEEL updated its

information indicating that each waste stream would be packaged in 55-gallon drums that would then be overpacked in SWBs and TDOPs. Therefore, the packaging material densities were recalculated based on the number of TDOPs and SWBs for each waste stream as given by INEEL in its updated information. Further, the original calculations were done using the actual volume of ten 55-gallon drums of waste (2.08 m^3) instead of the volume that the waste actually occupies (4.79 m^3). As a result, the mass of steel did not vary for the TDOP, but the volume increased, causing the steel packaging material density to decrease from 480 kg/m^3 to 208 kg/m^3. The plastic packaging material density originally reported by INEEL varied by waste stream. However, the mass of plastic did not change and, for most of the waste streams, the plastic packaging material density decreased from 55 kg/m^3 to 24 kg/m^3.

For the SWBs the steel and plastic packaging material densities were calculated in the routine calculation based on the volume of the SWB (1.89 m^3), as shown in Section DATA-F-D-2.6, for four 55-gallon drums overpacked in an SWB.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for Non-Debris AMWTF Waste Streams at INEEL for the Compliance Recertification Application (ERMS #530688). The packaging material densities for these 38 waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.3.3 Idaho National Engineering and Environmental Laboratory Waste Streams Requiring Overpacking

The INEEL reported data for its waste streams based, for the most part, on the current packaging configuration of the waste. For 13 of its waste streams, the current packaging configuration did not match the intended shipping configuration. For example, 55-gallon drums were reported, but INEEL actually intends to ship these drums inside SWBs.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Final Form Values For IN-AE-AGHC-01, IN-INTEC-SFS-01, IN-NRF-153, IN-W219.914, IN-W322.851, IN-W323.562, IN-W337.957, IN-W341.954, IN-W342.652, IN-W358.854, IN-W358.949, IN-W372.832, and IN-W372.918 for the Compliance Recertification Application (ERMS #530679). The packaging material densities for these 13 waste streams were adjusted according to the results of this calculation. The calculations needed for the packaging material densities for these INEEL waste streams in the routine calculation are summarized below.

DATA-F-D-3.3.3.1 Overpacking Three 55-Gallon Drums into a Remote-Handled-Transuranic Waste Canister

The packaging configuration for two of the 13 INEEL waste streams was determined to be three 55-gallon drums overpacked in an RH-TRU waste canister. Therefore, the steel and plastic packaging material densities were determined in the routine calculation based on the

volume of the RH-TRU waste canister (0.89 m^3), as shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister. The packaging material densities were calculated to be steel 526 kg/m^3, plastic 26 kg/m^3, and lead 464 kg/m^3.

DATA-F-D-3.3.3.2 Overpacking Three 30-Gallon Drums into a Remote-Handled-Transuranic Waste Canister

The packaging configuration for three of the 13 INEEL waste streams was determined to be three 30-gallon drums overpacked in an RH-TRU waste canister. Therefore, the steel and plastic packaging material densities were determined in the routine calculation based on the volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister, except that the total weight of steel for this case was determined based on the steel packaging material density given by the site for the 30-gallon drum (168 kg/m^3). The resulting steel packaging material density was 498 kg/m^3. Since the only source of lead is the RH-TRU waste canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. No plastic packaging was reported by the site for the 30-gallon drums.

DATA-F-D-3.3.3.3 Overpacking Four 55-Gallon Drums into a Standard Waste Box

The packaging configuration of the 13 INEEL waste streams was determined to be four 55-gallon drums overpacked in an SWB. Therefore, the steel and plastic packaging material densities were calculated in the routine calculation, as shown in Section DATA-F-D-2.6, for four 55-gallon drums overpacked in an SWB.

DATA-F-D-3.4 Los Alamos National Laboratory Packaging Material Densities

Los Alamos National Laboratory (LANL) reported data for its waste streams based on the current packaging configuration of the waste. Of the 63 waste streams reported by LANL, 33 were reported with unacceptable containers for shipment to WIPP in the TRUPACT-II (NRC 2003). Of the 33 waste streams, 27 waste streams were reported with containers that require overpacking prior to shipment, and six waste streams have container types that will require repackaging prior to shipment.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste Material Densities, Container Material Densities, and Radionuclide Concentrations for LANL Waste Streams for the Compliance Recertification Application (ERMS #530717). The packaging material densities for these 33 waste streams were adjusted according to the results of this calculation. The calculations needed for the packaging material densities of the LANL waste streams in the routine calculation are summarized below.

DATA-F-D-3.4.1 Overpacking 15-Gallon Drums into a 55-Gallon Drum

Los Alamos National Laboratory reported 15-gallon drums for one waste stream. In this calculation, it was assumed that three 15-gallon drums would be placed in one 55-gallon

drum. The calculated steel packaging material density for one 55-gallon drum and three 15-gallon drums was 262 kg/m^3. The plastic packaging material density for a 55-gallon drum liner was calculated as shown in Section DATA-F-D-2.1 for a directly loaded 55-gallon drum (37 kg/m^3).

DATA-F-D-3.4.2 Overpacking 30-Gallon Drums into 55-Gallon Drums

Los Alamos National Laboratory reported 30-gallon drums for several waste streams. In this calculation, it was assumed that one 30-gallon drum would be placed in one 55-gallon drum. The calculated steel packaging material density for one 55-gallon drum and one 30-gallon drum was 207 kg/m^3. The plastic packaging material density for a 55-gallon drum liner was calculated as shown in Section DATA-F-D-2.1 for a directly loaded 55-gallon drum (37 kg/m^3).

DATA-F-D-3.4.3 Overpacking Small Containers (Including "Other," "Unknown," and "Cardboard Box" into 55-Gallon Drums

Los Alamos National Laboratory reported other or unknown containers that will fit into 55-gallon drums for several waste streams. Because the container volumes of the other/unknown containers vary by waste stream and the container materials and dimensions were not provided by the site, the packaging materials for a directly loaded 55-gallon drum, as shown in Section DATA-F-D-2.1, were used (density of steel = 131 kg/m^3, and density of plastic = 37 kg/m^3).

DATA-F-D-3.4.4 Overpacking Crates, Fiberglass-Reinforced Polyethylene Boxes, or Other/Unknown Large Containers into Standard Waste Boxes or Standard Large Boxes

Los Alamos National Laboratory reported crates, FRP boxes, and "other" or "unknown" containers of various sizes. However, since the only acceptable large shipping containers are the SWB and the SLBs,[1] all crates, FRP boxes, and unknown/other containers that will fit into the SWBs and SLBs must be overpacked into the SWBs or SLBs.[2]

Because the container volumes of the crates, FRP boxes, and other/unknown containers varied by waste stream, and the container materials and dimensions were not provided by LANL, the packaging material densities for a directly loaded SWB, as shown in Section DATA-F-D-2.4, were used in the routine calculation for the SLBs.

[1] Development of the TRUPACT-III, which will allow shipment of the SLBs to WIPP for disposal, is under way. According to DOE guidance (DOE 2003), inventory estimates for the CRA allow the use of the SLB as a payload container for WIPP.

[2] The SLBs are sometimes generically referred to as "5 × 5 × 8 boxes," where the units of measure are in feet. The SLBs are in the preliminary design stage and only preliminary specifications are available. Therefore, the volume of the 5 × 5 × 8-foot box, 5.66 m^3, was used in the routine calculation as a close approximation of the internal volume of the SLB.

DATA-F-D-3.4.5 Repackaging (Size Reduction) of Crates, Fiberglass-Reinforced Polyethylene Boxes, or Other/Unknown Large Containers into Standard Waste Boxes

Los Alamos National Laboratory reported large containers (greater than the volume of the SLB) for six waste streams. In order for LANL to ship these waste streams to the WIPP, it will have to "size-reduce" the waste (including the original waste containers) and directly load the size-reduced waste and containers into SWBs.[3] Therefore, the steel and plastic packaging densities associated with the SWBs, as described in Section DATA-F-D-2.4, were used.

DATA-F-D-3.5 Argonne National Laboratory-East Packaging Material Densities

Argonne National Laboratory-East (ANL-E) reported a packaging configuration for waste stream AE-T009 as three 30-gallon drums overpacked in an RH-TRU waste canister (ERMS #526109). The volume of RH-TRU waste originally reported by ANL-E is the waste volume associated with the 30-gallon drums that will be loaded into the RH-TRU waste canister, which does not reflect the volume of waste that will be disposed in the WIPP. Therefore, the steel, plastic, and lead packaging material densities were recalculated based on the volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister, except that the total weight of steel for this case was determined based on the steel packaging material density given by the site for the 30-gallon drums (124.4 kg/m^3). The resulting steel packaging material density was 481 kg/m^3. Since the lead is contributed entirely by the RH-TRU waste canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. The density of plastic was also given by the site (39.9 kg/m^3), and this was used to determine the plastic packaging density (15 kg/m^3).

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for AE-T009 at ANL-E for the Compliance Recertification Application (ERMS #530643). The packaging material densities for this RH-TRU waste stream were adjusted according to the results of this calculation.

DATA-F-D-3.6 Argonne National Laboratory-West Packaging Material Densities

Argonne National Laboratory-West (ANL-W) reported a packaging configuration for eight waste streams as three 45-gallon drums overpacked in an RH-TRU-waste canister (ERMS #526407). The volume of RH-TRU waste originally reported by ANL-W is the waste volume associated with the 45-gallon drums that will be loaded into the RH-TRU waste canister, which does not reflect the volume of waste that will be disposed in the WIPP. Therefore, the steel, plastic, and lead packaging material densities were recalculated based on the volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister, except

[3] Repackaging into the SLBs is not considered in the routine calculation because the SWBs are currently approved and available for this use and the SLBs are not.

that the total weight of steel for this case was determined assuming the 45-gallon drums weighed 23 kg (51 lbs) each and that the mass of steel in an RH-TRU waste canister was 386 kg (851 lbs). The resulting steel packaging material density was 511 kg/m^3. Since the only source of lead is the RH-TRU waste canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. The density of plastic (21 kg/m^3) was determined by first calculating the mass of the plastic liner for a 45-gallon drum (6.3 kg).

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for RH Waste Streams at ANL-W for the Compliance Recertification Application, (ERMS #530639). The packaging material densities for these RH waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.7 Battelle Columbus Laboratories Packaging Material Densities

Battelle Columbus Laboratories (BCL) reported data for 12 RH-TRU waste streams. Specifically, BCL reported that the RH-TRU waste would be packaged in 55-gallon drums, and that those drums would be configured in a five-drum pallet inside the ChemNuclear Systems (CNS) 10-160B shipping container for shipment to WIPP (ERMS # 526424). The volumes of RH-TRU waste originally reported are those associated with the 55-gallon drums that will be loaded into the CNS 10-160B package. Ultimately, the 55-gallon drums will be taken to the WIPP RH-waste hot cell and placed in an RH-TRU waste canister for disposal. Therefore, the steel, plastic, and lead packaging material densities were recalculated based on the materials and volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister, except that the total weight of steel for this case was determined based on the steel packaging material density given by the site for the 55-gallon drums (481 kg/m^3). The resulting steel packaging material density for the RH-TRU waste canister with three 55-gallon drums in it was 770 kg/m^3. Since the lead is contributed entirely by the RH-TRU waste canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. The density of plastic was also given by the site (24 kg/m^3), and this was used to determine the plastic packaging density (17 kg/m^3) based on the updated volume.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for RH Waste Streams at BCL for the Compliance Recertification Application (ERMS #530634). The packaging material densities for these RH-TRU waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.8 Energy Technology Engineering Center Packaging Material Densities

Energy Technology Engineering Center (ETEC) reported data for two RH-TRU waste streams, and that the RH-TRU waste will first be packaged in 55-gallon drums, then placed in RH-TRU waste canisters for shipment to WIPP (ERMS #526444). The volumes of RH-TRU waste in the ETEC waste streams originally reported are the waste volumes associated with the

55-gallon drums loaded into the RH-TRU waste canister. Therefore, the steel, plastic, and lead packaging material densities were recalculated based on the materials and volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister. The resulting steel packaging material density for the RH-TRU waste canister with three 55-gallon drums in it was 525 kg/m^3. Since the lead is contributed entirely by the RH-TRU waste canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. The density of plastic was also given by the site (37 kg/m^3), and this was used to determine the plastic packaging density (26 kg/m^3).

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for ET-R1-DLR and ET-R2-D107 at ETEC for the Compliance Recertification Application (ERMS #530658). The packaging material densities for these RH-TRU waste streams were adjusted according to the results of this calculation.

DATA-F-D.3.9 Knolls Atomic Power Laboratory Packaging Material Densities

Knolls Atomic Power Laboratory (KAPL) (Schenectady, NY) reported data for two RH-TRU waste streams, and that the RH-TRU waste will be packaged in 55-gallon drums and then placed in RH-TRU waste canisters for shipment to WIPP (ERMS #526087). The volumes of RH-TRU waste in the KAPL waste streams originally reported are the waste volumes associated with the 55-gallon drums that will be loaded into the RH-TRU waste canister. Therefore, the steel, plastic, and lead packaging material densities were recalculated based on the materials and volume of the RH-TRU waste canister (0.89 m^3). The calculation is similar to that shown in Section DATA-F-D-2.7 for three 55-gallon drums overpacked in an RH-TRU waste canister, except that the total weight of steel for this case was determined based on the steel packaging material density given by the site for the 55-gallon drums (131 kg/m^3). The resulting steel packaging material density for the RH-TRU waste canister with three 55-gallon drums in it was 526 kg/m^3. Since the lead is contributed entirely by the RH-TRU canister, the lead packaging material density is 464 kg/m^3, as calculated in Section DATA-F-D-2.7. The density of plastic was also given by the site (37 kg/m^3) and used to determine the plastic packaging density (26 kg/m^3).

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for KA-T001 and KA-W016 at KAPL for the Compliance Recertification Application (ERMS #530648). The packaging material densities for these RH-TRU waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.10 Lawrence Livermore National Laboratory Packaging Material Densities

Lawrence Livermore National Laboratory (LLNL) reported data for three CH-TRU waste streams. These three waste streams are currently stored in miscellaneous-sized boxes that

cannot be used as payload containers for shipment to and disposal in WIPP (ERMS #526536). The volumes reported by LLNL are the waste volumes associated with the current storage configuration in various sized boxes. Therefore, acceptable shipping containers and the updated packaging material densities were needed. Each of the three waste streams will be shipped and disposed in 55-gallon drums, SWBs, and SLBs. The packaging materials reported for the 55-gallon drums did not change, since the drums did not require repackaging or overpacking. However, the miscellaneous sized boxes required repackaging. The steel originally reported as packaging material for the waste becomes waste material after repackaging and was added to the Iron-Base Metal/Alloys category. The steel packaging associated with shipping containers was simply the steel packaging for the shipping container (either a 55-gallon drum, SWB, or SLB). The SLB is a new box that will likely be used for repackaging LLNL waste. Because the SLB is still being designed (see Section DATA-F-D-3.4.5) and it has no set specifications, the packaging material densities for a directly loaded SWB, as shown in Section DATA-F-D-2.4, were used in the routine calculation for the SLBs. Therefore, the steel packaging material density was 154 kg/m^3 for both SWBs and SLBs. The calculation assumed no plastic packaging for the SWBs and SLBs.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for LL-T002, LL-T005, and LL-T034 for the Compliance Recertification Application (ERMS #530662). The packaging material densities for these RH-TRU waste streams were adjusted according to the results of this calculation.

DATA-F-D-3.11 Paducah Gaseous Diffusion Plant Packaging Material Densities

Paducah Gaseous Diffusion Plant (PGDP) reported data for one CH-TRU waste stream, which will be packaged in 55-gallon drums and then be placed in SWBs for shipment to WIPP (ERMS #526074). The volume of the waste in this waste stream is the waste volume associated with the 55-gallon drums that will be loaded into the SWB, which does not reflect the volume of waste that will be disposed in the WIPP. Therefore, the volume of waste was recalculated in the routine calculation identified below. However, the steel and plastic packaging material densities reported by the site did correspond to the packaging configuration for four 55-gallon drums overpacked in an SWB (steel and plastic packaging material densities were reported as 212 kg/m^3, and 17.5 kg/m^3, respectively), and were therefore not recalculated in the routine calculation.

The updated volume of waste that will be received at the WIPP, the corresponding waste and packaging material densities, and the radionuclide concentrations were determined and documented in Calculation of Waste Stream Volumes, Waste and Container Material Densities, and Radionuclide Concentrations for PA-A015 at PGDP for the Compliance Recertification Application (ERMS #530670). The packaging material densities for these RH-waste streams were adjusted according to the results of this calculation.

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