SUMMARY AND STATUS OF TRU WASTE CHARACTERIZATION*

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, is a nuclear repository designed for the disposal of transuranic (TRU) wastes generated and/or stored at Department of Energy (DOE) facilities across the country. Characterization of the TRU waste is an integral part of showing compliance with regulations governing its transportation to the WIPP and subsequent storage and disposal at the WIPP. Available waste characterization information for the TRU wastes has been compiled and presented in various documents including the TRUPACT-II Safety Analysis Report, and the WIPP No-Migration Variance Petition. The waste characterization information is primarily based on process knowledge, supplemented with limited sampling and analytical data. This paper summarizes the available waste characterization information for the TRU waste in the DOE system, and the basis for classifying the waste under a uniform system across all DOE sites.

BACKGROUND

TRU waste is material that is contaminated to greater than 100 nCi/gm with predominantly alpha emitting radionuclides having half lives greater than twenty years (e.g., plutonium-239) (1). TRU wastes are generated from DOE defense-related activities, including weapons production and research and development. TRU wastes are classified as either contact-handled (CH) or remote-handled (RH), depending on the dose rate at the surface of the waste container. The majority of the waste (approximately 97 percent by volume) planned for storage at the WIPP site is CH TRU waste (1), and is the subject of this paper. Currently, these wastes are generated and/or stored at ten major DOE sites across the country (1). The WIPP near Carlsbad, New Mexico, is an underground repository designed for the storage and disposal of transuranic wastes. Approximately 26 percent of the proposed WIPP CH TRU inventory is retrievably stored at the Idaho National Engineering Laboratory (INEL), and another 26 percent of the proposed WIPP inventory is newly generated waste (projected to the year 2013) from the Rocky Flats Plant (RFP) (1). Other sites having retrievably stored wastes and/or newly generated wastes are Richland-Hanford, Los Alamos National Laboratory, Savannah River Site, Oak Ridge National Laboratory, Argonne National Laboratory-East, Lawrence Livermore National Laboratory, Mound Laboratory, and the Nevada Test Site (1).

The waste destined for the WIPP site is either solid or solidified material, and can be grouped into four major waste types:

I - Solidified Inorganics (inorganic sludges)

II - Solid Organic Waste

III - Solid Inorganic Waste

IV - Solidified Organics (organic sludges)

Inorganic sludges (Waste Type I) are predominantly inorganic aqueous wastes solidified with some form of stabilizing agent, usually a cement-based material. Solid inorganic waste (Waste Type II) consists of metals, glass, graphite, firebrick, etc. Solid organic waste (Waste Type III) consists of organic materials such as paper, plastic, tissues, plywood, etc. Organic sludges (Waste Type IV) comprise a small fraction of the total waste inventory and contain immobilized organic solvents. These waste types are discussed in greater detail in a later subsection. The wastes generated at the different sites are comparable (due to the similar processes in operation), and can all be grouped under the waste forms discussed above, with few exceptions.

CH TRU waste is generally packaged in plastic bags (either polyethylene or polyvinyl chloride), which are then placed inside the waste containers (55-gallon steel drums or large metal boxes) (2). The waste containers are fitted with carbon composite filters to prevent the build-up of gas pressure in the containers, while retaining any particulates inside the containers (3).

GOVERNING REGULATIONS

The regulations governing the transportation, storage, and disposal of TRU wastes at the WIPP site are presented in Table I, and are discussed below.

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TABLE I

Regulations Governing the Transportation and Disposal of TRU Waste

REGULATION	ISSUE	REGULATORY AGENCY
10 CFR Part 71 (4)	Transportation	Nuclear Regulatory Commission
40 CFR Part 191 Subpart A (5)	Management and Storage of TRU Waste Prior to Disposal	Environmental Protection Agency - Office of Radiation Protection
40 CFR Part 191 Subpart B (5)	Disposal of TRU Waste at WIPP	Environmental Protection Agency - Office of Radiation Protection
40 CFR Part 268 (6)	Land Disposal Restrictions	Environmental Protection Agency - Office of Solid Waste Management

The transportation of radioactive waste is regulated under 10 CFR Part 71 (4). The shipping package to be used for the transportation of CH TRU waste is the TRUPACT-II package. The TRUPACT-II is a double-contained, Type B package that can transport up to 14 drums, or two metal boxes called Standard Waste Boxes (SWBs), per shipment. A Safety Analysis Report (SAR) for the TRUPACT-II package was submitted to the U.S. Nuclear Regulatory Commission (NRC) in 1989 (3). Based on the analyses presented in the SAR, the NRC issued a Certificate of Compliance (C of C) for the TRUPACT-II package in August, 1989. The C of C certifies that the TRUPACT-II package meets the requirements of 10 CFR Part 71.

The required long-term performance of a nuclear waste repository is governed by 40 CFR Part 191 Subpart B (5). An evaluation of compliance with this regulation is referred to as a performance assessment (PA). 40 CFR Part 191 Subpart B requires that the cumulative release of certain radionuclides present in the waste not exceed a specified amount over a 10,000-year period. A range of events and processes have to be considered in evaluating releases from the repository. The PA studies for the WIPP repository are on-going and are expected to be completed by 1994.

Implementation of the land disposal restrictions is regulated under 40 CFR Part 268 (6). A large portion of the CH TRU waste to be disposed of at the WIPP site is mixed waste, meaning that the waste is both radioactive and hazardous and may be subject to land disposal restrictions. Hazardous constituents in CH TRU waste may include solvents such as 1,1,1-Trichloroethane, and metals such as lead (7). A No-Migration Variance Petition (NMVP) (7) for the WIPP site was submitted to the U.S. Environmental Protection Agency (EPA) to obtain a variance from the land disposal restrictions (40 CFR Part 268) (6).

WASTE CHARACTERIZATION

Characterization of the CH TRU waste is required to show compliance with various aspects of the governing regulations discussed above. TRU waste characterization is primarily based on process knowledge, supplemented with limited sampling and analytical data. Process knowledge information has been gathered from the different DOE sites through questionnaires requesting specific information, and compiled into different databases and documents. This information is continually being updated to reflect the most current knowledge of the waste. In addition, available sampling and analytical data has been compiled and reported to supplement this process knowledge.

The databases and documents that have been used to collect and present waste characterization data are the following:

- TRUPACT-II Safety Analysis Report (SAR) (3)
- TRUPACT-II Content Codes (TRUCON) Document (2)
- TRUPACT-II Chemical Lists
- Waste Analysis Plan (WAP) of the WIPP No-Migration Variance Petition (NMVP) (7)
- TRU Mixed Waste Characterization Database
- Nonradionuclide Inventory Database
- Documentation of Sampling Programs at the Sites

Figure 1 is a schematic representation of these different documents containing the waste characterization information. The remainder of this paper discusses the waste characterization information presented in some of the major documents shown in Fig. 1.

TRUPACT-II Safety Analysis Report (SAR)

The TRUPACT-II SAR includes a description of the allowable payload (waste) for the TRUPACT-II package. The restrictions on the TRUPACT-II payload ensure that the payload is within the design capabilities of the TRUPACT-II package. The waste characterization information defines applicable transportation parameters as shown below:

One of the restrictions for the Type B TRUPACT-II package (a sealed container) is that the concentration of hydrogen be less than five percent for any layer of confinement in the package (3). This includes the plastic bag(s) used to package the wastes inside a drum or standard waste box. The TRUPACT-II payload (CH TRU waste) was characterized with respect to its gas generation potential and release rate characteristics to evaluate compliance with this restriction.

A waste classification system was developed in the SAR to provide a method for segregating waste by its potential to generate radiolytic gas. Table II defines the waste classification system used in the SAR. The four waste types, listed earlier, were used to segregate the waste based on its potential for hydrogen gas generation. This potential is quantified by a "G value," defined as the number of molecules of hydrogen produced per 100 ev of energy absorbed. As indicated in Table II, The bounding G value for Waste Type IV has not yet been determined. In some cases the waste types may be segregated even further, into waste material types. The chemicals that can be present in each waste material type are restricted, in order to conform with the bounding gas generation potentials established.

The release rate characteristics of a payload container (drum or standard waste box) were determined from measuring the release of hydrogen from simulated waste

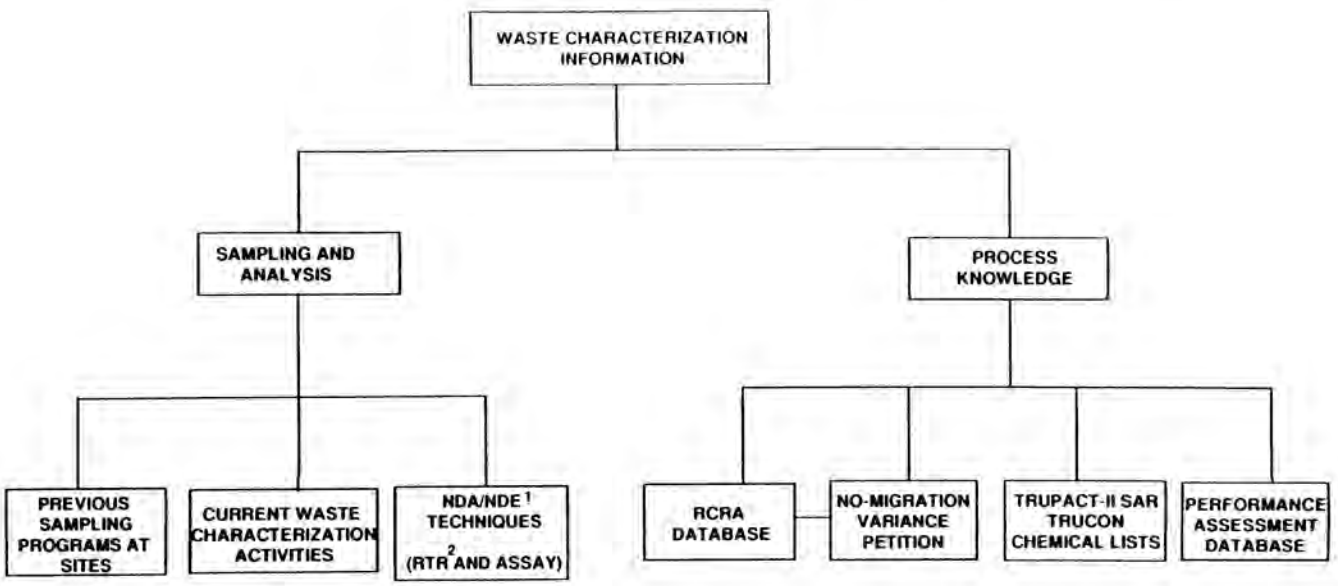

Fig. 1. TRU waste characterization information.

TABLE II

CH TRU Waste Classification

Waste Type and Waste Material Type	Effective G Value for Hydrogen*	Description
I		Solidified Aqueous or Homogeneous Inorganic Solids
I.1	1.6	Solidified Inorganic Liquids
I.2	1.3	Soils or Sludges
I.3	0.4	Concreted Inorganics
II		Solid Inorganics
II.1	1.7	Solid Inorganics in Plastic Packaging
II.2	0.0	Solid Inorganics in Metal Cans
III	3.4	Solid Organics
IV	Unknown	Solidified Organics

*Number of Molecules of H2 Produced per 100 ev of Energy Absorbed.

packaging configurations. Process knowledge provided information on the different packaging configurations used at each site. This waste characterization (quantification of the gas generation potential and gas release characteristics) was used to ensure compliance with the limits on hydrogen concentration (5% by volume within any layer of confinement) in the TRUPACT-II package.

Waste characterization information was also used to ensure chemical compatibility of the waste within itself and with the TRUPACT-II package during transportation. The basis for evaluating chemical compatibility in the SAR was the Environmental Protection Agency (EPA) document, "A Method for Determining the Compatibility of Hazardous Wastes" (8). Process knowledge was the basis for determining the chemicals and materials that can be present in the waste containers in each waste type. This information is documented in the TRUPACT-II Chemical Lists, an Attachment to the TRUPACT-II SAR (1).

The TRUPACT-II SAR defines the allowable payload contents for the TRUPACT-II package. Gas generation potential and chemical compatibility are the primary payload parameters requiring waste characterization. The basis for the determination of the allowable payload contents is waste characterization from process knowledge, available Non-destructive Assay and Non-destructive Examination (NDA/NDE) techniques, and/or visual inspections during packaging and handling.

TRUPACT-II Content Codes (TRUCON) Document

The TRUCON document (2) is a compilation and classification of all CH TRU waste in the DOE system that is eligible for transport in a TRUPACT-II package. TRUCON converts existing waste form numbers, content codes, and any other site-specific identification codes into a system (known as Content Codes) that is uniform for all of the DOE sites. Table III provides an example and description for the general TRUCON content codes. Each content code provides characterization of the CH TRU waste material in terms of transportation parameters like generation sources, waste description, processing and packaging history, assay method, descriptions of verification methods used to ensure the exclusion of prohibited items (i.e., corrosives, non-radioactive pyrophorics, explosives/compressed gases), decay heat limits for each payload content code, and correlation to any internal content codes used for the waste. The compilation of this waste characterization information in the TRUCON document effectively unifies the entire TRU waste system under a standard parametric description.

TABLE III

Example of General TRUCON Content Codes

Waste Type	Content Code	
I	*11	TRU Solidified Aqueous or Homoheneous Inorganic Solids - cemented or dewatered sludge precipitated from aqueous waste treatment processes. Soils which are not contaminated with organic chemicals are classified as homogeneous solids.
IV	*12	TRU Solidified Organics - cemented or absorbed organic liquids from production or laboratory processes.
IV	*13	TRU Solidified Laboratory Waste - cemented or absorbed neutralized aqueous laboratory waste (contains organic acids, etc).
I	*14	TRU Solidified Inorganic Process Solids - cemented inorganic particulate or sludge-like (not chemically precipitated) wastes from plutonium recovery operations.
II	*15	TRU Graphite Waste - discarded graphite molds, laboratory equipment and furnace equipment (whole or pieces) from plutonium casting or laboratory operations.
III	*16	TRU Combustible Waste - cellulosic, plastic or cloth waste from various processes.
II	*17	TRU Metal Waste - discarded metal (i.e., tantalum, auminum, stainless steel) from production or maintenance operations.
II	*18	TRU Glass Waste - discarded labware, windows, containers or raschig rings from various processes.

*Either "1" or "2", depending on if waste is newly-generated or retrievably stored, respectively.

Waste Analysis Plan of the No-Migration Variance Petition (NMVP)

The NMVP was submitted to the EPA to address compliance with 40 CFR Part 268. The Waste Analysis Plan is Appendix B to the NMVP. It includes the most comprehensive waste characterization information available for CH TRU waste and CH TRU mixed waste generated and/or stored at the ten DOE sites. In addition to waste characterization information provided specifically for the NMVP, the Waste Analysis Plan compiles all other available information for the waste as attachments. For example, the TRUCON document, TRUPACT-II Chemical Lists, the Resource Conservation and Recovery Act (RCRA) database, and available documentation of sampling programs at the sites, are attachments to the Waste Analysis Plan.

Table 2-1 of the Waste Analysis Plan is a summary of the available waste characterization for the CH TRU wastes to be emplaced at the WIPP site. For each TRUPACT-II shipping content code, the table lists the corresponding site-specific identification codes, processes which generate the waste, waste descriptions, hazardous chemicals (if applicable) with semi-quantitative concentrations, and total waste quantities for each content code (stored and projected generation to the year 2013).

The information in the Waste Analysis Plan is organized by site and TRUCON content code. For each content code, the waste characterization information is presented in two parts:

1. Waste and Process Descriptions and Flow Diagrams. This includes a description of the waste (including correlation of internal site content codes) and process

flow diagrams for that shipping content code. The process flow diagrams cite buildings and processes which generate the waste, potential presence of hazardous constituents, flow of the waste from generation to temporary on-site storage, and any pre-treatment or stabilization applied to the waste.

2. Available Sampling and Analyses Data and/or Quantified Waste Characterization Information. This section references any data (from process knowledge or sampling) available for the shipping content code, or any of its correlating internal site content codes. This includes the chemical list information, results of the chemical compatibility evaluation, identification of the hazardous constituents (per the RCRA definition), and any sampling and analyses applicable to the shipping content code. The waste characterization information presented in the Waste Analysis Plan is central to the EPA's evaluation of the No-Migration Variance Petition.

SUMMARY

Waste characterization is an integral part of evaluating the characteristics of CH TRU waste with respect to its transportation to, and eventual disposal at, the WIPP site. This paper presents an overview of the available information summarized in various documents as part of showing compliance with governing regulations. This waste characterization information, based primarily on process knowledge, has been compiled from the DOE sites and consolidated into a uniform classification extending across all sites.

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