DOCKET NO: A-98-49
II-B1-9

TECHNICAL SUPPORT DOCUMENT FOR

SECTION 194.24: REVIEW OF THE BASELINE INVENTORY USED IN THE COMPLIANCE RECERTIFICATION APPLICATION AND THE PERFORMANCE ASSESSMENT BASELINE CALCULATION

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March 2006

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ACRONYMS

AMWTF	Advanced Mixed Waste Treatment Facility
ANL-E	Argonne National Laboratory – East
ANL-W	Argonne National Laboratory – West
AP	Analysis Plan
BIR	Baseline Inventory Report
CBFO	Carlsbad Field Office
CCA	Compliance Certification Application
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH	Contact Handled
COBRA	Computerized Burial Record Archive
CPR	Cellulose, Plastic, and Rubber
CRA	Compliance Recertification Application
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
EDTA	Ethylenediaminetetraacetic Acid
EPA	U.S. Environmental Protection Agency
FGE	Fissile Gram Equivalents
FMT	Fracture Matrix Transport
Hanford-RL	Hanford Richland Operations Office
Hanford-RP	Hanford Office of River Protection
HLW	High-Level Waste
INEEL	Idaho National Engineering and Environmental Laboratory
INL	Idaho National Laboratory (formerly INEEL)
LANL	Los Alamos National Laboratory
LANL-CO	Los Alamos National Laboratory Carlsbad Operations
LLNL	Lawrence Livermore National Laboratory
LWA	Land Withdrawal Act (PL 102-579)
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
PA	Performance Assessment
PABC	Performance Assessment Baseline Calculation
PAPDB	Performance Assessment Parameter Database
PAVT	Performance Assessment Verification Test
PCBs	Polychlorinated Biphenyls
QA	Quality Assurance
RFETS	Rocky Flats Environmental Technology Site (currently designated as the Rocky Flats Closure Project)
RH	Remote Handled
SNL	Sandia National Laboratories
SQS	Small Quantity Site
SRS	Savannah River Site

SWB	Standard Waste Box
SWIFT	Solid Waste Integrated Forecast Tool
SWITS	Solid Waste Information and Tracking System
TDOP	Ten Drum Overpack
TRU	Transuranic Waste
TSD	Technical Support Document
TWBID	Transuranic Waste Baseline Inventory Database
TWBIR	Transuranic Waste Baseline Inventory Report
TWC	TRU Waste Characterization
WAC	Waste Acceptance Criteria
WAP	Waste Analysis Plan
WIPP	Waste Isolation Pilot Plant
WITS	Waste Information Tracking System
WTS	Washington TRU Solutions, LLC
WTWBIR	WIPP Transuranic Waste Baseline Inventory Report
WUF	Waste Unit Factor
WWIS	WIPP Waste Information System

EXECUTIVE SUMMARY

As part of the U.S. Environmental Protection Agency's (EPA or the Agency's) review of the U.S. Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP) Compliance Recertification Application (CRA), baseline inventory values that are summarized in the *Transuranic Waste Inventory Update Report, 2003* (Compliance Recertification Application, Appendix DATA, Attachment F) and the *TRU Waste Inventory for the Compliance Recertification Application Performance Assessment Baseline Calculation* (Leigh et al. 2005) were examined. In addition to the mandated volumes for the contact-handled and remote-handled radioactive waste, waste components such as the activity of specific radionuclides, and masses of metals, cellulosics, rubber, organic ligands, and certain anions must be tracked in the baseline inventory. Changes in these waste components since DOE's 1996 Compliance Certification Application (CCA) are the focus of this review.

The number of curies of transuranic elements with half-lives greater than 20 years to be disposed of at WIPP has decreased from 3.44 million curies in the 1996 Compliance Certification Application (CCA) to 2.48 million curies in the CRA, and to 2.32 million curies in the Performance Assessment Baseline Calculation (PABC) (each decayed to 2033, the assumed WIPP closure date). DOE assumes, as was done in the CCA, that the allowable contact-handled (CH) transuranic (TRU) waste volume will be fully utilized. Since current waste volume projections are less than the allowable capacity, estimates of to-be-generated wastes are scaled to the CH TRU waste volume limit of 164,485 m^3. For the remote-handled (RH) TRU wastes, DOE has identified more RH TRU waste than the WIPP is currently allowed to contain (i.e., 7,079 m^3), so the inventory estimate are scaled downward.

The Agency approached the review of the inventory by first assessing the processes used to collect, evaluate, and summarize inventory information obtained from the TRU waste generator sites. This was performed by visiting several waste generator sites and evaluating their data acquisition and transfer process, as well as by reviewing procedures and examining documented information exchanges between DOE and TRU waste generator sites. The Agency then examined information presented in the CRA obtained through this process to ensure that the data were assembled and subsequently manipulated through decay and inventory roll-up in an adequate and traceable manner. The resulting inventory values used in performance assessment (PA) were not evaluated here with respect to the technical adequacy of the parameters, since this was the subject of a separate EPA review (see our PABC review, EPA 2006b, Docket A-98-49 Item II-B1-16).

As a result of this analysis, the Agency found that DOE used a traceable and understandable process to acquire and manipulate data from sites for the CRA. While the process was not completely transparent (and should be made so in the future), the activities resulted in acquisition of information that could be traced back to the generator sites, even when the information required subsequent manipulation by DOE. The Agency also found that information derived through the inventory data call was adequately presented in the CRA, and could be traced between the various sources and roll-up tables. Changes occurring between the CCA and the CRA were appropriately documented.

Some changes occurred in the baseline inventory after the data call for the CRA was made to the waste generator sites (September 30, 2002, cutoff date), and some discrepancies were uncovered by DOE in its review of the CRA inventory and by EPA in its review of the completeness and adequacy of the CRA inventory. Therefore, EPA required DOE to revise the inventory parameters used to perform a subsequent PA—the Performance Assessment Baseline Calculation (PABC) (EPA 2006b). As part of the review described here, EPA also examined changes made to the baseline inventory between the CRA PA and the PABC and found them to be consistent with EPA guidance for the PABC.

A separate parameter review described in another Technical Support Document successfully verified and validated all values used in CRA and PABC performance assessments. This review included all inventory parameters changed since the CCA (EPA 2004 and EPA 2006a).

Based on the review described here, EPA concluded that the baseline inventory data assembly process, while sometimes complex and not always clearly documented, is adequate for its intended uses. On-going attention should be directed to improvements with respect to documentation of issues and identification/resolution of errors. The inventory reported in the CRA, as amended by the PABC, appropriately describes the chemical, radiological, and physical composition of the existing and to-be-generated waste, as required by 40 CFR194.24(a). The descriptions provided in the inventory reports reviewed here include documented, traceable lists of waste components and their approximate quantities in the waste, also required by 40 CFR 194.24(a).

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) operates the Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, for the disposal of defense-related transuranic (TRU) waste. DOE submitted the Compliance Certification Application (CCA) to the U.S. Environmental Protection Agency (EPA or the Agency) in 1996. After extensive review of the CCA and supplemental information provided by DOE, in 1998 the Agency certified that DOE met the relevant regulatory requirements and WIPP began accepting waste in March 1999. DOE is required to submit a Compliance Recertification Application (CRA) every 5 years after the date waste was first accepted at WIPP; the first CRA was submitted in March 2004 (DOE 2004a). DOE updated the WIPP waste inventory for the CRA, as required by 40 CFR 194.15. Under the requirements of 40 CFR 194.15(b), "To the extent that information for a re-certification of compliance remains valid and has been submitted in previous certification or re-certification application(s), such information need not be duplicated in subsequent applications…." Confirming the validity of the waste inventory information for both emplaced inventory and estimated inventories of stored wastes at the generator sites is important for performance assessment (PA).

This Technical Support Document (TSD) describes the Agency's evaluation of DOE's inventory update process and documentation to ensure its adequacy for use in PA. The results of this review document the Agency's evaluation of DOE's compliance with the requirements of relevant portions of 40 CFR Sections 194.24(a) and (b), and Section 194.15. The complete CRA submitted by DOE is included in EPA Docket A-98-49, Item II-B2-27. Sections 1–3 of this TSD focus on information provided in the CRA, while Section 4 addresses changes made to the performance assessment inventory used in the performance assessment baseline calculations (PABC), a second PA that EPA required DOE to conduct (Cotsworth 2005). Section 5 summarizes the review.

To assist the reader in using this report, the following definitions may be useful. An extensive glossary of terms is included in the CRA (Docket A-98-49, Item II-B2-27).

<u>Final waste form</u> – Final waste form is the expected physical form of the waste. The use of the final waste form helps to group waste streams that are expected to have similar physical and chemical properties at the time of disposal. Waste is assigned to 1 of 11 final waste forms, including solidified inorganics, salt, solidified organics, soils, uncategorized metals, lead/cadmium metal, inorganic non-metals, combustibles, graphite, heterogeneous, and filter.

<u>Waste</u> – Defined term in 40 CFR 194.2. *Waste means the radioactive waste, radioactive material, and coincidental material subject to part 191 of this chapter.*

<u>Waste characteristic</u> – Defined term in 40 CFR 194.2. *Waste characteristic means a property of the waste that has an impact on the containment of waste in the disposal system.* As noted in 40 CFR194.24(b)(1), waste characteristics include, but are not limited to, solubility, formation of colloidal suspensions containing radionuclides, production of gas from the waste, shear strength, and compactibility.

Waste component – Defined term in 40 CFR 194.2. *Waste component means an ingredient of the total inventory of the waste that influences a waste characteristic*. Waste components to be analyzed per 40 CFR 194.24(b)(2) include, but are not limited to, metals, cellulosics, chelating agents, waste and other liquids, and activity in curies of each isotope of the radionuclides present.

Waste material parameter – Waste material parameters characterize quantities of certain components of the waste that are used in performance assessment. These parameters are usually expressed as material densities (kg/m^3) and include the following categories: Fe-base metals/alloys, Al-base metals/alloys, other metals/alloys, other inorganic materials, vitrified materials, cellulosic materials, rubber, plastics, solidified inorganic materials, cement (solidified), and soil.

1.1 INVENTORY DATA AND PRESENTATION RELATIONSHIPS

The first DOE attempt to describe all transuranic (TRU) waste at the waste stream level was documented in the *WIPP Transuranic Waste Baseline Inventory Report* (WTWBIR, Revision 0) issued in June 1994 (DOE 1994). A revised report (WTWBIR, Revision 1) was issued in February 1995 (DOE 1995a). Revision 1 contained modifications based on site reviews and data quality checks. In Revision 2 of the report, published in December 1995 (DOE 1995b), the title was changed to *Transuranic Waste Baseline Inventory Report* (TWBIR, Revision 2) to reflect the fact that the revision included information on TRU waste not intended for disposal at the WIPP. The June 1996 revision of this report (DOE 1996a, TWBIR, Revision 3), together with Revision 2, was used by DOE to prepare the CCA. Based on its review of the CCA as submitted by DOE, EPA required DOE to revise some of the parameters and assumptions used in the CCA PA and rerun the PA. This revised performance was designated the Performance Assessment Verification Test (PAVT). The PAVT was used by EPA to certify, in May 1998, that the WIPP meets the disposal standards set forth in 40 CFR Part 191 and the specific WIPP compliance criteria set forth in 40 CFR Part 194. The inventory used for the PAVT calculations was the same as for the CCA PA.

To prepare for its submittal of the CRA, DOE updated the inventory to be current as of September 30, 2002. This revised inventory was documented in Appendix DATA, Attachment F, of the CRA, also referred to by DOE as the *2003 Update Report*.[1] Based on its review of the completeness of the CRA, EPA determined that changes should be made to the PA. Many of these changes were based on errors in the CRA inventory and changes in assumptions that had occurred since September 30, 2002. This revised PA, designated the Performance Assessment Baseline Calculation (PABC), provides the basis for the EPA compliance recertification decision. The adjusted inventory used in PABC is described by DOE in Leigh et al. 2005), also referred to here as the *PABC Inventory Report*. The chronology of reports documenting the WIPP TRU inventory is presented in Table 1-1.

[1] As will be discussed subsequently in this report, inventory information is also located in other sections of the CRA.

Table 1-1. Chronology of Reports Documenting the Development of the WIPP Baseline Inventory

Inventory	Date	Reference	Comments
WTWBIR Rev. 0	June 1994	DOE1994	First DOE attempt to report all TRU waste at waste stream level.
WTWBIR Rev. 1	February 1995	DOE 1995a	Included data changes based on site reviews and quality checks.
TWBIR Rev. 2	December 1995	DOE 1995b	Included WIPP & non-WIPP wastes and other information on characteristics.
TWBIR Rev. 3	June 1996	DOE 1996a	Included same waste stream data as TWBIR, Revision 2. Added information on waste components needed to support PA. Used for CCA and PAVT.
2003 Update Report	March 2004	CRA, Appendix DATA, Attachment F	Inventory updated to September 30, 2002. Used for CRA.
PABC Inventory Report	September 2005	Leigh et al. 2005	Inventory updated to 2005. Used for PABC.

The data from which the information in these inventory reports was developed is contained in the Transuranic Waste Baseline Inventory Database (TWBID)—a qualified electronic database. A Microsoft Access 2.0 format database was used to generate TWBIR Revision 3 (TWBIR.mdb, dated January 29, 1996). After compliance certification, this database was converted to Microsoft Access 2000 format and was modified to incorporate new requirements (Appendix DATA, Attachment F, Section DATA-F-2.2.1). This database was named TWBID, Revision 2.1. New site data reflective of the then-current TRU inventory status were incorporated into this database. TWBID Revision 2.1, Data Version 4.09 (Software Version 3.12), was used to develop the data for the *2003 Update Report*, while TWBID Revision 2.1, Data Version 4.16 (Software Version 3.13), was used for the *PABC Inventory Report*. A complete listing of the changes associated with each Data Version (D0.00 through D4.16) of TWBID Revision 2.1 is presented in Appendix A of Leigh et al. (2005).

Several key input parameters in the WIPP PA involve waste-inventory-related values. These input parameters were derived from the current baseline inventory report that is summarized in the 2003 Update Report, included in the CRA as Attachment F of Appendix DATA. Sites that generate or store transuranic waste provided their best estimates to DOE of waste-stream-specific stored and projected waste volumes, and associated radiological, chemical, and physical properties of each waste stream. These estimates were included in Waste Stream Profiles presented in CRA Appendix DATA, Attachment F, Annex J. DOE then summarized these data to obtain an estimate of the WIPP waste inventory, including the inventory that is expected to be shipped to WIPP in the future. In addition, DOE used information contained in the WIPP Waste Information System (WWIS) to determine the quantities of wastes (including radionuclide quantities, waste material parameter quantities, and packaging quantities) emplaced in the WIPP as of September 30, 2002. These data were summarized in Annex K of the *2003 Update Report*.

DOE indicated that the inventory estimates in the *2003 Update Report* reflect information obtained since the original baseline inventory report (TWBIR Revision 3) used in the CCA. The CRA identifies the following as two of the more significant changes (as quoted from the Preface to Appendix DATA, Attachment F):

- This report accounts for the Idaho National Laboratory (INL)[2] Advanced Mixed Waste Treatment Facility process, by which 55-gallon drums are compacted and put into 100-gallon drums, and disregards those calculations related to future waste incineration described in the TWBIR Revision 3 (DOE 1996a) that never went into operation.

- This report includes 7,095 m^3 (250,595 ft^3) of stored Hanford tank waste that was added to the inventory in December 2002.

The inventory parameters used in DOE's PA are presented in the CRA as a hierarchy, where the overall totals are presented in the text of the CRA and related appendices and attachments (e.g., Appendix DATA, Attachment F). These documents are supported by a series of more detailed inventory data sources (e.g., Annexes J and K). Waste inventory values are presented in Chapter 4 of the CRA, with the following CRA tables presenting summaries of relevant inventory information and comparing CRA and CCA/PAVT values:

- Table 4-1: Emplaced, Stored, and Projected (CH) Waste Inventory as of September 30, 2002

- Table 4-2: Stored and Projected (RH) Waste Inventory as of September 30, 2002

- Table 4-4: Non-Radionuclide TRU Waste Inventory for the WIPP

- Table 4-5: WIPP CH-TRU Waste and Container Material Disposal Inventory

- Table 4-6: WIPP RH-TRU Waste and Container Material Disposal Inventory

- Table 4-7: Radionuclides Considered in PA

- Table 4-9: Radionuclides that Contribute to the Waste Unit Factor

- Table 4-13: Quantities of Radionuclides Emplaced in the Repository as of September 30, 2002

- Table 4-14: Quantities of Non-Radioactive Waste Components Emplaced in the Repository as of September 30, 2002

[2] On February 1, 2005, the Idaho National Engineering and Environmental Laboratory (INEEL) was combined with Argonne National Laboratory-West, and the new entity was designated the Idaho National Laboratory (INL).

Specific tables in Appendix DATA, Attachment F that were examined to help understand the origin and traceability of inventory data included the following:

- Table DATA-F-6: WIPP CH-TRU Waste Anticipated Inventory By Site
- Table DATA-F-7: WIPP RH-TRU Waste Anticipated Inventory By Site
- Table DATA-F-8: Volume Scaling Factors
- Table DATA-F-9: Transuranic Waste Inventory By Final Waste Form For WIPP
- Table DATA-F-10: WIPP CH-TRU Waste Profiles – Combustible Material
- Table DATA-F-11: WIPP Contact-Handled Waste Profiles – Filter Material
- Table DATA-F-12: WIPP CH-TRU Waste Profiles – Graphite
- Table DATA-F-13: WIPP CH-TRU Waste Profiles – Heterogeneous Debris
- Table DATA-F-14: WIPP CH-TRU Waste Profiles – Inorganic Non-Metal
- Table DATA-F-15: WIPP CH-TRU Waste Profiles – Lead/Cadmium Metal
- Table DATA-F-16: WIPP CH-TRU Waste Profiles – Salt
- Table DATA-F-17: WIPP CH-TRU Waste Profiles – Soil
- Table DATA-F-18: WIPP CH-TRU Waste Profiles – Solidified Inorganic
- Table DATA-F-19: WIPP CH-TRU Waste Profiles – Solidified Organic
- Table DATA-F-20: WIPP CH-TRU Waste Profiles – Uncategorized Metal
- Table DATA-F-21: WIPP RH-TRU Waste Profiles – Combustible Material
- Table DATA-F-22: WIPP RH-TRU Waste Profiles – Filter Material
- Table DATA-F-23: WIPP RH-TRU Waste Profiles – Heterogeneous Debris
- Table DATA-F-24: WIPP RH-TRU Waste Profiles – Inorganic Non-Metal
- Table DATA-F-25: WIPP RH-TRU Waste Profiles – Lead/Cadmium Metal
- Table DATA-F-26: WIPP RH-TRU Waste Profiles – Soil
- Table DATA-F-27: WIPP RH-TRU Waste Profiles – Solidified Inorganic Material
- Table DATA-F-28: WIPP RH-TRU Waste Profiles – Solidified Organic Material
- Table DATA-F-29: WIPP RH-TRU Waste Profiles – Uncategorized Metal
- Table DATA-F-30: WIPP CH-TRU Waste Material Parameter Disposal Inventory
- Table DATA-F-31: WIPP RH-TRU Waste Material Parameter Disposal Inventory
- Table DATA-F-32: Assumed Packaging Material Densities
- Table DATA-F-33: Mass of Potential Complexing Agents in the WIPP Repository
- Table DATA-F-34: Mass of Oxyanions and Cement in the WIPP Disposal
- Table DATA-F-35: CH-TRU Waste Curies on a Site-by-Site Basis
- Table DATA-F-36: RH-TRU Waste Curies on a Site-by-Site Basis
- Table DATA-F-37: WIPP Disposal Radionuclide Inventory for the CRA

Attachment F of Appendix DATA also contains several "Annexes" that present additional inventory-related information. The Attachment F Annexes reviewed include the following:

- ANNEX B: Comparison of 2003 Update Data to TWBIR Revision 3
- ANNEX C: Crosswalk of TWBIR Revision 2 and 2003 Update Waste Streams
- ANNEX E: Waste Stream Level Radionuclide Activities for the CRA-2004
- ANNEX J: Waste Stream Profiles—WIPP
- ANNEX K: Waste Stream Profiles—WIPP

In addition to Appendix DATA, Appendix PA included some of the PA input parameters related to derived inventory values. Appendix PA of the CRA presents the mathematical models used to evaluate the performance of the repository and the results of the modeling efforts. Attachment PAR of Appendix PA presents input parameter values used in the PA specific to codes pertaining to direct brine release and radionuclide transport in the Salado and Culebra. Tables in Attachment PAR of Appendix PA that contain inventory-derived parameter values are as follows:

- Table PAR-34: Waste Area and Waste Material Parameters
- Table PAR-37: Isotope Inventory
- Table PAR-50: TRU Waste Stream Volume and EPA Units per m^3
- Table PAR-51: Isotopes Activity, Total Activity and EPA Units for CH-TRU Waste Streams at Time 0 years (Subsequent tables in Attachment PAR present similar data for CH TRU at times of 100, 125, 175, 350, 1,000, 3,000, 5,000, 7,500, and 10,000 years)
- Table PAR-61: Isotopes Activity, Total Activity and EPA Units for RH-TRU Waste Streams

1.2 OVERVIEW OF DOE'S INVENTORY DATA ACQUISITION, REVIEW, AND ROLL-UP PROCESSES

Figure 1-1 presents the DOE's general data acquisition and manipulation processes. As shown in this figure, DOE acquired information from sites through a complex-wide data call. This data call was initiated through a series of letters sent to the sites requesting specific information and providing guidance as to how information should be assembled and reviewed. Sites were provided with data supplied from the TWBIR Revision 2 waste stream profiles (used in the CCA) and asked to indicate changes that had occurred between the time of the CCA/PAVT and the CRA cutoff date of September 30, 2002. Sites responded (Step 1 of Figure 1-1) by providing edited versions of the original waste profiles; alternatively, some sites (such as Hanford) provided the information to DOE via electronic data transfer. Detailed analysis of this data assembly and transfer process is presented in Section 2 of this report. The inventory generation process was reviewed at an EPA-DOE Technical Meeting on April 20-21, 2004, in Washington, DC (see Docket A-98-49, Item II-B2-40 for a summary of the DOE presentations).

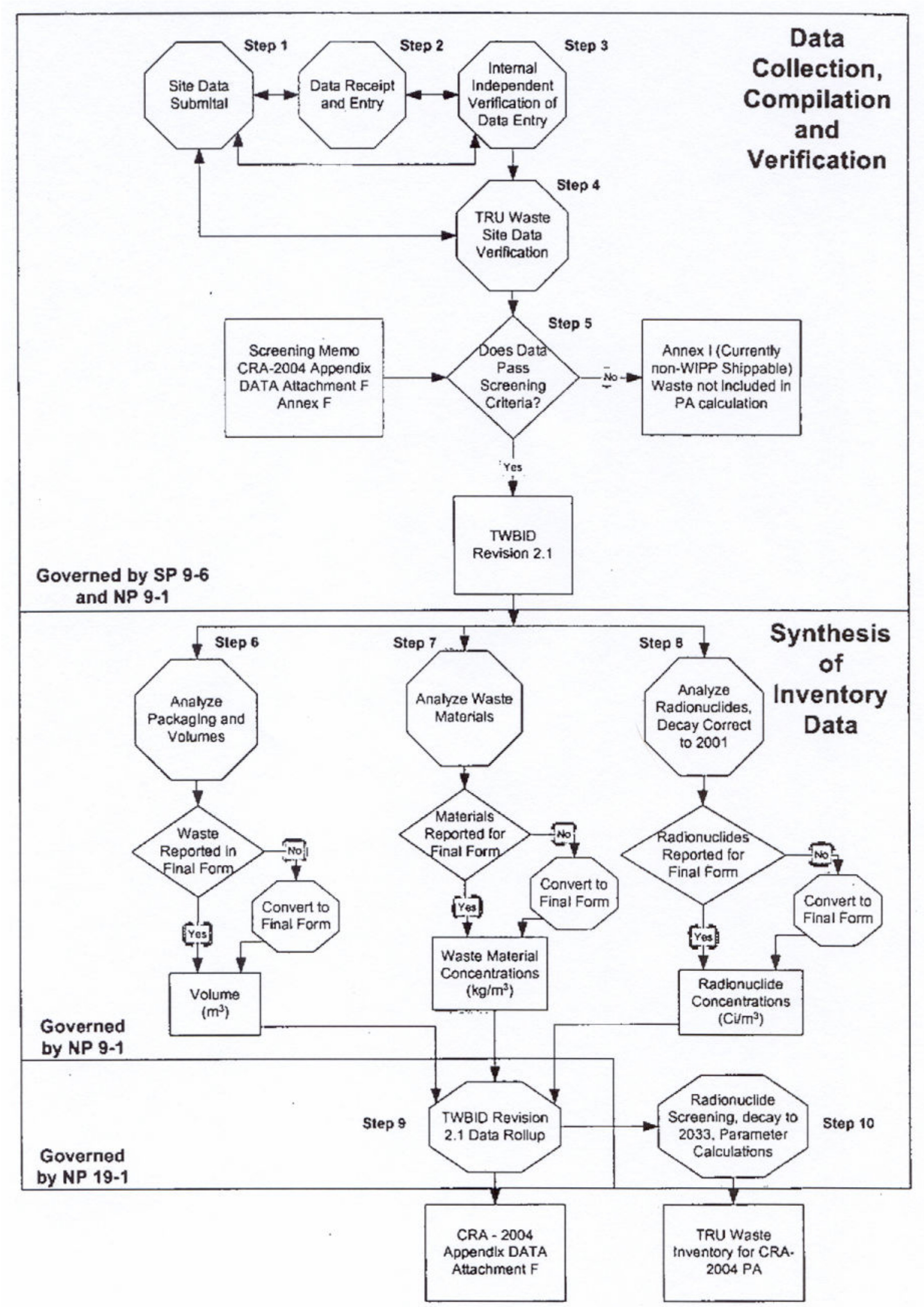

Figure 1-1. Process for Preparing CRA TRU Waste Inventory (Leigh et al. 2005)

During the data acquisition phase, Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) personnel visited some sites to facilitate data collection and resolve issues. Following acquisition of site data, DOE, LANL-CO and Sandia National Laboratory (SNL) representatives examined the information provided, going back to the sites for additional clarification if questions arose. Section 2 of this report details the information exchange between DOE/LANL-CO/SNL and sites for select waste streams, which shows the types of questions that arose, and how those issues were resolved and documented. Once issues were addressed, the waste stream profile information was validated by the DOE site manager responsible for TRU waste management. Data were then evaluated based upon screening criteria to determine whether the wastes were eligible for disposal at WIPP; wastes that were not eligible were not included in future data evaluations and roll-ups, although these wastes were included for informational purposes in Appendix DATA, Attachment F, Annex I. Data obtained from the sites were then decay-corrected to a common base year (2001), and packaging volume corrections were made. This information from individual waste streams was rolled up for use in PA, or was directly input into PA (i.e., cuttings and cavings). The information from this data call, which was used in the CRA, was designated TWBID Revision 2.1, Version 3.12, Data Version 4.09.

To further check the inventory information obtained, DOE/SNL examined the *2003 Update Report* for issues and discrepancies, and also compared the CCA information to the new inventory information obtained. DOE identified several general data reporting issues associated with the *2003 Inventory Update*, as well as other questions about the information provided, as documented in *Summary Review of Transuranic Waste Baseline Inventory Waste Profile Forms Developed to Support the Compliance Recertification Application* (Warren 2004).[3] SNL examined the issues identified and prepared a response document, entitled *Inventory Reassessment Summary for the CRA 2004, TRU Waste Inventory* (Leigh and Crawford 2004). This document evaluated major issues raised pertaining to waste volume/final waste form determinations, waste packaging, and radionuclide inventories. DOE/SNL determined that "None of the conclusions [with respect to waste packaging materials and waste volumes] have an impact on PA". DOE/SNL further concluded that with respect to radionuclides, "some of the… [issues]...result in a need to revise the CRA-2004 TRU waste inventory, but none have a significant effect on PA." However, as a result of these discoveries and other issues raised by EPA, DOE was directed by EPA to revise certain inventory parameters for use in the PABC. These changes are presented and discussed in Chapter 4 of this report.

The procedures described above in this section summarize the manner in which DOE developed the inventory of stored and projected wastes at each generator site. In addition, since the CCA was approved, significant quantities of TRU waste have been shipped to the WIPP. This material, designated emplaced waste, must also be included in the baseline inventory. At the CRA inventory cutoff date of September 30, 2002, 1,255 shipments with a total volume of

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[3] In earlier SNL documentation, this report was referred to as Harvill 2004.

7,716 m^3 had been made to the WIPP (Leigh et al. 2005, Section 4.1.1).[4] DOE tracks the emplaced inventory through the WIPP Waste Information System (WWIS).

As described in CRA Appendix TRU WASTE (Section TRU WASTE-5.0), all waste sites planning to ship waste to WIPP must supply the required characterization data to the WWIS computerized data management system The system is used to gather, store, and process information pertaining to TRU waste disposed at the WIPP, and includes automatic certification-based compliance limit and quality assurance checks. The WWIS is designed, maintained, and operated in compliance with nuclear quality assurance requirements for computer software for nuclear facility applications. To ensure compliance with the data requirements, DOE reviews the data package for each container of each shipment for completeness and adequacy before notifying the shipping site of acceptance. DOE provides EPA with an annual report using information generated from the WWIS on waste parameters important to performance assessment, such as radioactivity of various radionuclides, quantities of CPR materials, quantities of ferrous metals, etc. WWIS data are also included in CRA Appendix DATA, Attachment D.

1.3 EPA'S REVIEW PROCESS

The Agency reviewed the DOE's inventory data acquisition and data manipulation processes to determine whether (1) the process was reasonable and well documented, and (2) PA input parameters could be traced back through the CRA to confirm data origin. This review did not examine the actual data values received from the sites for technical adequacy. Rather, the review was performed to ensure that an adequate process was used to assemble and interpret inventory information, and to ensure that PA parameters can be reasonably traced to the initial site inventory information.

The Agency performed site visits to the Oak Ridge National Laboratory, the Hanford Site, and Savannah River Site (SRS) to examine the TRU waste data acquisition processes at these sites. Site reports for each visit are provided in EPA Docket A-98-49: Items II-B3-78, II-B3-86, and II-B3-87. Detailed discussions of the Agency's site visits and conclusions are presented in Section 2 of this report. In addition, the Agency met with DOE/SNL representatives in Albuquerque to further discuss the data acquisition and transfer process from sites, as well as the data manipulation and review process performed after data receipt. EPA Docket A-98-49, Item II-B2-43 presents the EPA meeting report for this activity. Through the course of these meetings, the Agency gained an understanding of the data assembly process at a sample of the TRU waste sites, as well as how this information was examined, reviewed, modified, and manipulated by DOE for inclusion in the CRA and PABC. Through this analysis, the Agency attempted to verify that information within the CRA was consistent and traceable within the various chapters, appendices, attachments, and annexes.

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[4] As of August 1, 2005, the total volume of waste shipped to the WIPP was 30,719 m^3, including all of the CH TRU waste from Rocky Flats Environmental Technology Site (RFETS) (Leigh et al. 2005, Section 4.1.1), currently designated at the Rocky Flats Closure Project.

2.0 VERIFICATION OF THE INVENTORY ASSEMBLY PROCESS

The CCA included the *Transuranic Waste Baseline Inventory Report, Revisions 2 and 3* as Appendix BIR2 and Appendix BIR, respectively, that presented detailed waste profile forms, as well as additional radionuclide and waste material information pertinent to PA. This information was carefully reviewed by EPA in making its compliance certification for the WIPP. Most, if not all, of the information used to assemble these data, was based upon the knowledge of waste-generating processes at the TRU waste sites, including historic sampling data, safeguards measurement data, etc. The sum of this information is referred to as Acceptable Knowledge. Also included in the CCA was a waste characterization process that would provide measurement system information to better define the waste inventory as it was being characterized for shipment. Since approval of the CCA, significant TRU waste shipments have been made to WIPP. Also, characterization activities, programmatic changes, waste management modifications, and other factors have changed the TRU waste inventory with respect to the estimate presented in the CCA. As a result, DOE initiated an overhaul of the information contained in TWBIR Revisions 2 and 3, referred to herein as the *2003 Update Report*, updating each waste profile originally included in the CCA, and identifying new waste streams not addressed in the TWBIR Revisions 2 or 3. This new information ultimately served as input to the CRA. The Agency has reviewed the data acquisition and inventory assembly process for the CRA[5] to ensure that the activities performed were reasonable and adequate for use in PA.

Figure 1-1 presents the overall DOE data assembly process used to update and revise the CCA/PAVT inventory. The Agency has examined the data acquisition process in detail to gain a thorough understanding of these data acquisition and review activities that ultimately resulted in the CRA inventory presented in the *2003 Update Report* (CRA, Appendix DATA, Attachment F). To do so, the Agency met with DOE and its contractors to gain a detailed understanding of the data assembly process. The Agency also traveled to three sites—Hanford, Oak Ridge, and Savannah River—to see first-hand how information was assembled, evaluated, and transferred from these sites. Additionally, the Agency obtained information exchange requests between DOE (or their contractors/representatives) and sites to gain a complete picture of how issues were resolved and documented.

2.1 INVENTORY INFORMATION ASSEMBLY AND REVIEW PROCESS

In addition to site visits, the Agency reviewed several documents applicable to the inventory data assembly and analysis process performed by DOE. Documents reviewed included the following:

- AP-92, *Analysis Plan for Transuranic Waste Inventory Update Report, 2003*
- SP 9-6, *Nuclear Waste Management Program Procedure SP 9-6, Baseline Inventory Report (BIR) Change Report Data Collection and Entry, Revisions 1 and 2*

[5] As noted earlier, based on its review of the CRA submitted by DOE in March 2004, EPA determined that the PA required revision. This revision, designated the PABC, relied to a large extent on information included in the CRA and its supporting documents. Consequently, most of EPA's review of the CRA is equally applicable to the PABC and, except as specifically noted, a CRA review can be considered a CRA/PABC review.

- NP 6-1, *Nuclear Waste Management Procedure NP 6-1 Document Review Process, Revision 5*

- NP 17-1, *Nuclear Waste Management Procedure NP 17-1, Records, Revision 5*

- NP 5-1, *Nuclear Waste Management Procedure NP 5-1, Implementing Procedure*

The general baseline inventory data collection, entry, review, revision, and finalization process is best described in SP 9-6. As presented in that document, the activities performed to develop an update of the TWBIR were conducted by both LANL and SNL under a Memorandum of Agreement. LANL staff were responsible for technical work associated with data collection, entry, and some data calculations, while SNL staff provided a quality assurance (QA) function for the activity, as well as technical assistance. Controls were established by written procedures/instructions prepared in accordance with NP 5-1, and other applicable QA procedures were also followed. The first activity performed was "Request and Obtain Transuranic Waste Inventory Data Updates." This was performed by sending a letter (examples of which were attached to SP 9-6) to each TRU waste site, requesting either an update of their existing waste profile for each waste, or a new waste profile for newly identified waste. Data requests as presented in Giambalvo (2002) were specifically identified.

Additionally, data collection personnel visited each large quantity site and several small quantity sites to help assemble and evaluate the applicable information. Original "in process" information obtained from the sites was submitted to the records center, after first being authenticated by the DOE site representatives, site subcontractors, or LANL Inventory Team Lead to attest to its accuracy and completeness. If a data entry person with LANL/SNL identified discrepancies, it was resolved by contacting the site, identifying the discrepancy, and requesting a response. When the response was received, it was authenticated and documented on the appropriate form. All forms, when completed, were to be submitted to document control. If, after the discrepancy resolution process was completed, even more information was necessary from the site, an additional information request was submitted. This request would be made, for example, when a site initially contacted failed to respond. This second data request, as well as failures to respond, subsequent responses, or new discrepancy resolution correspondence, was placed in the site data file. As part of the data acquisition activities, waste streams deleted for various reasons from the previous inventory report were identified and documented. After all possible data issues were resolved, a final data confirmation was performed. All files were then submitted to the records center, per procedure NP 17-1. Figure 1-1 presents the general data acquisition process. The types of information requested as part of the data call are summarized as follows (Giambalvo 2002):

- Waste stream volumes

- Radionuclide inventory by waste stream including Am-241, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241, U-233, U-234, U-235, U-236, U-238, Cs-137, Sr-90, Am-243, Np-237, Pu-242, Pu-244, Th-239, Th-230, and Th-232

- Waste material parameters

- Other non-radioactive materials that are a significant portion of that waste stream as a result of change to that waste stream

- Cellulosics, plastics, and rubber

- Sulfate, nitrate, and phosphate

- Other WIPP scale inventory needs

These inputs to the baseline inventory are unchanged from the CCA/PAVT and since no new needs have been identified, the data call requirements outlined above provide an adequate basis for updating the inventory.

The Agency met with DOE representatives to verify this understanding of the data request and assembly process. For example, during a meeting in Albuquerque, New Mexico (Docket A-98-49, Item II-B2-43), representatives shared information summarized above, as well as information shown in Figure 1-1. The representatives also offered the following information to further explain not only the original data assembly process, but how additional issues identified since submittal of the CRA in March 2004 were being addressed.

Issues identified and potential changes included the following:

- Two site-driven changes have been made and are related to corrections made to the Hanford waste stream (reduction of volume) and the addition of INL pre-1970 buried wastes.

- A number of changes have been made to the inventory data based on reviews that have been performed and changes that have been requested by the sites.

- The cut-off date for the CRA-2004 was September 30, 2002, although updates have now been included in Data Version 4.10 of the TWBID.

- Data are being revised for an update that includes INL pre-1970 buried waste, Hanford tank wastes, corrections from Hanford over-reporting and changes made based on assessment of reviewers comments.

These issues are discussed in greater detail in Section 4.

2.2 SITE VISITS

To verify data assembly at generator sites, the Agency traveled to three sites—Hanford, Oak Ridge, and Savannah River—to discuss the information assembly and transfer process at the generator site level. Results of each trip with respect to inventory data assembly are discussed below and site visit reports are included in EPA Docket A-98-49 (for ORNL:II-B3-86, for SRS: II-B3-87, for Hanford: II-B3-75).

2.2.1 Hanford Site CRA Data Assembly

All inventory, not just TRU waste, is tracked by Hanford Solid Waste. TRU program wastes are dealt with as a separate activity (TRU Waste Management which characterizes waste in accordance with EPA requirements), but the focus of that activity is short term and limited in scope, examining only waste that is ready to ship. However, the overall focus of Solid Waste is broad and encompasses the entire waste population, including those wastes not yet ready to ship (forecast wastes). Also, Solid Waste deals strictly with waste in burial grounds and above-ground storage. Waste in tanks is characterized under the River Protection (RP) program, which includes high-level waste (HLW).

The Solid Waste Information Tracking System (SWITS) monitors existing individual containers in a database. A second database, SWIFT (Solid Waste Information Future Tracking), was instituted in the 1990s, and monitors the "to-be-generated" waste population. When the data request was first received for updated baseline inventory information, the information was processed within the Hanford database(s), and output was made consistent with the data call. .

Data inputs were discussed with respect to completion of new Waste Stream Profiles, including data input quality control measures and data entry checks during acceptance for SWITS, recognizing that at Hanford, the "ability to change [input] information is controlled by roles." SWITS is set up for configuration control and data management—onsite generators input waste information (presumably to SWITS), and send paperwork to the Solid Waste acceptance group, who checks the paperwork against SWITS input. The container then moves to "operations," at which point the generator can no longer make any changes. Changes to isotopic data are "done by roles" and changes are tracked. With respect to SWIFT, two data calls per year are sent.

The general data acquisition process with respect to forecast waste was also discussed. The process for acquiring waste forecast data is as follows:

(1) Prepare data call
(2) Issue a call to data generators
(3) Complete forecast at generator level and then send to Fluor Hanford
(4) Review and approve the forecast, after which the data are "frozen"
(5) Publish the data

The type of information collected in SWIFT, i.e., by container level (as available) and waste type, includes radionuclide concentrations, physical waste forms (final waste forms), hazardous waste identification, waste descriptions, and background on generating source and uncertainties.

The forecast data collection process includes establishing assumptions, collecting data and notes, entering data into SWIFT, acquisition of approvals, and sending of documents to management. A checklist is used to compare previous and current forecasts.

Configuration controls were also discussed, including the use of approval forms, retention of originally submitted data, maintenance of the database on a secure server, and release of SWIFT reports via the Hanford Document Control System. Changes to forecasts that are made based on discussion with generators are placed in the Forecast File and are documented in the forecast itself. Factors contributing to uncertainty in the forecasting process were also addressed. These included estimation of the types of wastes received, technical hindrances, regulatory constraints, and programmatic decisions (i.e., CERCLA decisions, etc.).

As part of the meeting, SNL representatives described the *2003 Update Report* data call process and how the Hanford site responded to this data call. SNL received data from generator sites, input this data into Microsoft Access (if not received in Access format), then input this information into the TWBID Revision 2.1 database qualified under NP19-1. SNL representatives then examined activity concentration, waste matrix code density, and the number of containers, all of which are required for input into the revised TWBID. The database automatically assigned a volume based on the number and type of containers. After data input, SNL performed a verification step and, if any problems were identified, they contacted the generator sites with questions. Verification was done independently from input under procedure SP 9-6.

Once data were verified, a second verification was done by SNL that followed the same documentation pathway, but this verification was performed by upper management. A screening step is performed to look for excluded wastes (i.e., PCBs, unknowns, pre-1970 waste, liquids, greater than 23 Ci/l waste). Streams identified by this step were separated out from the WIPP eligible pool (see CRA Appendix DATA, Attachment F, Annex I). At this point, eligible wastes went to the "transorigen interface" and then into ORIGEN 2.2 (qualified under SNL WIPP Procedure NP 19-1, *Software Requirements*), decaying the inventory to a common start date of December 31, 2001.

For wastes in overpacks, SNL adjusted the volumetric data and radionuclide concentrations. As a result of this action, a new volume for wastes in Ten Drum Overpacks (TDOPs) was derived, as well as new waste material parameter amounts and radionuclide totals. These data were the source of information for tables that provided input to PA, i.e., Appendix DATA, Attachment F. Only Hanford and LANL provided data to SNL in Microsoft Access; all other sites provided information that had to be manually input into the Access database.

2.2.2 Oak Ridge National Laboratory CRA Data Assembly

Prior to the site visit, the Agency posed 12 questions about the Oak Ridge TRU waste inventory and data assembly process, and ORNL provided a written response to each of the 12 questions prior to the meeting (Docket A-98-49, Item II-B3-86). A cross reference was prepared that showed how each of the original 16 TWBIR Revision 2 waste streams was consolidated into the 9 waste streams for the *2003 Update Report*. ORNL intends to follow the Waste Analysis Plan (WAP)6 and the Waste Acceptance Criteria (WAC)(DOE 2002) requirements with respect to waste characterization, but offered no numeric uncertainty values for the current inventory estimates, noting that current values in the CRA were derived primarily through Acceptable Knowledge. The ORNL Data Management Process was provided, showing that data are currently obtained from the generators and documented on Form 2109. The database used to

[6] The WAP addresses requirements of the New Mexico Environmental Department Hazardous Waste Permit.

track information, the Waste Information Tracking System, or WITS, is under configuration and quality control.

With regard to organic ligands (or complexing agents), ORNL representatives indicated that no ligands are expected to be in the final waste form anticipated for shipment to WIPP, and that no (additional) CPR will be used in packaging. ORNL representatives indicated that there is only a low possibility that additional waste streams may be added to the current inventory. Sorting, segregation, size reduction, in-drum compaction, and drying of sludge were identified as waste form modifications that will take place. Site representatives indicated that they may "waste load" (i.e., combine less than 100 nCi/g waste with greater than 100 nCi/g waste from the same waste stream), but every attempt is being made to send as much waste possible to the Nevada Test Site (NTS). No inventory changes have occurred between the CRA submittal (based on September 30, 2002, data) and the July 2005 meeting.

2.2.3 Savannah River Site CRA Data Assembly

At the April 2005 meeting, EPA reviewed a flowchart describing the SRS management process for TRU waste, and toured the TRU waste storage, handling, and processing facilities in E Area (see Docket A-98-49, Item II-B3-87). SRS has TRU waste located on pads and old burial grounds. The waste in the old burial grounds is not part of the WIPP inventory. That waste is pre-1970, and is the subject of a CERCLA decision to remain in the burial ground. The waste on the pads is the inventory intended for WIPP. All waste at SRS intended for WIPP is considered to be debris waste.

At SRS, the Computerized Burial Record Archive (COBRA) database was the primary data repository until 1998. COBRA was a keypunch-driven system populated primarily with information from the Burial Ground Record forms. In 1998 SRS adopted the TRU Waste Characterization (TWC) database, which was initially populated by a download of the COBRA information. Since that time the TWC has been populated using information from the TRU Waste Container Characterization Form (OSR 29-90). COBRA was used to generate the information for the CCA; the inventory for the CRA was generated from TWC database.

One of the facts that emerged at the meeting was that the iron inventory from the TDOPs was not included in the waste material parameters for the CRA, because SRS began using TDOPs after the cutoff date for submission of the CRA inventory data. This increased iron inventory was not added to the PABC inventory. However, this is not an issue for PA, because sufficient iron is already present in the PABC inventory to meet the minimum repository requirement of 2×10^7 kg. This requirement is based on the need to have sufficient iron present to maintain the desired redox conditions in the repository. This ensures that radionuclides are in their lower, less soluble oxidation states. It can be deduced from Table 11 of Leigh et al. (2005) that the amount of ferrous metals in packaging materials exceeds the minimum requirement shown in CRA Appendix TRU WASTE, Table TRU WASTE-16.

Based on the technical discussions, EPA concluded that the manner in which SRS data were collected, analyzed, and transferred to the baseline inventory was transparent and appropriate.

2.3 SNL/LANL DATA CALL REVIEW AND REVISION

As part of the Agency's evaluation of the data assembly, transfer, manipulation, modification, and completion process, the information exchanged between DOE and generator sites was examined to understand the complete documentation paper trail, and specifically to understand how issues were identified and resolved. The Agency requested examples of selected information exchanges between DOE/SNL personnel assembling the TWBID, Revision 2.1 and TRU waste sites to understand the "paper trail" associated with the inventory update, and how issues, if identified, were resolved. EPA requested information for waste streams present at several facilities. Table 2-1 presents the waste streams about which the Agency requested information, including preferred waste streams and possible alternatives.

Table 2-1. Waste Streams Examined to Evaluate the Inventory Data Assembly Process

Waste Type	Suggested Waste Streams	Alternative Waste Streams
Emplaced CH TRU Waste	RF009.01 Rocky Flats Pyrochemical Salts W027-FB-Pre86c, SRS Heterogenous Debris	WP-LA-TA 55-43.01 Debris Waste, Los Alamos WP-RF001.01 Rocky Flats Combustible Debris SR-W027-221F-HETA, SRS Heterogenous Debris
Eligible, Unshipped CH TRU Waste (as of 2002)	IN-W157.144 Special Set-Up Sludges, INL NT-W001 Heterogeneous Debris, Nevada Test Site	RP-W755 Bismuth Phosphate Solids, Hanford River Protection IN-BN-510 Idaho Supercompacted Debris Waste RF W122 Organic Resins, Rocky Flats RF TT3011 Heterogeneous Debris, Rocky Flats
RH TRU Waste	OR-W213 Oak Ridge Soils	OR-W215 Oak Ridge Solidified Sludge

Of the options listed, DOE provided information on waste streams RF009.01, W027-FB-Pre86c, SR-W027-221F-HETA, IN-BN-510, RF-(TT)MT0375A/B, and OR-W213. Table 2-2 presents the information provided for each of these waste streams.

Table 2-2. Waste Stream Traceability Data Provided to EPA for Review

Waste Type	Selected Waste Streams	Traceability Information Provided	Reference Number
Emplaced CH TRU Waste	RF009.01 Rocky Flats, Pyrochemical Salts W027-FB-Pre86c, SRS, Heterogenous Debris SRW027-221F-HETA, SRS, Heterogenous Debris	Waste Stream Profile Forms, each stream	WSPattachment.pdf
Eligible, Unshipped CH TRU Waste (as of 2002)	IN-BN-510 Idaho Super-compacted Debris Waste RF TT0375A/B Heterogeneous Debris, Rocky Flats	Information Transfer Logs, Emails, portions of spreadsheets/databases, Form SP 9-4 Change Request Logbook Sheet,	ERMS 526770, 526771, 526772, 526774, 526776, 536313 526791, 528533, 526788 (all RFETS waste), 526792 (all RFETS waste), 526902 (all RFETS waste)
RH TRU Waste	OR-W213 Oak Ridge Soils		526595, 526596

For the emplaced waste, copies of the Waste Stream Profile Forms were provided, noting that physical, chemical, and radiological characteristics of these wastes were obtained through direct measurement or other examination techniques employed as part of the EPA-approved characterization process.

The Agency examined the information provided to determine whether questions regarding the original inventory were adequately documented. In general, the information provided documentation that questions posed had been, at least in part, addressed, but the documentation was sometimes incomplete and difficult to follow. In the case of waste stream IN-BN-510, the documentation could not be followed without supplementary information. This waste stream is composed of about 50 individual waste streams identified in the 1996 TWBIR Revision 2, which are now to be combined into a single large newly generated waste stream that will ultimately be examined, assayed, and supercompacted. DOE provided the following explanation of the IN-BN-510 paper trail (Crawford 2005):

> *The IN-BN-510 information required clarification regarding traceability to TWBIR Rev. 2, final form waste containers, and assignment of TWBIR Rev. 2 waste streams to the waste stream identified in the Transuranic Waste Inventory Update Report in December 2002 (McTaggart, 2002). The radionuclide speciation and content of the IN-BN-510 waste stream were questioned in November 2002 (McTaggart, 2003a). Additional questions regarding radionuclides, waste packaging, and comments submitted by the site describing treatment scenarios (McTaggart, 2003b) and requests for decay or assay dates for radionuclide decay correction were made in January 2003 (McTaggart, 2003c). In February 2003, documentation of all data files related to the IN-BN-510 waste stream were submitted (Sparks, 2003a). Finally, revised data on radionuclide content of IN-BN-510 were received from the site in response to*

questions that were addressed after completion of a WIPP internal review of the inventory data in February 2004 (Torres, 2004).

The Agency examined information provided by DOE regarding this waste stream to confirm the above discussion and to better understand how issues were identified, tracked, and resolved. A general understanding of data transfer could be obtained by reviewing the provided files. However, for waste stream IN-BN-510, without the above explanation by the site representatives, the specific issues and resolution of those issues could not be directly obtained by just examining the "paper trail."

2.4 CONCLUSION

The Agency met with DOE, SNL, and LANL personnel to gain a detailed understanding of the data assembly, review, revision, and finalization process. Additionally, the Agency traveled to three separate TRU waste generating sites to see, first hand, how the TRU waste inventory data are assembled at the sites and transferred to LANL/SNL. The Agency reviewed several controlled documents and procedures pertaining to the inventory generation and revision process, reviewed the paper trail between generator sites, and interviewed LANL/SNL personnel to better understand how issues and questions were resolved.

The data acquisition, review, documentation, and assembly process associated with the *2003 Inventory Update* is adequately documented and appears to be sufficient with respect to establishing a general protocol and methodology for acquiring the information. However, the paper trail is not always consistent or transparent. Implementation of new procedures put into place after the initial data calls for the CRA should improve the system, but care must be taken by DOE to ensure that all inventory changes and manipulations are carefully documented and are readily traceable.

3.0 CHANGES TO THE CCA/PAVT INVENTORY FOR THE CRA

As noted in Section 1.1, the inventory used for the CCA and the PAVT was contained in the *TWBIR Revisions 2 and 3*. The inventory used for the CRA, as described in the *2003 Update Report* (CRA, Appendix DATA, Attachment F) was based on site inventories as of September 30, 2002. Principal changes which occurred in the 6 years since TWBIR Revision 3 was published include the following:

- Emplacement of 7,716 m^3 of CH TRU waste at the WIPP
- Inclusion of waste from the INL Advanced Mixed Waste Treatment Facility process, by which 55-gallon drums are compacted and put into 100-gallon drums
- Deletion of product from future waste thermal treatment at INL described in the TWBIR Revision 3, since the process was never implemented
- Inclusion of 7,095 m^3 (250,595 ft^3) of stored Hanford tank waste that was added to the inventory
- Inclusion of updates to site Waste Stream Profiles that were reported in TWBIR Revision 2[7]

3.1 WASTE VOLUMES

Waste volumes developed for the CRA are compared with waste stream volumes for the CCA/PAVT in Table 3-1 (CRA Appendix DATA, Attachment F, Annex B, Table DATA-F-B-3). (Anticipated waste volumes are the sum of projected and stored waste volumes.) The "Difference" columns in Table 3-1 are obtained by subtracting the CCA/PAVT inventory from the CRA inventory.

[7] Waste stream profiles were unchanged between TWBIR Revision 2 and Revision 3. Additional data on waste inventory components were compiled in Revision 3.

Table 3-1. Comparison of Stored, Projected, and Anticipated TRU Waste Volumes (m^3) Between *2003 Inventory Update* and *TWBIR Revision 2*

Volume Source	2003 Update Stored	TWBIR Revision 2 Stored	Difference in Stored	2003 Update Projected	TWBIR Revision 2 Projected	Difference in Projected	2003 Update Anticipated	TWBIR Revision 2 Anticipated	Difference in Anticipated
CH TRU Waste at Sites	1.09×10^5	5.81×10^4	5.14×10^4	2.47×10^4	5.36×10^4	-2.89×10^4	1.34×10^5	1.12×10^5	2.20×10^4
CH TRU Waste Emplaced	7.72×10^3	0.00×10^0	7.72×10^3	0.00×10^0	0.00×10^0	0.00×10^0	7.72×10^3	0.00×10^0	7.72×10^3
Total CH TRU Waste	1.17×10^5	5.81×10^4	5.91×10^4	2.47×10^4	5.36×10^4	-2.89×10^4	1.42×10^5	1.12×10^5	2.97×10^4
RH TRU Waste at Sites	5.31×10^3	3.61×10^3	1.70×10^3	1.04×10^4	2.30×10^4	-1.35×10^4	1.57×10^4	2.72×10^4	-1.15×10^4
Total TRU Waste	1.23×10^5	6.17×10^4	6.08×10^4	3.51×10^4	7.74×10^4	-1.23×10^4	1.58×10^5	1.39×10^5	1.82×10^4

Changes in waste volume, per se, have no effect on PA, since the projected volumes are scaled to the statutory limits of 7.08×10^3 m^3 for RH and 1.68×10^5 m^3 for CH TRU waste. However, changes in projected waste volumes can affect the radionuclide content of the scaled projected waste streams. As can be seen in Table 3-1, the anticipated volume of RH TRU wastes (1.57×10^4 m^3) for the CRA exceeds the limit, so the volume of projected waste is scaled downward by a factor of 0.172 to meet the limit (Appendix DATA, Attachment F, Table DATA-F-8). Conversely, since the anticipated and emplaced volume of CH TRU waste, 1.42×10^5 m^3, is less than the limit, projected wastes are scaled upward in the CRA by a factor of 2.11 to reach the limit.

The stored and anticipated CH TRU waste volume in Table 3-1 for the *2003 Update Report* (1.42×105 m^3) is 26.5% higher than in the TWBIR Revision 2. Increases in estimates of stored waste at INL, SRS, Hanford, and RFETS reflect new data and increased accessibilty to the waste. At Hanford, tank wastes handled by the Office of River Protection (Hanford-RP), had been identified in the TWBIR Revision 2, but not included in the CCA/PAVT. Subsequently, these wastes were added to the CRA inventory. On the other hand, estimates of projected CH TRU wastes are lower in the CRA than in the CCA/PAVT. This change is consistent with progress in site clean-up and decommissioning activities where projected wastes have been converted to stored wastes.

As shown in Table 3-1, stored RH TRU wastes increased from 3.61×10^3 m^3 in the CCA/PAVT to 5.31×10^3 m^3 in the CRA. Hanford increased the volume of wastes under the aegis of Richland Operations Office (Hanford-RL), based on new information, and added the Hanford-RP wastes. ORNL moved all of its RH TRU waste from the stored category in the CCA/PAVT to the projected category in the CRA, based on a decision to process all their RH waste using segregation, size reduction, and evaporative drying (Leigh et al. 2005, Section 4.1.2.2). Projected RH TRU waste volumes decreased by 1.35×10^4 m^3 from the CCA/PAVT to the CRA (Table 3-1). Most of this is based on a reassessment of projected wastes at Hanford-RL.

Additional details on inventory changes between the CCA/PAVT and the CRA are included in Attachment A to this report.

3.2 RADIONUCLIDE INVENTORY

Since the radioactivity in each waste stream is not measured at the same time, the waste stream activities are decay-corrected to December 31, 2001, using the ORIGEN2 Version 2.2 computer code. The radioactivity based on scaled CH TRU waste volumes of each radionuclide in each waste stream is summed over all the waste streams to give the total CH TRU waste activity for each nuclide. This activity is divided by the allowable CH TRU waste volume of 168,485 m^3 to determine the activity concentration in Ci/m^3. The process is duplicated for RH TRU waste using a volume limit of 7,079 m^3. The total radioactivity associated with CH TRU waste in the CRA is 5.33×10^6 Ci (decayed to December 31, 2001), as compared to 6.42×10^6 Ci (decayed to December 31, 1995) in the CCA/PAVT (Appendix DATA, Attachment F, Annex B, Table DATA-F-B-27). As shown in Table 3-2, the five most significant radionuclides in the waste—Am-241, Pu-238, Pu-239, Pu-240, and Pu-241—contribute 97.2% of the total CH TRU waste activity in the CRA and 99.0% in the CCA/PAVT.

Table 3-2. Most Important Radionuclides in CH TRU Waste Inventory

Radionuclide	Radioactivity in CCA/PAVT[1] (Ci)	Radioactivity in CRA[2] (Ci)
Am-241	4.42×10^5	4.01×10^5
Pu-238	2.61×10^6	1.61×10^6
Pu-239	7.85×10^5	6.60×10^5
Pu-240	2.10×10^5	2.40×10^6
Pu-241	2.31×10^6	5.18×10^6
Fraction of Total Inventory	99.0%	97.2%

[1] Decayed through 1995
[2] Decayed through 2001

Similar information on the five most significant radionuclides in RH TRU waste is presented in Table 3-3 (Appendix DATA, Attachment F, Annex B, Table DATA-F-B-28). The total RH TRU waste inventory in the CCA/PAVT is 1.02×10^6 Ci while that in the CRA is 1.33×10^6 Ci. These values are substantially lower than the RH TRU waste limit of 5.1 million curies specified in the WIPP LWA (PL102-579).

Table 3-3. Most Important Radionuclides in RH TRU Waste Inventory

Radionuclide	Radioactivity in CCA/PAVT[1] (Ci)	Radioactivity in CRA[2] (Ci)
Ba-137m	2.04×10^5	3.36×10^5
Cs-137	2.16×10^5	3.65×10^5
Pu-241	1.42×10^5	1.12×10^5
Sr-90	2.09×10^5	2.46×10^5
Y-90	2.09×10^5	2.43×10^5
Fraction of Total Inventory	96.1%	97.6%

[1] Decayed through 1995
[2] Decayed through 2001

For use in PA, these inventories are decayed using the ORIGEN2 Version 2.2 computer code to 2033, the assumed closure date for the WIPP, and to various dates up to 10,000 years to assess the effects of various intrusion times on disturbed repository performance scenarios (e.g., see Appendix PA, Attachment PAR, Table PAR-50).

3.2.1 Isotopic Decay Calculation Checks

To assess whether the ORIGEN2 Version 2.2 decay calculations were performed correctly, selected isotopes were decayed independently using this code. Results of these decay calculations are presented in Attachment B to this report. Decay calculations show that on a spot-check basis, the ORIGEN2 values derived by DOE and used in EPAUNI[8] were done correctly.

In addition, spreadsheets were developed to assess the decay of Np-237 with respect to the potential need for inclusion in PA. Results of this analysis are also presented in Attachment B of this report, based on the three spreadsheet comparisons. The first spreadsheet presents the calculation of activity for Pu-241, Am-241, and Np-237 using a three-isotope Bateman equation formulation. Values were calculated at 100-year intervals to 10,000 years, with initial values taken from Table 4-7 of the CRA, which provides the repository inventories at closure (defined as 2033). The second spreadsheet presents a set of validation calculations on the formulation to ensure the expected conservation of atoms. The third spreadsheet provides a summary of the results. As expected, based on a 14.4-year half-life, the Pu-241 is effectively gone within 100 years, and the Np-237 builds up to a relatively small, almost equilibrium value of about 100 curies. For perspective, the total radioactivity in the CH TRU waste inventory after 10,000 years is about 5.3×10^5 curies (Appendix PA, Attachment PAR, Table PAR-60). Thus, Np-237 is less than 0.02% of the total. This confirms DOE's decision to omit the Np-237 isotope in PA.

3.3 NON-RADIOACTIVE MATERIALS

It is also necessary to track certain non-radioactive materials in the waste, since these can also affect PA. For example, the quantities of cellulosics, plastics, and rubber (CPR) can affect gas generation and consequently pressure within the repository. Certain chemical species can act as complexing agents affecting the solubility of actinide elements within the waste leading to higher releases from the repository. Ferrous metals can corrode, also contributing to gas generation. They also reduce water in the repository and stabilize the redox conditions in a favorable manner. Certain anions can facilitate microbial reactions within the repository. These materials may be associated with the waste streams or with the waste packaging materials.

3.3.1 Waste Material Parameters

Table 3-4 compares the average waste material densities for CH TRU waste used in the CCA/PAVT and the CRA (Leigh et al. 2005, Table 9). The waste material densities are obtained by rolling up the waste material masses and waste stream volumes for each waste stream, as described in Appendix DATA, Attachment F, Section DATA-F-3.2.1.2.

The data in Table 3-4 show that generally small changes occurred in the waste material densities of CH TRU waste between the CCA/PAVT and the CRA. Such changes are to be expected as more information is gathered on waste streams between the two inventories. Quantities of metals were smaller in the CRA, as were vitrified materials, cement, and soils. CPR materials, solidified organic and inorganic materials, and other inorganic materials increased in the CRA. The increase in CPR materials is attributable, in large measure, to a decision made by INL, after the CCA/PAVT inventory had been developed, not to thermally treat certain waste streams, but rather to supercompact them, a process that does not destroy the CPR materials.

[8] EPAUNI is a computer code that calculates the activity per m^3 for each waste stream at a discrete set of times.

Table 3-4. Comparison of CCA/PAVT and CRA Waste Material Inventories for CH TRU Waste

Waste Material	CRA Average Density (kg/m^3)	CCA/PAVT Average Density (kg/m^3)
Fe-Base Metals/Alloys	1.1×10^2	1.7×10^2
Al-Base Metals/Alloys	1.4×10^1	1.8×10^1
Other Metals/Alloys	3.0×10^1	6.7×10^1
Other Inorganic Materials	4.2×10^1	3.1×10^1
Vitrified Materials	6.2×10^0	5.5×10^1
Cellulosic Materials	5.8×10^1	5.4×10^1
Rubber	1.4×10^1	1.0×10^1
Plastic	4.2×10^1	3.4×10^1
Solidified Inorganic Materials	7.7×10^1	5.4×10^1
Solidified Organic Materials	1.6×10^1	5.6×10^0
Cement (Solidified)	2.9×10^1	5.0×10^1
Soil	1.9×10^1	4.4×10^1

Similar data for RH TRU wastes are included in Table 3-5 (Leigh et al. 2005, Table 10). In the CRA, the metals content, the CPR content, and the other materials content are all reduced as compared to the CCA/PAVT.

Table 3-5. Comparison of CCA/PAVT and CRA Waste Material Inventories for RH TRU Waste

Waste Material	CRA Average Density (kg/m^3)	CCA/PAVT Average Density (kg/m^3)
Fe-Base Metals/Alloys	1.1×10^2	1.0×10^1
Al-Base Metals/Alloys	2.5×10^0	7.1×10^0
Other Metals/Alloys	3.2×10^1	2.5×10^2
Other Inorganic Materials	3.5×10^1	6.4×10^1
Vitrified Materials	5.7×10^{-2}	4.7×10^0
Cellulosic Materials	4.5×10^0	1.7×10^1
Rubber	3.1×10^0	3.3×10^0
Plastic	4.9×10^0	1.5×10^1
Solidified Inorganic Materials	3.9×10^1	2.2×10^1
Solidified Organic Materials	4.0×10^0	9.3×10^{-1}
Cement (Solidified)	8.79×10^{-1}	1.0×10^0
Soil	2.6×10^1	--

3.3.2 Complexing Agents

During the data call to develop the CRA inventory, none of the sites reported any changes to the quantities of complexing agents (also referred to as organic ligands) in the waste streams included in TWBIR Revision 3. However, TWBIR Revision 3 included two estimates; one based on the assumption that RFETS wastes stored at INL would be vitrified, thereby destroying the organic complexing agents, and one based on the assumption that the wastes would not be thermally treated. Since INL subsequently decided not to thermally treat the wastes, the appropriate estimate from TWBIR Revision 3 was used in developing the CRA inventory. In addition, some new waste streams were added in response to the CRA data call. For the CRA, the quantities of complexing agents in these new streams were added to the totals from TWBIR Revision 3.

Summary data for the two estimates are presented in Table 3-6. It can be seen from this table that the major change was associated with sodium acetate and sodium oxalate in the Hanford-RP wastes, which were not included in the CCA/PAVT

Table 3-6. Comparison of Quantities of Complexing Agents in CCA/PAVT and CRA (kg)

Site	Acetic Acid	Sodium Acetate	Citric Acid	Sodium Citrate	Oxalic Acid	Sodium Oxalate	Sodium EDTA
CCA Estimate							
RFETS	132	1,110	90	400	90	--	23
LANL	10	--	1,100.5	--	13,706	--	--
Hanford-RP	--	--	--	--	--	--	--
CCA Total	142	1,110	1190.5	400	13.796	--	23
CRA Estimate							
RFETS	132	1.110	90	400	90	--	25.6
LANL	10	--	1,100.5	--	13,706	--	--
Hanford-RP	--	7,400	--	--	--	33,940	--
CRA Total	142	8,510	1,190.5	400	13.796	33,940	25.6

3.3.3 Packaging Materials

In addition to non-radioactive materials contained in the waste streams, the waste packaging materials may contribute materials to the repository that can affect PA. Table 3-7 compares the quantities of packaging materials for CH and RH TRU waste based on the CCA/PAVT and the CRA. The CRA data are from Tables DATA-F-30 and 31, Appendix DATA, Attachment F, while the CCA/PAVT data are from Tables ES-1 and ES-2 of the TWBIR Revision 3.

Table 3-7. Comparison of Container Packaging Materials in CCA/PAVT and CRA

Packaging Material	CRA Average Density (kg/m^3)	CCA/PAVT Average Density (kg/m^3)
For CH TRU Waste		
Steel	1.7×10^2	1.4×10^2
Plastic and Liners	1.6×10^1	2.6×10^1
Lead	1.4×10^{-2}	0.0×10^0
For RH TRU Waste		
Steel	4.8×10^2	4.5×10^2
Plastic and Liners	1.4×10^0	3.1×10^0
Lead	4.4×10^2	4.7×10^2

The comparison in Table 3-7 shows an increase in steel packing materials and a decrease in plastics and liners for CH TRU waste. These changes are primarily attributable to the fact that currently more waste is expected to be placed in steel overpacks, such as 100-gallon drum overpacks and pipe overpacks, with an attendant decrease in the use of plastic liners.

3.3.4 Oxyanions in the Waste Inventory

CRA Appendix DATA, Attachment F, Table DATA-F-34, provides total masses for oxyanions, including nitrates, phosphates, and sulfates. Information on these chemical species is important to PA, because they can influence the amount of gas generation by microbial processes and the composition of the generated gases. The calculation of the oxyanion mass in the repository for the CRA is documented in Leigh and Sparks-Roybal (2003). As with organic ligands, sites were not required to update their inventory estimates for these components unless environmental restoration or D&D wastes were added to the inventory. Thus, the information presented in TWBIR Revision 3, Appendix B-6, served as a baseline for the CRA. The waste stream volumes were adjusted to the CRA volumes, and data on new waste streams from LANL and Hanford-RP were added. In addition, the oxyanion content for one RFETS waste stream was updated. Although the adequacy of the calculations and inventory information were not reviewed, the total estimated masses of nitrates (2.51×10^6 kg), sulfates (4.21×10^5 kg), and phosphates (1.05×10^5 kg) reported in Leigh and Sparks-Roybal (2003) were compared to the values in Attachment F, Table DATA-F-34, and these values were found to be equivalent. The masses of oxyanions developed for the CCA/PAVT are compared with those in the CRA in Table 3-8 (Leigh et al. 2005, Table 17).

The addition of phosphates to the oxyanion inventory in the CRA, primarily from the Hanford-RP tanks, is the most significant change in oxyanions from the CCA/PAVT to the CRA. While the molar quantities of sulfates and nitrates in the waste inventory are used in PA calculations, the quantity of phosphates is not. The phosphates can act as nutrients for the growth of microbial colonies, assuring that sufficient microbes are present to promote the modeled gas generation processes.

Table 3-8. Masses of Oxyanions Used in CCA/PAVT and CRA Performance Assessments

Generator Site	Nitrate (kg)	Sulfate (kg)	Phosphate (kg)
CCA/PAVT Estimate			
RFETS	1.27×10^4	4.44×10^4	--
INL	3.09×10^5	5.48×10^3	--
LANL	1.30×10^6	5.82×10^5	--
LLNL	--	8.51×10^4	--
Total	1.62×10^6	6.33×10^5	--
CRA Estimate			
RFETS	9.28×10^3	5.56×10^4	8.51×10^1
INL	7.82×10^5	1.03×10^4	--
LANL	5.56×10^5	3.18×10^5	--
Hanford-RP	1.14×10^4	3.54×10^4	1.05×10^5
LLNL	--	1.22×10^3	--
Total	2.51×10^6	4.21×10^5	1.05×10^5

3.3.5 Other Materials

The baseline inventory also includes estimates of the masses of cement and pyrochemical salts. Since this information is not used in PA, these materials are not discussed here. A list of all waste streams containing pyrochemical salts is included in CRA, Appendix DATA, Attachment F, Annex A. The mass of cement in the solidified TRU waste is discussed in CRA, Appendix DATA, Attachment F, Section DATA-F-3.2.3.1.

3.3.6 Materials Limits

DOE has established limits (minima or maxima) for the quantities of certain non-radioactive materials that can be included in the repository (CRA Chapter 4, Table 4-11). A ferrous metals minimum limit of 2×10^7 kg has been set to insure that sufficient iron is present so that radionuclides are reduced to their lowest and least soluble oxidation states. Based on the information presented in Tables 3-4, 3-5, and 3-7 above, the amount of ferrous metals in the repository at closure is estimated to be 5.1×10^7 kg—a value well in excess of the established minimum.

Similarly, DOE has set a limit of 2×10^3 kg of non-ferrous metals (CRA Chapter 4, Table 4-11). These metals are expected to complex with any organic ligands present to prevent the ligands from being available to increase actinide element solubility. Based on the data in Tables 3-4 and 3-5 above for Al-Base Metals/Alloys and Other Metals/Alloys, it can be estimated that the total mass of these materials is 7.4×10^6, which substantially exceeds the specified minimum. However, this information on masses of non-ferrous metals is not used in the CRA PA because thermodynamic data have become available for organic ligands, allowing the direct calculation of actinide complexation by the ligands in the FMT code.

DOE also set a maximum limit on the amount of CPR materials at 2.2×10^7 kg, since degradation of these materials by microbial processes can increase gas pressure in the repository due to CO_2 formation (CRA Chapter 4, Table 4-11). Based on the data in Tables 3-4, 3-5, and 3-7 above, the total mass of CPR materials is 2.2×10^7 kg—a value at the specified limit. Any further additions of CPR materials would require emplacement of additional MgO to sequester excess CO_2.

3.4 VERIFICATION OF CRA PARAMETERS USED IN PA

Since the completion of the CCA/PAVT, EPA has conducted three studies to verify and validate the parameters used in the CRA. These studies involved many of the inventory parameters discussed in this report. The first EPA study (*Review of WIPP Performance Assessment Parameter Database Migration Final Report*), completed in April 2003 and docketed in A-98-49 as Item II-B3-51, assessed the migration of the CCA/PAVT parameters to a new database (EPA 2003).

This review was necessitated by the fact that the CCA and PAVT parameter databases used to support performance assessment codes had been moved to a new database, a new operating system, and a new processor. In addition, some parameter values had been changed, and supporting documentation had been moved from Albuquerque to Carlsbad, New Mexico. The new parameter database—the Performance Assessment Parameter Database (PAPDB)—was designed to support the CRA calculations. To evaluate the accuracy of the data migration, EPA and its contractors reviewed the quality checks done by SNL, and visually compared the values of 113 key parameters in the old and new database. No discrepancies other than minor ones already uncovered by SNL were observed. All the values changed from the CCA to the PAVT were checked, and two discrepancies in the PAVT parameters were detected and corrected. EPA concluded that the migrated PAVT parameter database was adequate as corrected, and summarized their findings as follows:

> *Based on the review documented in this report, the Agency concludes that the CCA database has been adequately migrated. Similarly, the Agency also concludes that the PAVT database, as corrected by SNL, has been adequately migrated. The Agency also found that the changes to parameter values and metadata identified in this report are justified and appropriate. However, the Agency believes that the procedural inconsistencies, discrepancies, and independence issues noted in this report need to be corrected. Although the Agency does not believe that these procedural issues need to be addressed retroactively, they do not constitute good practice and should be corrected in future work.*

In December 2004, EPA published a TSD—*Technical Support Document For Section 194.23: Review of Changes to the WIPP Performance Assessment Parameters Since the Database Migration* (EPA 2004)—describing changes to the parameter database that had occurred from the time the database migration had been completed until the CRA PA was issued in March 2004. EPA's conclusions are noted below:

> *There were 128 new parameters and 203 changes to parameter values in the PAPDB since the Technical Baseline Migration was conducted in 2002 and 2003 that support DOE's Compliance Recertification Application. Accuracy of the data entry process was checked and found to be satisfactory. There were no transcription errors between the parameter entry forms and the entry of data into the computer database. Our review of the parameter entry forms found them to be adequate although the practice of permitting data entry staff to make changes to the data entry forms may result in data entry errors or data values not intended by the data originator. Although current procedures do not explicitly prohibit this practice, procedures should be modified to prohibit this practice. All parameter values in the PAPDB as of July 2004 appear correct and traceable to documentation justifying their values.*

The TSD also documents (in Table 7 of that report) the verification of numerous parameters used in PA that are not included in the PAPDB.

In addition to the detailed checking of all the parameters in the PAPDB described above, EPA, as part of its review of the WIPP waste inventory, conducted numerous cross checks of the inventory data located in various places in the CRA, including Chapter 4, Appendix PA, Attachment PAR, and Appendix DATA, Attachment F, and Appendix TRU WASTE, for consistency of data reporting in the various locations, and also spot checked the rolled-up values to ensure that the summed data were consistent with the individual waste stream data. No discrepancies were discovered in this review.

The third parameter review, which audits changes made from the CRA to the PABC, will be discussed in Section 4.4.

4.0 CHANGES TO THE CRA INVENTORY FOR THE PABC

As noted previously, DOE uncovered several discrepancies and changed situations during its review of the CRA inventory. DOE's documentation and review of these issues is described in Warren 2004 and Leigh and Crawford 2004. Concurrent with the DOE review of the CRA inventory, EPA was conducting an independent review. EPA raised questions regarding completeness and technical adequacy of the CRA inventory in comment letters to DOE, and DOE provided responses to each comment. EPA inventory questions were documented in Cotsworth 2004a, 2004b, 2004c, and 2004d, and Gitlin 2005. These items are included in Docket A-98-49 as Items II-B3-72, II-B3-73, II-B3-74, II-B3-78, and II-B3-79, respectively. DOE responses are documented in Detwiler 2004a, 2004b, 2004c, 2004d, 2004e, and 2004f, Piper 2004, Patterson 2005, and Triay 2005. (Docket A-98-49, Items II-B2-39, II-B2-38, II-B2-35. II-B2-34, II-B2-36, II-B2-37, II-B2-40, II-B2-47, and II-b2-41, respectively). This correspondence was supplemented by technical meetings involving DOE, EPA, and their contractors. EPA's comments and DOE's responses are summarized in Section 1.3 of Leigh et al. 2005.

Based on EPA's review of the CRA and the supplementary information supplied by DOE, EPA required that the CRA PA be rerun with certain modifications (Cotsworth 2005). As noted previously, the revised PA was designated the PABC. The inventory changes included in the PABC are discussed in Leigh et al. 2005. Data for the PABC inventory are contained in TWBID Revision 2.1, Data Version 4.16.

Major changes to the inventory between the CRA and the PABC are described in the following paragraphs.

Hanford Wastes

After submittal of the CRA data, Hanford-RL discovered that some waste streams had been double counted. Correcting this resulted in removal of nine waste streams (8350.0 m^3) of RH TRU waste and three waste streams (7362.6 m^3) of CH TRU waste for the PABC. In addition, a discrepancy in the Sr-90 and Ba-137m content of two waste streams was uncovered by Hanford-RL. Correcting this discrepancy resulted on a reduction of about 50% in the values used for these radioisotopes in the PABC.

As noted previously, in Section 3.0, one of the major changes to the CRA inventory was the inclusion of Hanford tank wastes. EPA discussed the Hanford tank wastes during a September 14 and 15, 2004, meeting at the site (Docket A-98-49, Item II-B3-75). Subsequent to the meeting, EPA requested additional documentation from DOE to show that the waste in 12 tanks was TRU waste and not high-level waste (HLW) (Cotsworth 2004d, Docket A-98-49, Item II-B3-78). Disposal of HLW at the WIPP is prohibited under the Land Withdrawal Act (PL 102-579). Both EPA and stakeholders had concerns as to whether or not the waste was properly classified. To further investigate the issue, EPA asked DOE to provide data on two CH TRU tank waste streams (RP-W754 and RP-W755) and two RH TRU tank waste streams (RP-W013 and RP-W016) stored in these 12 tanks. In addition, EPA had concerns that some K-Basin sludges added to the CRA inventory might also be HLW or Spent Nuclear Fuel (SNF) and requested additional data on waste streams RL-W445 and RL-W446.

DOE responded with information supporting their contention that the tank wastes and sludges were appropriately categorized (Patterson 2005). After additional dialogue with DOE, EPA concluded that the nine tanks containing residues from the Bismuth Phosphate Process (waste streams RP-W754 and RP-W733) are probably CH TRU wastes. In two of the three tanks presumed to contain RH TRU waste, a HLW liquid had been stored over a TRU waste sludge. DOE asserted that, after processing to remove HLW components, these waste streams would meet the WIPP waste acceptance criteria as RH TRU waste.

With regard to the K-Basin sludges, DOE indicated that any SNF fragments and other SNF components would be removed by processing, resulting in material that will meet the WIPP waste acceptance criteria.

Based on its review of these Hanford waste streams added since the CCA/PAVT, EPA decided that it was acceptable to include these waste streams in PA calculations for the PABC. (See 2005 EPA WIPP Issue Paper No. 3, Docket A-98-49, Item II-B1-5.) However, none of this waste would be approved for shipment to the WIPP unless it meets the applicable waste acceptance criteria for TRU waste.

Idaho National Laboratory Wastes[9]

Pre-1970 buried waste had been identified at INL, but had not been included in the inventory designated for WIPP. However, after a court decision made after the CRA inventory data call, DOE decided that the pre-1970 buried waste could be excavated, packaged, and shipped to the WIPP. INL identified five waste streams for inclusion in the PABC having a total volume of 17,997.6 m^3 (Leigh et al. 2005). In addition, data on the isotopic composition of waste stream IN-BN-510 was incorrectly reported in the CRA inventory, and this was corrected for the PABC. One other change involved the concentrations of radioisotopes in non-debris AMWTF waste, based on the number and type of final form waste containers.

Los Alamos National Laboratory Wastes

Review of the data on LANL waste stream LA-TA-55-48 indicated that the fissile gram equivalents (FGE) were about 10 times greater than acceptable for shipment to the WIPP. Volume data and FGE for this waste stream were changed.

[9] On February 1, 2005, the Idaho National Engineering and Environmental Laboratory (INEEL) was combined with Argonne National Laboratory-West, and the new entity was designated the Idaho National Laboratory (INL).

Rocky Flats Environmental Technology Site[10]

No substantive changes were made to the RFETS inventory for the PABC. A minor change was made designating some drums as "compressed" rather than supercompacted..

Other Sites

No substantive changes were made to the inventory for the other waste generator sites; however, the changes described above affect the scaled projected volumes for all sites.

Although none of the major issues with respect to inventory were thought to impact PA, a procedure (AP-113) was written that describes a process that will be followed for subsequent PA calculations based on the Leigh and Crawford (2004) improvement recommendations. This process is designed to ensure that the issues identified pertaining to the inventory are rectified. Specifically, AP-113 states the following:

> *Specific recommendations made in Leigh and Crawford (2004) and its supporting documents will be implemented under this scope of work....when a systematic omission or inconsistency identified in Harvill (2004)*[11] *was substantiated in Leigh and Crawford (2004) and its supporting documents, queries of the ...(TWBID)...will be run to identify other possible instances of the systematic omission so that they all can be corrected, even when each omission was not separately identified...*

Primary inventory areas that were addressed in this procedure include the following:

- Waste Stream Volumes—adequate reporting of final form volumes by viable payload containers

- Waste and Packaging Materials—revision of LANL packaging material densities and changes to assignments of packaging material densities where none were reported by a given TRU waste site

- Radionuclide Activities—correction of decay dates to a common start date on the waste profile forms; correcting Am-241 concentrations in INL, LANL, and SRS waste streams; addition of Sr-90 in ANL and ANL-E wastes; correction of Pu-241 under reporting in INL AMWTF wastes; removal of "unimportant" daughter products from waste profile forms; correction of Cm-244 concentration in LANL waste streams; correction of site reporting error for LA-TA-55-48 FGE

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[10] The Rocky Flats Environmental Technology Site (RFETS) is currently designated at the Rocky Flats Closure Project, and is a Department of Energy-owned clean-up and closure site.

[11] Harvill 2004 is the same as Warren 2004.

- Waste Stream Descriptions—correction of waste stream name, description, waste material parameters, final waste forms and other fields on waste profile forms

- EPA Codes—removal of redundant codes, correction of code identification errors

4.1 WASTE VOLUMES

Stored and projected waste volumes for the CRA and the PABC are presented in Tables 4-1 and 4-2 for CH TRU and RH TRU wastes, respectively (Leigh et al. 2005, Tables 5 and 6). The volumes in emplaced wastes were unchanged from the CRA to the PABC, remaining at 7.7×10^3 m^3.

Table 4-1. Comparison of CH TRU Waste Volumes for CRA and PABC

TRU Waste Generator Site	Stored CH TRU Waste (m^3)	Projected CH TRU Waste (m^3)	Stored CH TRU Waste (m^3)	Projected CH TRU Waste (m^3)
	PABC		CRA	
Hanford-RL	1.3×10^4	5.5×10^3	1.3×10^4	1.3×10^4
Hanford-RP	3.9×10^3	0.0×10^0	3.9×10^3	0.0×10^0
INL	6.1×10^4	1.8×10^4	6.1×10^4	1.2×10^2
LANL	1.2×10^4	3.3×10^3	1.2×10^4	3.3×10^3
ORNL	0.0×10^0	4.5×10^2	0.0×10^0	4.5×10^2
RFETS	5.4×10^3	2.8×10^3	5.4×10^3	2.7×10^3
SRS	1.3×10^4	2.4×10^3	1.3×10^4	2.4×10^3
SQS	1.2×10^3	2.9×10^3	1.2×10^3	2.8×10^3
Totals	1.1×10^5	3.5×10^4	1.1×10^5	2.5×10^4

Table 4-2. Comparison of RH TRU Waste Volumes for CRA and PABC

TRU Waste Generator Site	Stored RH TRU Waste (m^3)	Projected RH TRU Waste (m^3)	Stored RH TRU Waste (m^3)	Projected RH TRU Waste (m^3)
	PABC		CRA	
Hanford-RL	3.8×10^2	1.1×10^3	3.8×10^2	9.4×10^3
Hanford-RP	4.5×10^3	0.0×10^0	4.5×10^3	0.0×10^0
INL	2.2×10^2	0.0×10^0	2.2×10^2	0.0×10^0
LANL	1.3×10^2	0.0×10^0	1.2×10^2	0.0×10^0
ORNL	0.0×10^0	6.6×10^2	0.0×10^0	6.6×10^2
RFETS	0.0×10^0	0.0×10^0	0.0×10^0	0.0×10^0
SRS	0.0×10^0	2.3×10^1	0.0×10^0	2.3×10^1
SQS	9.5×10^1	3.1×10^2	9.5×10^1	3.3×10^2
Totals	5.3×10^3	2.1×10^3	5.3×10^3	1.0×10^4

From Table 4-1 it should be noted that the stored inventory of CH TRU waste was unchanged from the CRA to the PABC. Major changes in projected CH TRU waste inventory involved the addition of buried pre-1970 waste at INL and removal of three double-counted waste streams at Hanford-RL. Similarly, for RH TRU waste, Table 4-2 shows that stored waste is unchanged for the PABC and that projected waste is decreased by 7.9×10^3 m^3, primarily due to the deletion of double-counted waste streams at Hanford-RL.

Since the volume of emplaced plus stored plus projected CH TRU waste was greater for the PABC ($7.7 \times 10^3 + 1.1 \times 10^5 + 3.5 \times 10^4 = 1.5 \times 10^5$ m^3) than for the CRA ($7.7 \times 10^3 + 1.1 \times 10^5 + 2.5 \times 10^4 = 1.4 \times 10^5$ m^3), the scaling factor for the projected waste in the PABC was reduced to 1.48 from 2.11 used in the CRA. This scaling factor assures that allowable CH TRU waste capacity of 168,485 m^3 is fully accounted for in PA calculations.

For RH TRU waste, the volume of stored plus projected waste for the PABC is 7.4×10^3 m^3, as compared to 1.5×10^4 m^3 in the CRA. There is no emplaced RH TRU waste to date. Based on allowable repository limit of 7,079 m^3, the scaling factor for projected RH TRU waste in the PABC is 0.861 as compared to 0.172 in the CRA. The increase in the scaling factor is basically due to the reduction in projected RH TRU waste from Hanford-RL in the PABC.

4.2 RADIONUCLIDE INVENTORY

Based on the waste stream changes discussed above at the beginning of Section 4.0 and the revised scaling factors discussed in Section 4.1, which affect projected waste stream volumes and, consequently, activity levels, the total activity at closure (2033) is estimated in the PABC to be 3.53×10^6 Ci from all radionuclides (Leigh and Trone 2005). In calculating release limits used to assess compliance with 40 CFR 191.13, it is necessary to know the number of curies of transuranic alpha-emitting radionuclides with half-lives greater than 20 years in order to calculate the Waste Unit Factor (WUF). The amount of TRU waste radioactivity used to calculate the WUF was 3.44×10^6 Ci in the CCA, 3.59×10^6 Ci in the PAVT, 2.48×10^6 Ci in the CRA, and 2.32×10^6 Ci in the PABC (Leigh et al. 2005, Section 4.4; and CRA, Appendix TRU WASTE, Section TRU WASTE-2.3.1). The activity at closure for the principal radionuclides is compared between the CRA and PABC in Table 4-3 (Leigh et al. 2005, Table 14). For CH TRU waste, 98.3% of the radioactivity regulated under Table 1 of 40 CFR 191 is contributed by four radionuclides – Am-241, Pu-238, Pu-239, and Pu-240. For RH TRU waste, 99.5% of the regulated radioactivity is contributed by six radionuclides -- Am-241, Pu-238, Pu-239, Pu-240, Cs-137 and Sr-90 (Leigh et al. 2005, Section 4.4).

The quantities of major radionuclides used in PA for the CCA, the CRA, and the PABC are shown graphically in Figure 4-1 (SNL 2005). The overall decrease in radioactivity is attributed by DOE to the addition of pre-1970 buried waste from INL which is low in activity.

Table 4-3. Most Important Radionuclides in TRU Waste Inventory: CRA Versus PABC

Radionuclide	Radioactivity in PABC (Ci)	Radioactivity in CRA (Ci)
Am-241	5.17×10^5	4.58×10^5
Pu-238	1.13×10^6	1.25×10^6
Pu-239	5.82×10^5	6.65×10^5
Pu-240	9.54×10^4	1.08×10^5
Cs-137	2.07×10^5	1.79×10^5
Sr-90	1.76×10^5	1.42×10^5

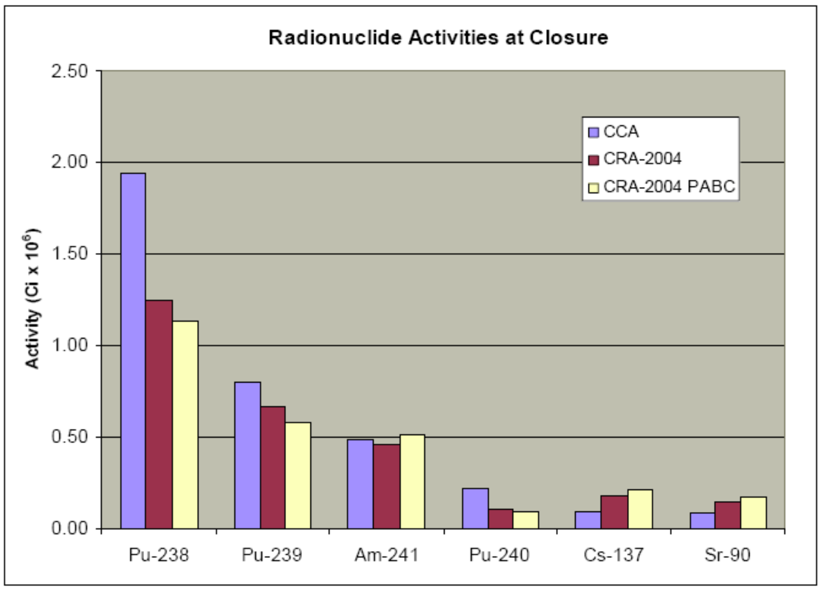

Figure 4-1. Comparison of Quantities of Major Radionuclides in CCA, CRA, and PABC (Source: SNL 2005, Figure 2-50)

The total scaled RH TRU waste inventory at closure (2033) in the PABC is 7.50×10^5 Ci. (Leigh and Fox 2005). This value is substantially lower than the RH TRU waste limit of 5.1 million curies specified in the WIPP LWA (PL102-579).

4.3 NON-RADIOACTIVE MATERIALS

4.3.1 Waste Material Parameters

Table 4-4 compares the average waste material densities for CH TRU waste used in the PABC and the CRA (Leigh et al. 2005). The waste material densities are obtained by rolling up the waste material masses and waste stream volumes for each waste stream, as described in Appendix DATA, Attachment F, Section DATA-F-3.2.1.2.

Table 4-4. Comparison of PABC and CRA Waste Material Inventories for CH TRU Waste

Waste Material	CRA Average Density (kg/m^3)	PABC Average Density (kg/m^3)
Fe-Base Metals/Alloys	1.1×10^{2}	1.1×10^{2}
Al-Base Metals/Alloys	1.4×10^{1}	1.4×10^{1}
Other Matals/Alloys	3.0×10^{1}	3.2×10^{1}
Other Inorganic Materials	4.2×10^{1}	4.0×10^{1}
Vitrified Materials	6.2×10^{0}	5.8×10^{0}
Cellulosic Materials	5.8×10^{1}	6.0×10^{1}
Rubber	1.4×10^{1}	1.3×10^{1}
Plastic	4.2×10^{1}	4.3×10^{1}
Solidified Inorganic Materials	7.7×10^{1}	1.1×10^{2}
Solidified Organic Materials	1.6×10^{1}	3.3×10^{1}
Cement (Solidified)	2.9×10^{1}	3.9×10^{1}
Soil	1.9×10^{1}	1.1×10^{2}

The most significant change between the CRA inventory and the PABC inventory is a six-fold increase in soils. This is due to the inclusion in the PABC of the pre-1970 buried waste from INL with a high soil content.

Similar data for RH TRU waste is included in Table 4-5, which shows an increase in metals, a decrease in CPR materials, and a decrease in other materials in the PABC, as compared to the CRA.

Table 4-5. Comparison of PABC and CRA Waste Material Inventories for RH TRU Waste

Waste Material	CRA Average Density (kg/m^3)	PABC Average Density (kg/m^3)
Fe-Base Metals/Alloys	1.1×10^{2}	5.9×10^{1}
Al-Base Metals/Alloys	2.5×10^{0}	5.0×10^{0}
Other Metals/Alloys	3.2×10^{1}	5.7×10^{1}
Other Inorganic Materials	3.5×10^{1}	1.6×10^{1}
Vitrified Materials	5.7×10^{-2}	1.2×10^{-1}
Cellulosic Materials	4.5×10^{0}	9.3×10^{0}
Rubber	3.1×10^{0}	6.7×10^{0}
Plastic	4.9×10^{0}	8.0×10^{0}
Solidified Inorganic Materials	3.9×10^{1}	6.2×10^{1}
Solidified Organic Materials	4.0×10^{0}	8.3×10^{-1}
Cement (Solidified)	8.79×10^{-1}	1.9×10^{0}
Soil	2.6×10^{1}	5.0×10^{1}

4.3.2 Complexing Agents

The inventory of complexing agents was unchanged from the CRA to the PABC. However, in its completeness comments (Cotsworth 2004c, Comment C-24-5), EPA requested that DOE provide a breakdown of complexing agents by waste stream. This breakdown, presented in Table 4-6, shows that these materials are included in only 18 of the more than 700 waste streams scheduled for disposal at the WIPP (Leigh et al. 2005, Table 16).

Table 4-6. Waste Stream Breakdown of Complexing Agents in PABC Inventory

Waste Stream	Acetic Acid (kg)	Sodium Acetate (kg)	Citric Acid (kg)	Sodium Citrate (kg)	Oxalic Acid (kg)	Sodium Oxalate (kg)	EDTA (kg)
IN-W218.9099	130	1,100	86	384	86	0	22
RF-MT0007	0	0	0	0	0	0	0
RF-MT0541	0	0	0	0	0	0	3
RF-MT0803	0	1	0	0	0	0	0
RF-MT0807	5	43	4	16	4	0	1
RP-W013	0	0	0	0	0	26,000	0
RP-W016	0	7,400	0	0	0	6,490	0
RP-W754	0	0	0	0	0	1,450	0
LA-TA-50-17	0	0	37	0	454	0	0
LA-TA-50-10	0	0	0	0	2	0	0
LA-TA-50-19	2	0	200	0	2,480	0	0
LA-TA-55-38	1	0	143	0	1,780	0	0
LA-TA-55-41	0	0	7	0	92	0	0
LA-TA-55-19	5	0	546	0	6,810	0	0
LA-TA-56-20	1	0	106	0	1.320	0	0
LA-TA-55-43	0	0	11	0	136	0	0
LA-TA-55-44	0	0	39	0	484	0	0
LA-TA-55-62	0	0	12	0	154	0	0

4.3.3 Packaging and Emplacement Materials

Small changes to the inventory of packaging materials were made in the PABC based on the CRA inventory review summarized in (Warren 2004). The packaging materials inventory for the two PAs are compared in Table 4-7 (Leigh et al. 2005, Tables 11 and 12).

Table 4-7. Comparison of Container Packaging Materials in PABC and CRA

Packaging Material	CRA Average Density (kg/m^3)	PABC Average Density (kg/m^3)
For CH TRU Waste		
Steel	1.7×10^2	1.7×10^2
Plastic and Liners	1.6×10^1	1.7×10^1
Lead	1.4×10^{-2}	1.3×10^{-2}
For RH TRU Waste		
Steel	4.8×10^2	5.4×10^2
Plastic and Liners	1.4×10^0	3.1×10^0
Lead	4.4×10^2	4.2×10^2

In addition to packaging materials, other materials associated with the emplacement of wastes in the repository are also used. These materials, which include such items as plastic sacks for the MgO, plastic or cardboard slip sheets between waste packages, and plastic wrap around seven-packs of drums, can contribute to the total quantity of CPR in the repository. These materials were not included in the CCA/PAVT and CRA inventories.

In its completeness review of the CRA, EPA questioned the lack of inclusion of the emplacement materials in PA (Cotsworth 2004b, Comment G-2). In responding to the EPA comment, DOE noted that addition of emplacement materials would increase the CPR content of the waste by 12% over that used in the CRA and that this quantity of CPR would have negligible impact on PA (Detwiler 2004d). Nevertheless, EPA specified that, in the interests of completeness and use of the most current information in PA, emplacement materials should be included in the PABC calculations. Consequently, 2.07×10^5 kg of cellulosics and 1.48×10^6 kg of plastics were added for the PABC. It should be noted that, in its July 2004 response to Comment G-2, DOE stated that the quantities of cellulosics and plastics associated with emplacement materials would be 2×10^5 and 2.6×10^6, respectively (Docket: A-98-49, Item II-B2-34). However, by the time the PABC inventory was developed in mid-2005, the estimated masses had been refined to the values quoted in Leigh, et al. (2005).

The total quantity of MgO in the repository is also of interest to EPA. In the CRA, DOE set a limit on the total amount of CPR materials to be emplaced in the repository of 2.2×10^7 kg (Appendix TRU WASTE, Table TRU WASTE-16). Microbial degradation of these materials may generate carbon dioxide gas and increase pressure within the repository. Placement of MgO in the repository to remove CO_2 has been specified as an engineered barrier under 40 CFR 194.44. The amount of MgO required is based on the amount of CPR materials with an appropriate safety factor.[12] Based on the information presented in Tables 4-4, 4-5, and 4-7, together with the masses of emplacement materials noted above, the total mass of CPR materials in the PABC inventory is estimated to be 2.4×10^7 kg – a value which exceeds the established limit by about 9%. Even with this higher CPR amount, DOE is in compliance with the

[12] In its approval of emplacing supercompacted waste from the INL AMWTF at WIPP, EPA specified that a safety factor of 1.67 be maintained. (Docket A-98-49, Item II-B3-68).

numerical requirements of 40 CFR 191.13. This 2.4×10^7-kg mass will be the new limit for CPR materials.

Another MgO issue of concern to EPA was whether the amount of MgO placed in individual disposal rooms would be sufficient to compensate for certain waste forms. For example, supercompacted wastes from the AWMTF at INL may contain elevated quantities of CPR materials. Because of this possibility, DOE agreed to track the quantities of all CPR materials and MgO as they are emplaced and to adjust the MgO content to insure that adequate quantities of the CO_2-sequestering agent are included in each room (Docket A-98-49, Item II-B2-38).

4.3.4 Oxyanions in the Waste Inventory

Updated masses of oxyanions used in the PABC are presented in Table 4-8 (Leigh et al. 2005, Table 17).

Table 4-8. Masses of Oxyanions Used in PABC and CRA Performance Assessments

Generator Site	Nitrate (kg)	Sulfate (kg)	Phosphate (kg)
PABC Estimate			
RFETS	9.28×10^3	5.53×10^4	8.51×10^1
INEL	7.82×10^5	1.03×10^4	--
LANL	7.35×10^5	3.41×10^5	--
Hanford-RP	1.14×10^6	3.54×10^4	1.05×10^5
LLNL	--	1.03×10^3	--
Total	2.67×10^6	3.43×10^5	1.05×10^5
CRA Estimate			
RFETS	9.28×10^3	5.56×10^4	8.51×10^1
INEL	7.82×10^5	1.03×10^4	--
LANL	5.56×10^5	3.18×10^5	--
Hanford-RP	1.14×10^6	3.54×10^4	1.05×10^5
LLNL	--	1.22×10^3	--
Total	2.51×10^6	4.21×10^5	1.05×10^5

Changes between the CRA and the PABC are due solely to changes in waste stream volumes for projected wastes. No limits have been set on these species for purposes of performance assessment.

4.4 VERIFICATION OF PABC PARAMETERS USED IN PA

EPA reviewed all changes to the PAPDB parameters made between the CRA and the PABC. Many of these parameter changes involved inventory-related items. As described in EPA 2006a, no database problems were identified during the review. Transcription accuracy and technical adequacy were checked for the 13 new parameters and the 92 parameters that had been updated between the CRA and PABC analyses. All parameter distributions, values, and units were correctly entered into the PAPDB, and were technically adequate and appropriate. The rationale for dropping certain parameters from the CRA analysis was also evaluated and found to be acceptable. In addition, the technical adequacy of previous changes from the Technical Baseline

Migration to the CRA analysis was reviewed, and all changes were found to be technically adequate and appropriate.

A check of all supporting documents listed in the PAPDB was made for 27 selected parameters and 30 different documents. Based on this check, EPA concluded that the necessary documents are readily available to support the new and updated parameters. A database-code interface evaluation was performed for the same 27 parameters, and the correct parameter values were retrieved from the PAPDB for each parameter.

5.0 CONCLUSIONS

The EPA inventory review was designed to assess both the PA inventory assembly process from the generator sites and within the CRA and PABC. The review focused on changes to the inventory from the approved baseline (i.e, the CCA/PAVT inventory) to that in the CRA application, and on subsequent changes from the CRA application to the inventory used in the PABC (EPA 2006b). This evaluation indicated that the following inventory values related to PA were accurately obtained from the summary inventory data provided in the CRA:

- The data assembly process, while sometimes complex and not clearly documented, is generally adequate, although continued improvements with respect to documentation of issues and identification/resolution of errors should occur.

- The total scaled RH and CH TRU waste volumes as presented in Attachment F of Appendix DATA were properly rolled up from waste-stream-specific data and are consistent with the values used in the CRA PA.

- The pre-scaled inventory waste material parameter densities of plastics, cellulosics, and rubber in CH and RH total waste, as presented in Attachment F of Appendix DATA, were properly rolled up from waste-stream-specific data.

- The organic ligands and oxyanion inventory values are documented in the CRA and supporting references. However, a detailed check of the calculations used to arrive at these values was not performed.

- Waste material parameter and radionuclide data are traceable within the CRA.

- The process of updating of inventory data and parameters from the CRA to the PABC was transparent and done accurately.

The following issues were identified:

- It is not possible to derive all of the relationships between data tables in the CRA based on the CRA text alone. Tables should be well explained.

- In the future, DOE must better explain data limitations associated with summary tables, particularly those associated with Appendix PAR, which do not contain all PA input data.

- Recognizing that the inventory is dynamic, it is also clear that the implemented process resulted in errors significant enough to warrant PABC parameter changes. To avoid potential issues in the future, inventory changes directly impacting PA should be monitored for potential changes that would affect future compliance as modeled by PA.

EPA's conclusions regarding the adequacy of the inventory data assembly process were based on site visits, technical meetings, discussions with DOE/SNL/LANL staff, and review of responses by DOE to specific comments posed by the Agency. While the process of data collection, assembly, and manipulation was judged to be adequate, changes to the inventory after the September 2002 data call, and discrepancies uncovered in reviews of the CRA inventory by DOE and EPA, resulted in a requirement by EPA that the CRA PA be rerun with revised inventory data. Based on problems with the CRA inventory, SNL instituted a procedure designed specifically to rectify inventory problems. The corrected inventory was used in the PABC (EPA 2006b).

The inventory reported in the CRA, as amended by the PABC, adequately describes the chemical, radiological, and physical composition of the existing and to-be-generated waste as required by 40 CFR 194.24(a). The descriptions provided in the inventory documents reviewed here include comprehensive lists of waste components and their approximate quantities in the waste also required by 40 CFR 194.24(a).

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ATTACHMENT A

SUMMARY OF SIGNIFICANT DIFFERENCES BETWEEN THE CCA/PAVT AND CRA INVENTORIES

SUMMARY OF SIGNIFICANT DIFFERENCES BETWEEN THE CCA/PAVT AND CRA INVENTORIES

CRA Appendix DATA, Attachment F, Annex C, contains a crosswalk of waste stream differences between the CCA/PAVT inventory and the CRA inventory. There are several instances where multiple waste streams were combined into single waste streams, or single waste streams were segregated into different waste streams, based upon characterization information, changes in waste treatment options, etc. A summary of the observed changes, as presented in Annex C for each site, is presented below:

<u>ANL-E</u> – The waste stream population and quantities were generally comparable. The number of waste streams was consolidated from eight waste streams to three waste streams.

<u>ANL-W</u> – Seven waste streams listed in the *TWBIR Revision 2* inventory were subsequently listed as N/A in the *2003 Update Report* inventory. Four additional waste streams were added to the *2003 Update Report* that were not in the TWBIR Revision 2 inventory. The total quantity of waste increased significantly from 26 to 306 cubic meters. The increase is attributed to suspected TRU wastes that are currently stored in silos, but had not been adequately characterized as of the 2002 data call deadline.

<u>Battelle Columbus</u> – The single initial waste stream presented in the *TWBIR Revision 2* was segregated into 12 separate waste streams in the *2003 Update Report*. The initial inventory of 580 cubic meters was reduced to 35 cubic meters between the two inventory reports. The decrease was attributed to elimination of wastes as TRU waste, based upon further sorting, decontamination, and compacting of wastes.

<u>Bettis Atomic Power Laboratory</u> – The waste stream population and quantities were generally comparable.

<u>Energy Technology Engineering Center</u> – The waste stream population and quantities were generally comparable.

<u>Hanford</u> – There are 136 waste streams that were listed in the *TWBIR Revision 2* inventory that are not included in the *2003 Update Report*, but CRA Appendix DATA, Attachment F, Annex C, did not clarify why the waste streams were no longer included in the CRA inventory. There are also 317 additional waste streams identified in the *2003 Update Report* inventory that were not included in the *TWBIR Revision 2* report. The primary change in the Hanford inventory, as indicated in Annex C, was the inclusion of tank wastes in the *TWBIR Revision 3* report. DOE identified 12 tanks from the River Protection Program that they believed were TRU wastes (RH and CH).

<u>INL</u> – The primary change at INL (formerly INEEL) is the implementation of the AMWTF program to compact wastes. Based upon the information in CRA Appendix DATA, Attachment F, Annex C, it appears that approximately 200 separate waste streams originally in the *TWBIR Revision 2* report were combined into a single compacted waste stream IN-BN-510 in *2003 Update Report*. A summary comparison of the compacted waste stream profile in comparison to

a small sample of the individual waste streams from the TWBIR Revision 2 inventory that comprised the compacted waste stream indicates that the plastic and steel packaging in the compacted drums was accounted for in the IN-BN-510 waste stream. However, a detailed analysis was not performed as part of this report to determine if the density and radionuclide values in the IN-BN-510 waste stream are traceable to the individual waste streams comprising the compacted waste stream.

<u>Knolls Atomic Power Laboratory</u> – The waste stream population and quantities were generally comparable.

<u>Lawrence Berkeley</u> – The waste stream population and quantities were generally comparable.

<u>LLNL</u> – The waste stream population and quantities were generally comparable.

<u>LANL</u> – This site has generated an additional 1,600 containers of waste between 1996 and 2003. Several waste streams were reassigned and broken up into a larger number of waste streams.

<u>NTS</u> – One additional waste stream has been identified at NTS. Other than this stream, the waste stream population and quantities were generally comparable.

<u>ORNL</u> – The number of waste streams has been consolidated from 16 in the *TWBIR Revision 2* report to 9 in the *2003 Update Report*. ORNL has increased its projected Curie load from 125,000 Curies to 250,000 Curies, attributed to better characterization information and the addition of new wastes. The volume of the projected wastes has decreased from 3,800 cubic meters to 1,100 cubic meters. DOE attributes the decrease to planned volume reduction techniques.

<u>Paducah Gas Diffusion</u> – The waste stream population and quantities were generally comparable.

<u>RFETS (currently designated as the Rocky Flats Closure Project)</u> – Several waste streams were reassigned into multiple waste streams in the *2003 Update Report* and, in some instances, several waste streams were consolidated into a smaller number of waste streams. All residues were recharacterized as waste and have been processed and packaged as TRU or TRU mixed waste. In addition, several new waste streams were added. As a result, the volume of stored CH TRU waste increased, the volume of projected CH TRU waste decreased and the volume of anticipated CH TRU waste increased.

<u>SNL</u> – The waste stream population and quantities were generally comparable. Waste volumes associated with the Lovelace facility decreased, because the Lovelace facility is no longer associated with DOE, and the use of radionuclides and radioactive materials at the facility have ceased.

<u>SRS</u> – The waste stream volume at SRS increased from 9,194 cubic meters to 11,612 cubic meters. DOE attributes this increase to abandonment of their plans to vitrify large quantities of the debris waste, and to fit large metal pieces into Standard Waste Boxes (SWBs) instead of the 5 x 5 x 8 ft containers that they now plan to use.

U.S. Army Material Command – The waste stream population and quantities were generally comparable.

West Valley Demonstration Project – Some waste streams were reassigned into multiple waste streams, while some volume reduction has occurred in existing waste streams.

DOE also evaluated changes in waste material parameter densities and radionuclide concentrations between the *TWBIR Revision 2 Report* and the *2003 Update Report* (see Annex B of that report). DOE indicates that there were minor differences between the CCA/PAVT and the CRA densities for the waste material parameters. Tables DATA-F-B-24 and DATA-F-B-25 present these differences for CH TRU and RH TRU wastes, respectively. These changes are reasonable, based upon the further characterization information, implementation of volume reduction strategies, and addition of new waste streams. Table A-1 presents the change in radionuclide concentration for the radionuclides of interest between the *TWBIR Revision 2 Report* and *2003 Update Report* inventories.

It appears that there is a general decline in the plutonium and uranium isotope curie content in the 2003 inventory and a significant increase in isotopes typically associated with RH waste, such as Sr-90 and Cs-137. Possible reasons for this change include the addition of low-level waste in TRU waste streams and the inclusion of Hanford tank wastes.

Table A-1
Change in Radionuclide Curies[1] Between CCA and CRA

Radionuclide	CH/RH Waste	CCA Inventory (Curies)[2]	CRA Inventory (Curies)[3]	Difference
Am-241	CH	4.42E+05	4.01E+05	-9.28%
Cs-137	CH	8.06E+03	9.65E+03	19.7%
Pu-238	CH	2.61E+06	1.61E+06	-38.3%
Pu-239	CH	7.85E+05	6.60E+05	-15.9%
Pu-240	CH	2.10E+05	1.07E+05	49.0%
Pu-241	CH	2.31E+06	2.40E+06	3.2%
Sr-90	CH	6.85E+03	5.75E+04	73.9%
U-233	CH	1.79E+03	1.24E+03	-30.9%
U-234	CH	4.65E+02	1.68E+02	-63.9%
U-235	CH	1.28E+01	1.32E+00	-89.7%
U-238	CH	3.96E+01	2.44E+01	-38.4%
Am-241	RH	5.96E+03	1.36E+04	128%
Cs-137	RH	2.16E+05	3.65E+05	69.0%
Pu-238	RH	1.45E+03	3.61E+03	149%
Pu-239	RH	1.03E+04	5.38E+03	-47.8%
Pu-240	RH	5.07E+03	1.68E+03	-66.9%
Pu-241	RH	1.42E+05	1.12E+05	21.1%
Sr-90	RH	2.09E+05	2.46E+05	17.7%
U-233	RH	1.58E+02	3.41E+01	-78.4%
U-234	RH	4.27E+01	2.17E+01	-49.2%
U-235	RH	4.63E+01	9.42E-01	-79.7%
U-238	RH	1.05E+02	1.3E+03	1,140%

Source: Appendix DATA, Attachment F, Annex B, Tables DATA-F-B-27 and DATA-F-B-28

[1] Based on total volume of 168,485 m^3 for CH TRU waste and 7,079 m^3 for RH TRU waste

[2] Decayed through 1995

[3] Decayed through 2001

ATTACHMENT B

NEPTUNIUM AND GENERAL INVENTORY DECAY CALCULATION CHECKS

NEPTUNIUM AND GENERAL INVENTORY DECAY CALCULATION CHECKS

Purpose of Comparison

The purpose of this comparison was to check the decay calculations used to develop the radionuclide inventory numbers for the performance assessment. Two calculations were performed for this comparison. First, an independent calculation of Np-237 activity over the 10,000-year analysis period was made, and second, independent runs of the ORIGEN2 Version 2.2 code were made on three waste streams. The Np-237 calculation was intended to verify DOE's position that Np-237 could be eliminated from consideration as a key isotope. The ORIGEN2 calculations were performed to verify DOE's calculations that generated the basic isotopic source input to the EPAUNI code.

Neptunium Calculation

The Np-237 calculation was performed using Microsoft Excel. Three independent spreadsheets were developed. The first is the calculation of activity for Pu-241, Am-241, and Np-237 using a three-isotope Bateman equation formulation. Isotopic activities are calculated at 100-year intervals out to 10,000 years from repository closure. The initial (time 0) values used were the isotopic activities at closure, defined as year 2033, from Table 4-7 of the CRA. Table B-1 provides the isotopic parameters used as input values for the calculation.

Table B-1. Input Parameters for Np-237 Calculation

Parameter	Pu-241	Am-241	Np-237
Activity at t=0 (Ci)	5.38E+05	4.58E+05	1.01E+01
Half-life (years)	14.7	432	2.14E+06
Lambda (years^{-1})	0.04714	0.00160	3.24E-07

The second spreadsheet is a set of validation calculations performed to ensure the Bateman equation solutions programmed into the first sheet were properly operating. The Bateman solutions used here should provide for a conservation of the total number of atoms in the three-isotope system, with the only change being a steady loss attributable to the decay of the Np-237. The validation results provided in Figure B-1 show that the total number of atoms calculated by the system behaves as expected throughout the decay calculation.

The third spreadsheet provides a graphical summary of the results. As expected, the Pu-241 is effectively gone within 100 years, the Am-241 decays linearly on the log scale with a slope determined by the half-life, and the Np-237 builds up to a near-equilibrium value after approximately 2,000 years. This is the expected near-equilibrium point, as it represents approximately 10 half-lives of Am-241. The resulting low level of residual Np-237 activity supports the DOE treatment of not including this isotope in PA.

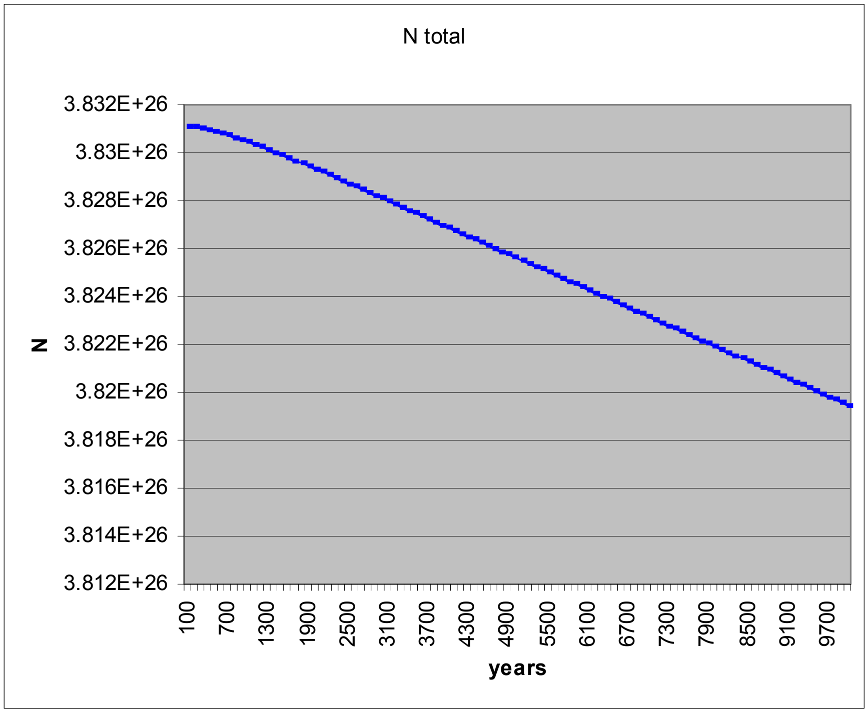

Figure B-1: Validation Check Results

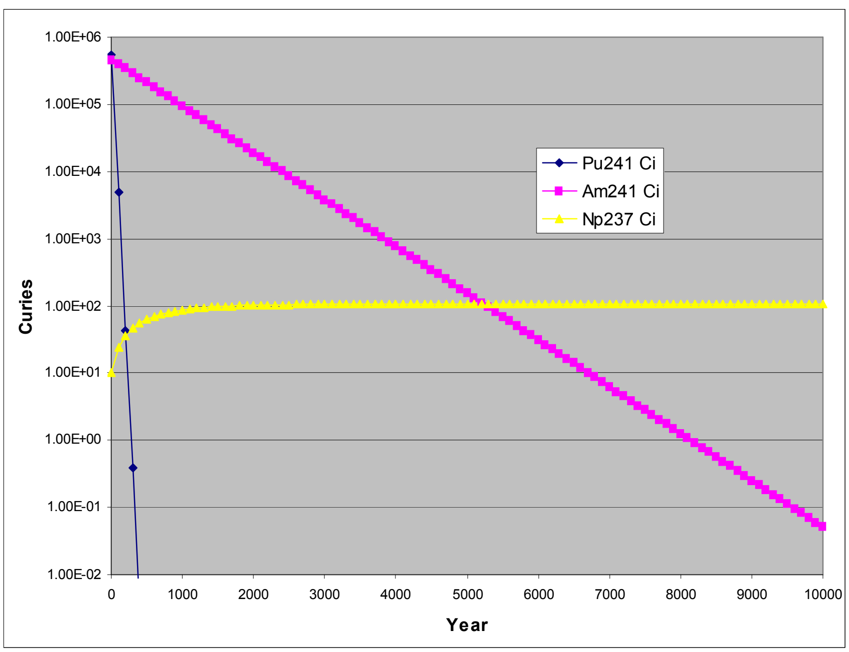

Figure B-2: Results of Decay Calculation

ORIGEN2 Calculation Check

In order to build the input radiological source term for the CRA, DOE requested from each TRU waste generating site a list of the waste streams planned for disposal at the WIPP, and the best estimate of total activity in each waste stream. When DOE CBFO received the individual waste stream inventory data from the sites, the isotopic activity information needed to be placed in a common basis year in order to produce a consistent inventory as input to the CRA. DOE generated this basis by decaying all waste stream data to the year 2001 using Version 2.2 of the ORIGEN2 code. These results were then used to produce the input to various WIPP documents and codes, including the EPAUNI code.

EPA received the data sets used to perform the decay calculations in ORIGEN2 as part of the CRA review information. Three waste streams were selected for comparison; AE-T001, AE-T003, and LA-TA-03-12. EPA performed an independent decay calculation on these three waste streams using a separately procured version of the ORIGEN2 Version 2.2 code. The calculation check was performed in three steps:

(1) Review of the DOE batch files for executing ORIGEN2 to verify the proper library calls
(2) Develop new batch files to run the EPA test calculations
(3) Run ORIGEN2 and compare the EPA output files to the DOE output files

The file comparisons were performed using the Windows XP command line file comparison utility, FC. The resulting EPA output files were identical to the DOE output files, except for the time and date information regarding the run.