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Estimate of Portland Cement in TRU Waste For Disposal in WIPP for the Compliance Recertification Application Supercedes ERMS# 529684

Revision 1

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Author — C.D. Leigh, 6821 — 9/18/03 Date
SNL Performance Assessment and Decision Analysis Group

Author — Sheila Lott , EES-12 — 9/18/03 Date
Los Alamos National Laboratory

Technical Review — Jim Garner, 6821 — 9/18/03 Date
SNL Performance Assessment and Decision Analysis Group

QA Review — Kathleen Byle, 6820 — 9/18/03 Date
SNL Carlsbad Programs Group

Management Review — D. S. Kessel, 6821 — 9/18/03 Date
SNL Performance Assessment and Decision Analysis Manager

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1. INTRODUCTION

In 1996 the Department of Energy (DOE) completed a performance assessment (PA) calculation for the Waste Isolation Pilot Plant (WIPP). The PA was part of the Compliance Certification Application (CCA) submitted to the Environmental Protection Agency (EPA) to demonstrate compliance with the radiation protection regulations of 40 Code of Federal Regulations (CFR) 191 and 40 CFR 194. As required by the WIPP Land Withdrawal Act (Public Law 102-579), DOE is required to submit documentation to EPA for the recertification of the WIPP every five years in order to continue operating the site. This will require that a Compliance Recertification Application (CRA) be prepared and submitted to the EPA by November 2003.

This analysis is governed by AP-092, *Analysis Plan for Transuranic Waste Inventory Update Report, 2003*. In particular, an estimate of the mass of portland cement in the WIPP repository based on updated inventory information collected by Los Alamos National Laboratory (LANL) is needed for the CRA PA. This analysis was performed in accordance with the Sandia National Laboratories (SNL) Quality Assurance Program and was prepared as prescribed by the SNL NWMP Procedure, NP 9-1, *Analyses*.

1.1 ACRONYMS

AP	Analysis Plan
CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CRA	Compliance Recertification Application
DOE	Department of Energy
EPA	Environmental Protection Agency
ERMS	Electronic Records Management System
LANL-CO	Los Alamos National Laboratory – Carlsbad Operations
NP	NWMP Procedure
NWMP	Nuclear Waste Management Program
PA	Performance Assessment
SNL	Sandia National Laboratory
TRU	Transuranic
WIPP	Waste Isolation Pilot Plant

2. PROBLEM DESCRIPTION

In support of the WIPP PA for the CCA, the DOE prepared the *Transuranic Waste Baseline Inventory Report, Revision 3* (U.S. DOE 1996a) which is referred to throughout the rest of this document as the TWBIR Revision 3. The purpose of the TWBIR Revision 3 was to document the total inventory of DOE TRU waste.

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In support of the CRA, the DOE is preparing the *Transuranic Waste Inventory Update Report, 2003*. The purpose of the *Transuranic Waste Inventory Update Report, 2003* is to update the total inventory of DOE TRU waste for recertification of the WIPP repository. Therefore, DOE through its contractor, LANL, issued a data call to the generator sites. Data collected during the 2003 update data call has been processed and is currently stored in the Transuranic Waste Baseline Inventory Database (TWBID) Revision 2.1 Version 3.12 developed by LANL (LANL 2003a). TWBID Revision 2.1 Version 3.12 was qualified in accordance with NP 19-1, *Software Requirements*, and is the source of data for this calculation.

Scaled waste stream volumes for waste emplaced in the WIPP repository and waste coming to the WIPP repository from the generator sites for the *Transuranic Waste Inventory Update Report, 2003* have been provided by LANL (LANL, 2003b). The scaled volume is the inventory volume defined for WIPP emplacement to be used for PA calculations for the CRA. The Land Withdrawal Act defines the total amount of TRU waste allowed in the WIPP as 6,200,000 ft^3 or 175,538 m^3 (U.S. Congress, 1992). The "Agreement for Consultation and Cooperation" limits the RH TRU inventory to 250,000 ft^3 or 7,080 m^3 (U.S. DOE and State of New Mexico, 1981). By difference, the CH TRU inventory is limited to 5,950,000 ft^3 or 168,500 m^3.

The PA for the CRA requires an estimate of the mass of cement expected for disposal in the repository. An estimate of the mass of cement expected for disposal for the CCA was given in Appendix B-7 of the TWBIR Revision 3. The purpose of this calculation is to estimate the mass of cement expected in the scaled waste stream volumes for the WIPP CRA PA.

3. COMPUTATIONAL METHOD

The method employed in this calculation is based on Appendix B-7 of the TWBIR Revision 3. Appendix B-7 of the TWBIR Revision 3 is a calculation of the cement content of TRU solidified waste forms scheduled for disposal in WIPP. Appendix B-7 lists the waste streams from the TWBIR Revision 3 that were expected to contain cement and the expected density of cement in the waste streams at the time of the CCA. The calculation in Appendix B-7 of the TWBIR Revision 3 is based on scaled waste stream volumes as reported in Appendix B-2 of the TWBIR Revision 3.

While the waste stream volumes reported by the generator sites in the 2003 update to the TWBIR Revision 3 have changed some when compared to the TWBIR Revision 3 volumes, the waste streams identified by the sites at the time of the TWBIR Revision 3 as containing cement have not changed. On the whole, the TRU waste generator sites did not report any new information about cement in the 2003 update to the TWBIR Revision 3.

As a result, the method employed here involves developing a correlation between the waste streams in Appendix B-7 of the TWBIR Revision 3 and the waste streams in the 2003 update to the TWBIR Revision 3. Once that correlation is made, the volumes for the waste streams can be updated and the calculation of mass of cement can proceed. The correlation between the cement bearing waste streams from the TWBIR Revision 3 and the 2003 update to the TWBIR Revision 3 falls into one of five cases:

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1. There is a direct correlation between the TWBIR Revision 3 waste stream and the waste stream in the 2003 update to the TWBIR Revision 3.
2. A TWBIR Revision 3 waste stream has been divided into several waste streams in the 2003 update to the TWBIR Revision 3.
3. Two or more TWBIR Revision 3 waste streams will be divided into two or more waste streams in the 2003 update to the TWBIR Revision 3.
4. Several TWBIR Revision 3 waste streams have been combined to create a waste stream in the 2003 update to the TWBIR Revision 3.
5. In a few cases the sites may have added waste streams containing cement to the inventory that were not reported in the TWBIR Revision 3.

3.1 CASE 1

For most of the waste streams identified in Appendix B-7 of the TWBIR Revision 3, there is a direct correlation to a waste stream in the 2003 update to the TWBIR Revision 3. In this case, an estimate of the mass of cement can be made using the scaled volume reported in LANL 2003b for the waste stream and the density of cement in the waste stream from Table 1 in Appendix B-7 of the TWBIR Revision 3. Equation 1 gives the mass of cement from a waste stream in this case:

$$M(ws_i) = v_{si} * p_i \quad (1)$$

Where

$M(ws_i)$ is the mass of cement in the waste stream, ws_i
v_{si} is the scaled volume from LANL 2003b for the waste stream, ws_i
p_i is the density of cement in ws_i from Table 1 of Appendix B-7 of the TWBIR Revision 3

3.2 CASE 2

Sometimes a TWBIR Revision 3 waste stream has been divided into several waste streams in the 2003 update to the TWBIR Revision 3. In this case, the mass of cement can be determined by including all of the component waste streams from the 2003 update to the TWBIR Revision 3 in the calculation using Equation 2. Equation 2 can be used because all cement mass is accounted for. For example, if the TWBIR Revision 3 waste stream, A was divided to create waste streams B and C in the 2003 update to the TWBIR Revision 3, the mass of cement can be calculated as:

$$M(ws_B) + M(ws_C) = v_{sB} * p_A + v_{sC} * p_A \quad (2)$$

Where

$M(ws_B)$ is the mass of cement in the waste stream, B
$M(ws_C)$ is the mass of cement in the waste stream, C
v_{sB} is the scaled volume from LANL 2003b for the waste stream, B
v_{sC} is the scaled volume from LANL 2003b for the waste stream, C

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p_A is the density of cement in waste stream A from Table 1 of Appendix B-7 of the TWBIR Revision 3

3.3 CASE 3

Sometimes two or more TWBIR Revision 3 waste streams have been divided into two or more waste streams in the 2003 update to the TWBIR Revision 3. In this case, there is no way to determine how much of each TWBIR Revision 3 waste stream is allocated to each waste stream in the 2003 update to the TWBIR Revision 3. As the ratio of how much material derived from each waste stream is not known, the method of calculation employed in this case results in the most conservative estimate of mass. For example, if waste stream C in the 2003 update to the TWBIR Revision 3 is composed of components from waste streams A and B in the TWBIR Revision 3, the mass of cement would be:

$$M(ws_C) = v_{sC} * \text{MAX}(p_A \text{ or } p_B) \quad (3)$$

Where

MAX is a function that chooses the larger of the two values
$M(ws_C)$ is the mass of cement in the waste stream, C
v_{sC} is the scaled volume from LANL 2003b for the waste stream, C
p_A is the density of cement in waste stream A from Table 1 of Appendix B-7 of the TWBIR Revision 3
p_B is the density of cement in waste stream B from Table 1 of Appendix B-7 of the TWBIR Revision 3

The maximum density value is chosen as a bounding value for the density in waste stream C because there is no way to determine how much of the waste stream C volume correlates to waste stream A and how much correlates to waste stream B.

3.4 CASE 4

Several TWBIR Revision 3 waste streams have been combined to create a waste stream in the 2003 update to the TWBIR Revision 3. In this case, an estimate of the mass of cement can be made by dividing the volume of the waste stream in the 2003 update to the TWBIR Revision 3 into volumes that correlate to the TWBIR Revision 3 waste streams that were combined and applying Equation 4. For example, if two TWBIR Revision 3 waste streams (A and B) were combined to create waste stream C in the 2003 update to the TWBIR Revision 3, the mass of cement can be calculated as:

$$M(ws_C) = v_{sC} * [{}^{\text{Rev 3}}v_{sA} / ({}^{\text{Rev 3}}v_{sA} + {}^{\text{Rev 3}}v_{sB})] * p_A$$
$$+ v_{sC} * [{}^{\text{Rev 3}}v_{sB} / ({}^{\text{Rev 3}}v_{sA} + {}^{\text{Rev 3}}v_{sB})] * p_B \quad (4)$$

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Where

$M(ws_C)$ is the mass of cement in the waste stream, C
v_{sC} is the scaled volume from LANL 2003b for the waste stream, C
$^{Rev\ 3}v_{sA}$ is the scaled volume from the TWBIR Revision 3 for the waste stream, A
$^{Rev\ 3}v_{sB}$ is the scaled volume from the TWBIR Revision 3 for the waste stream, B
p_A is the density of cement in waste stream A from Table 1 of Appendix B-7 of the TWBIR Revision 3
p_B is the density of cement in waste stream B from Table 1 of Appendix B-7 of the TWBIR Revision 3

If there are waste streams from TWBIR Revision 3 included in the waste stream in the 2003 update to the TWBIR Revision 3 that do not contain cement, their scaled volumes would be included in the denominators in Equation 4.

3.5 CASE 5

In a few cases the sites added waste streams to the inventory that were not contained in the TWBIR Revision 3. In this case, to find an appropriate density of cement to use for new waste streams, the new waste streams were matched with similar waste streams and the density data from the matching waste streams can be used in Equation 1 to calculate the mass of cement.

4. RESULTS

Applying the computational method from Section 3 to the waste streams in the TWBIR Revision 3 and the 2003 update to the TWBIR Revision 3 produces the results given in Tables 1 through 5.

Table 1 shows the Case 1 waste streams. These are waste streams that appear in Appendix B-7 Table 1 of the TWBIR Revision 3. They were identified in the TWBIR Revision 3 as containing cement. The same waste streams are also in the 2003 update to the TWBIR Revision 3. In some cases the waste stream identifier changed in the 2003 update to the TWBIR Revision 3, but the sites provided a cross-walk between the waste stream identifiers. The sites did not update their estimates of the density of cement in the waste streams. Therefore, the densities shown in Appendix B-7 Table 1 of the TWBIR Revision 3 are used below in Table 1 for the calculation of cement mass. The volume shown below in Table 1 is the scaled volume for each waste stream from LANL 2003b. The mass is simply the product of the density times the volume.

Table 2 shows the Case 2 waste streams. These are waste streams that appear in Appendix B-7 Table 1 of the TWBIR Revision 3. These waste streams were divided into a number of waste streams in the 2003 update to the TWBIR Revision 3. For example the TWBIR Revision 3 waste stream RF-T010 was reported as three waste streams, RF-MT0800, RF-MT0803, and RF-MT0807, in the 2003 update to the TWBIR Revision 3. Further, the TWBIR Revision 3 waste

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stream LA-M002 was reported as five waste streams, LA-TA-03-28, LA-TA-21-13, LA-TA-21-43, LA-TA-50-17, and LA-TA-50-18, in the 2003 update to the TWBIR Revision 3. The 2003 update waste streams, LA-TA-21-15, LA-TA-48-01, LA-TA-50-15, were derived solely from the TWBIR Revision 3 waste stream LA-T006 and the 2003 update waste streams LA-TA-03-30, LA-TA-21-16, LA-TA-55-41, LA-TA-55-44, LA-TA-55-53 were derived solely from the TWBIR Revision 3 waste stream LA-W006. LA-T006 and LA-W006 also contribute to some of the waste streams in Table 3.

Because all of the 2003 update waste streams in Table 2 came from TWBIR Revision 3 waste streams identified in Appendix B-7 Table 1 as containing cement, and the sites did not update their estimates of the density of cement in these waste streams, the densities shown in Appendix B-7 Table 1 of the TWBIR Revision 3 are used below in Table 2 for the calculation of cement mass. The volume shown below in Table 2 is the scaled volume for each waste stream from LANL 2003b. The mass is simply the product of the density times the volume.

Table 3 shows the Case 3 waste streams. These are waste streams that appear in Appendix B-7 Table 1 of the TWBIR Revision 3. Like the waste streams shown in Table 2, the waste streams shown in Table 3 represent TWBIR Revision 3 waste streams that were reported in the 2003 update to the TWBIR Revision 3 as several component waste streams. The difference is that the 2003 update waste streams shown in the first column of Table 3 contain material from two or more TWBIR Revision 3 waste streams. For example, the 2003 update waste stream LA-TA-50-19 has material from the TWBIR Revision 3 waste streams LA-W003 and LA-W006. In this case, one cannot identify how much of LA-TA-50-19 was derived from LA-W003 and how much was derived from LA-W006. As a result the bounding approach is to assign the highest cement density (645.9 kg/m^3 for LA-W003 instead of 508.1 kg/m^3 from LA-W006) to LA-TA-50-19. This is shown in Table 3 in the column titled "Percent Applied." The first entry under "Percent Applied" indicates that 100 percent of the scaled volume for LA-TA-50-19 will have an applied cement density of 645.9 kg/m^3. The next entry (Row 2) indicates that 0 percent of the scaled volume for LA-TA-50-19 will have an applied cement density of 508.1 kg/m^3.

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Table 1. Calculation of Cement Mass for Case 1 Waste Streams

Waste Stream Identifier		Density (kg/m^3)[a]	Scaled Volume (m^3)[b]	Mass (Kg)
2003 Update to the TWBIR Revision 3	TWBIR Revision 3			
AW-W020.13	AW-W020.13	73.1	16.5	1.20E+03
IN-W163.1007	IN-W163.1007	73.1	11.5	8.41E+02
IN-W181.162	IN-W181.162	308.8	80.3	2.48E+04
IN-W218.909	IN-W218.909	130.6	2082.8	2.72E+05
IN-W219.914	IN-W219.914	73.1	1.9	1.38E+02
IN-W315.601	IN-W315.601	308.8	34.4	1.06E+04
IN-W319.584	IN-W319.584	73.1	4.8	3.50E+02
IN-W321.1023	IN-W321.1023	73.1	11.5	8.38E+02
IN-W348.1012	IN-W348.1012	73.1	22.9	1.68E+03
IN-W375.1096	IN-W375.1096	308.8	199.8	6.17E+04
LL-M001	LL-M001	100.0	34.0	3.40E+03
LL-T001	LL-T001	394.2	382.9	1.51E+05
RF-MT0001	RF-MT0001	187.6	8.2	1.53E+03
RF-MT0007	RF-MT0007	130.6	0.8	1.04E+02
RF-MT0377	RF-MT0377	73.1	74.4	5.44E+03
RF-MT0800	RF-MT0800	193.8	62.5	1.21E+04
RF-MT0803	RF-MT0803	55.6	2.3	0.0*
RF-MT0806	RF-MT0806	73.1	0.2	1.46E+01
RF-MT0807	RF-MT0807	71.7	84.2	6.04E+03
RF-MT0823	RF-MT0823	17.5	0.2	3.50E+00
RF-TT0806	RF-TT0806	73.1	0.0	0.0*
RF-TT0809	RF-TT0809	73.1	4.7	3.44E+02
RF-TT0823	RF-TT0823	17.5	0.2	3.50E+00
			TOTAL	5.54E+05 kg

(a) Density values from Appendix B-7 Table 1 of the TWBIR Revision 3
(b) Scaled volumes from LANL 2003b

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Table 2. Calculation of Cement Mass for Case 2 Waste Streams

Waste Stream Identifier		Density (kg/m^3)[(a)]	Scaled Volume (m^3)[(b)]	Mass (Kg)
2003 Update to the TWBIR Revision 3	TWBIR Revision 3			
RF-MT0800	RF-T010	140.2	62.5	0.00*
RF-MT0803	RF-T010	140.2	2.3	3.21E+02
RF-MT0807	RF-T010	140.2	84.2	1.18E+04
LA-TA-03-28	LA-M002	693.0	5.8	4.05E+03
LA-TA-03-30	LA-W006	508.1	0.8	4.22E+02
LA-TA-21-13	LA-M002	693.0	16.2	1.12E+04
LA-TA-21-15	LA-T006	514.4	3.5	1.82E+03
LA-TA-21-16	LA-W006	508.1	71.7	3.64E+04
LA-TA-21-43	LA-M002	693.0	2533.7	1.76E+06
LA-TA-48-01	LA-T006	514.4	0.6	3.19E+02
LA-TA-50-15	LA-T006	514.4	159.1	8.19E+04
LA-TA-50-17	LA-M002	693.0	216.3	1.50E+05
LA-TA-50-18	LA-M002	693.0	98.4	6.82E+04
LA-TA-55-33	LA-T006	514.4	6.7	3.43E+03
LA-TA-55-41	LA-W006	508.1	43.7	2.22E+04
LA-TA-55-44	LA-W006	508.1	230.7	1.17E+05
LA-TA-55-53	LA-W006	508.1	216.3	1.10E+05
			TOTAL	2.37E+06 kg

(a) Density values from Appendix B-7 Table 1 of the TWBIR Revision 3
(b) Scaled volumes from LANL 2003b

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Table 3. Calculation of Cement Mass for Case 3 Waste Streams

Waste Stream Identifier		Density (kg/m^3)[a]	Scaled Volume (m^3)[b]	Percent Applied[c]	Applied Volume (m^3)[d]	Mass (Kg)
2003 Update to the TWBIR Revision 3	TWBIR Revision 3					
LA-TA-50-19	LA-W003	645.9	1179.8	100	1179.8	7.62E+05
LA-TA-50-19	LA-W006	508.1	1179.8	0	0.0	0.00E+00
LA-TA-55-30	LA-T006	514.4	3312.0	100	3312.0	1.70E+06
LA-TA-55-30	LA-W006	508.1	3312.0	0	0.0	0.00E+00
LA-TA-55-32	LA-T006	514.4	4.8	100	4.8	2.47E+03
LA-TA-55-32	LA-W006	508.1	4.8	0	0.0	0.00E+00
LA-TA-55-38	LA-T006	514.4	848.2	100	848.2	4.36E+05
LA-TA-55-38	LA-W006	508.1	848.2	0	0.0	0.00E+00
LA-TA-55-49	LA-T006	514.4	18.3	100	18.3	9.41E+03
LA-TA-55-49	LA-W006	508.1	18.3	0	0.0	0.00E+00
					TOTAL	2.91E+06 kg

(a) Density values from Appendix B-7 Table 1 of the TWBIR Revision 3
(b) Scaled volumes from LANL 2003b
(c) Percent of scaled volume corresponding to the listed cement density (Column 3).
(d) Cubic meters of scaled volume corresponding to the listed cement density (Column 4 x Column 5)

The volume shown below in Table 3 is the scaled volume for each waste stream from LANL 2003b. The mass is simply the product of the density times the volume.

Table 4 shows the Case 4 waste streams. These are waste streams that appear in Appendix B-7 Table 1 of the TWBIR Revision 3. They were identified in the TWBIR Revision 3 as containing cement. Table 4 shows TWBIR Revision 3 waste streams that were grouped together and reported as one waste stream in the 2003 update to the TWBIR Revision 3. For example, the TWBIR Revision 3 waste streams IN-W157.144 and IN-W157.906 were reported as one waste stream in the 2003 update to the TWBIR Revision 3 called IN-W157.144. Since the TWBIR Revision 3 waste streams IN-W157.144 and IN-W157.906 had different cement densities in Appendix B-7 Table 1 (187.9 kg/m^3 and 212.8kg/m^3 respectively), the cement density for the 2003 update waste stream IN-W157.144 is a linear combination of the two densities based on the volumes for IN-W157.144 and IN-W157.906 reported in the TWBIR Revision 3. In this case, there were 49.91 m^3 reported in the TWBIR Revision 3 for IN-W157.144 and 163.70 m^3 reported in the TWBIR Revision 3 for IN-W157.906. Therefore, 23% [(100 x 49.91 m^3)/(49.91 m^3+163.70 m^3)] of the scaled volume for the 2003 update waste stream IN-W157.144 will have a cement density of 187.9 kg/m^3 and 77% of the scaled volume for the 2003 update waste stream IN-W157.144 will have a cement density of 212.8kg/m^3.

For the 2003 update waste stream IN-BN-510, over 150 waste streams reported in the TWBIR Revision 3 were grouped together and reported as IN-BN-510 in the 2003 update to the TWBIR Revision 3. Therefore, only a small percent of the waste stream, the part which corresponds to the contributions of the TWBIR Revision 3 waste streams IN-W166.151, IN-W166.928, IN-W187.1094, IN-W317.1029, IN-W317.757, IN-W317.758, will contain cement.

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The volume shown below in Table 4 is the scaled volume for each waste stream from LANL 2003b. The mass is simply the product of the density times the volume.

Tables 1 through 4 contain the information for 59 of the 65 TWBIR Revision 3 waste streams identified in Appendix B-7 Table 1 as containing cement. The remaining six TWBIR Revision 3 waste streams from Appendix B-7 Table 1, AW-W022.22, AL-W005, MD-T001, MD-W002, IN-W228.886, IN-W146.699, have no corresponding waste streams in the 2003 update to the TWBIR Revision 3.

As a last step in the analysis, the TWBID Revision 2.1 Version 3.11 (LANL 2003a) database was queried to identify if any additional waste streams, other than those identified in Appendix B-7 Table 1, list cement as a component in the waste stream. The result was the identification of eight additional waste streams containing cement. These are shown in Table 5. IN-GEM-01, IN-W337.673, and IN-W337.957 are completely new waste streams with no equivalent in the TWBIR Revision 3. BCLRH-T006, RF-MT-0292, RF-MT-0299, RF-MT-0372, and RF-TT0802 have equivalents in the TWBIR Revision 3 but were not identified in the TWBIR Revision 3 as containing cement.

The total estimated weight of cement in the scaled solidified waste forms for the 2003 update to the TWBIR Revision 3 is 11.97E+06 kg. This is the sum of the totals from Tables 1 through 5:

$$1.20E+07\ kg = (5.54E+05 + 2.37E+06 + 2.91E+06 + 6.10E+06 + 3.18E+04)\ kg$$

The cement reported is both reacted and unreacted cement in waste. There are no data available to estimate the percentage of reacted versus unreacted cement.

This estimate of cement mass in the WIPP repository (1.20E+07 kg) is larger than the estimate made for the CCA which was 8.54E+06 kg. The increase in cement mass is due primarily to larger volumes projected for existing waste streams and the added waste streams in Table 5.

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Table 4. Calculation of Cement Mass for Case 4 Waste Streams

Waste Stream Identifier		Density (kg/m^3)[a]	Scaled Volume (m^3)[b]	Percent Applied[c]	Applied Volume (m^3)[d]	Mass (Kg)
2003 Update to the TWBIR Revision 3	TWBIR Revision 3					
AE-T003	AE-W038	73.8	52.1	100	52.1	3.85E+03
AE-T003	AE-W040	73.8	52.1	0	0.0	0.00E+00
AE-T003	AE-W039	73.8	52.1	0	0.0	0.00E+00
IN-BN-510[e]	IN-W166.151	73.8	19874.8	7.25E-02	14.4	1.06E+03
IN-BN-510	IN-W166.928	83.6	19874.8	2.57E-01	51.1	4.27E+03
IN-BN-510	IN-W187.1094	102.0	19874.8	3.17E-03	0.6	6.43E+01
IN-BN-510	IN-W317.1029	73.1	19874.8	1.63E-02	3.2	2.37E+02
IN-BN-510	IN-W317.757	73.1	19874.8	1.77E-01	35.2	2.57E+03
IN-BN-510	IN-W317.758	73.1	19874.8	5.21E-02	10.4	7.57E+02
IN-W157.144	IN-W157.144	187.9	745.6	2.30E+01	171.5	3.22E+04
IN-W157.144	IN-W157.906	212.8	745.6	7.70E+01	574.1	1.22E+05
IN-W188.160	IN-W188.1093	308.8	149.1	7.50E+01	111.8	3.45E+04
IN-W188.160	IN-W188.160	188.3	149.1	2.50E+01	37.2	7.02E+03
IN-W179.158	IN-W179.1084	394.2	1995.8	6.05E+01	1207.4	4.76E+05
IN-W179.158	IN-W179.158	325.0	1995.8	3.95E+01	788.3	2.56E+05
IN-W216.98	IN-W216.875	308.8	12743.2	9.10E+01	11596.3	3.58E+06
IN-W216.98	IN-W216.877	215.3	12743.2	2.70E-01	34.4	7.41E+03
IN-W216.98	IN-W216.98	273.8	12743.2	6.30E-01	80.3	2.20E+04
IN-W220.114	IN-W220.114	27.6	1892.6	2.20E+01	416.4	1.15E+04
IN-W220.114	IN-W220.925	308.8	1892.6	7.80E+01	1476.2	4.56E+05
IN-W221.927	IN-W221.113	127.7	39.2	7.62E+01	29.9	3.81E+03
IN-W221.927	IN-W221.927	109.1	39.2	2.38E+01	9.3	1.02E+03
IN-W222.116	IN-W222.116	102.0	259.0	7.00E+01	181.3	1.85E+04
IN-W222.116	IN-W222.965	115.6	259.0	3.00E+01	77.7	8.98E+03
IN-W228.101	IN-W228.101	117.7	8063.4	3.20E+01	2580.3	3.04E+05
IN-W228.101	IN-W228.883	132.8	8063.4	6.80E+01	5483.1	7.28E+05
IN-W353.859	IN-W353.859	73.1	0.0	100	0.0	0.00E+00
IN-W353.917	IN-W353.917	73.1	0.2	100	0.0	1.54E+01
OR-W215	OR-W042	396.6	33.0	14.1	4.7	1.84E+03
OR-W215	OR-W046	396.6	33.0	85.9	28.3	1.12E+04
					TOTAL	6.10E+06 kg

(a) Density values from Appendix B-7 Table 1 of the TWBIR Revision 3

(b) Scaled volumes from LANL 2003b

(c) Percent of scaled volume corresponding to the listed cement density (Column 3). TWBIR Revision 3 Data for calculating the percent values is: 49.91 m^3 in IN-W157.144; 163.70 m^3 in IN-W157.906; 16.00 m^3 in IN-W166.151; 56.78 m^3 in IN-W166.928; 4.58 m^3 in IN-W179.1084; 1.51 m^3 in IN-W179.158; 0.68 m^3 in IN-W187.1094; 1478.88 m^3 in IN-W216.875; 43.91 m^3 in IN-W216.877; 555.65 m^3 in IN-W216.98; 122.80 m^3 in IN-W220.114; 443.04 m^3 in IN-W220.925; 11.65 m^3 in IN-W221.113; 3.65 m^3 in IN-W221.927; 24.75 m^3 in IN-W222.116; 10.61 m^3 in IN-W222.965; 287.33 m^3 in IN-W228.101; 608.82 m^3 in IN-W228.883; 3.56 m^3 in IN-W317.1029; 39.10 m^3 in IN-W317.757; 11.51 m^3 in IN-W317.758.

(d) Cubic meters of scaled volume corresponding to the listed cement density (Column 4 x Column 5)

(e) Over 150 waste streams that were reported in the TWBIR Revision 3 have been combined and reported as IN-BN-510 in the 2003 update to the TWBIR Revision 3. The total volume for all of the TWBIR Revision 3 waste streams contributing to IN-BN-510 is 22,070.442 m^3.

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Table 5. Calculation of Cement Mass for Case 5 Waste Streams

Waste Stream Identifier		Density (kg/m^3)[a]	Scaled Volume (m^3)[b]	Mass (Kg)
2003 Update to the TWBIR Revision 3	TWBIR Revision 3			
BCLRH-T006	BC-T001	72.0	0.9	6.41E+01
IN-GEM-01	N/A	116.6	204.8	2.39E+04
IN-W337.673	N/A	1412.0	0.2	2.82E+02
IN-W337.957	N/A	1412.0	1.9	2.67E+03
RF-MT-0292	RF-MT-0292	17.5	24.0	4.20E+02
RF-MT-0299	RF-MT-0299	17.5	31.1	5.44E+02
RF-MT-0372	RF-MT-0372	17.5	1.5	2.63E+01
RF-TT0802	RF-TT0802	68.3	57.1	3.90E+03
			TOTAL	3.18E+04 kg

5. RELEVANT PROCEDURES AND REFERENCES

5.1 PROCEDURES

AP-092, *Analysis Plan for Transuranic Waste Inventory Update Report, 2003* Sandia National Laboratory Nuclear Waste Management Program Analysis Plan, January 8, 2003.

NP 9-1, *Analyses*. Sandia National Laboratory Nuclear Waste Management Program Procedure, August 29, 2001.

NP 19-1, *Software Requirements*. Sandia National Laboratory Nuclear Waste Management Program Procedure, June 12, 2002.

5.2 REFERENCES

Los Alamos National Laboratory (LANL) 2003a. *Transuranic Waste Baseline Inventory Database, Revision 2.1, Version 3.12*. User's Manual. ERMS# 530622. Carlsbad, NM: Los Alamos National Laboratory. August 12, 2003.

LANL 2003b. *Response to Request for Radionuclide Activities in TRU Waste Streams from the TWBID Revision 2.1 Version 3.12; Data Version D.4.08*. ERMS#530918. Carlsbad, NM: Los Alamos National Laboratories.

U.S. Congress 1992. *Waste Isolation Pilot Plant Land Withdrawal Act*, Public Law 102-579, 1992, and amended Public Law 104-201, 1996.

U.S. Department of Energy 1996a. *Transuranic Waste Baseline Inventory Report, Revision 3*, DOE/CAO-1996-2184. Carlsbad, NM: U.S. Department of Energy.

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