

# WASTE CHARACTERIZATION REQUIREMENTS FOR THE WASTE ISOLATION PILOT PLANT PROGRAM

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## ABSTRACT

This paper includes a discussion of the regulatory and programmatic requirements for transuranic (TRU) waste characterization information and how this information is integrated into the Waste Isolation Pilot Plant (WIPP) Waste Characterization Program. Prior to initiation of the operational phase at the WIPP, the Department of Energy (DOE) must comply with the Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level, and Transuranic Radioactive Wastes as required under 40 CFR Part 191, Subpart B and the Resource Conservation and Recovery Act (RCRA), Land Disposal Restrictions for management of restricted hazardous waste, as required under 40 CFR Part 268. Both these regulations require a demonstration of the long-term performance of the WIPP repository. Waste characterization is an integral part of compliance with these requirements.

## INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) site is located in Eddy County in southeastern New Mexico, approximately 42 km east of Carlsbad. The WIPP underground facility, which is 655 m below the land surface in a 610 m-thick bedded salt and anhydrite formation, was constructed as a research and development facility to demonstrate the safe disposal of transuranic (TRU) waste from DOE defense facilities. Ultimately, DOE plans to receive and dispose of TRU wastes generated from defense-related plutonium reprocessing and fabrication as well as defense-related research activities.

TRU waste is material contaminated with alpha-emitting radionuclides having atomic numbers greater than 92, half-lives greater than 20 years, and activity levels greater than 3 700 Bq/g of waste. Much of the TRU waste to be sent to the WIPP is mixed waste, that is, it contains RCRA-regulated, hazardous wastes as defined under 40 CFR Part 261, Subparts C and D. TRU waste exists in a variety of physical forms, ranging from unprocessed laboratory trash (e.g., tools, paper, glassware) to solidified wastewater treatment sludges. Ten DOE facilities currently generate and/or retrievably-store TRU wastes that are planned for permanent disposal at the WIPP.

Prior to initiation of the operational phase at the WIPP, the Department of Energy (DOE) must comply with the Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level, and Transuranic Radioactive Wastes as required under 40 CFR Part 191, Subpart B and the RCRA, Land Disposal Restrictions for management of restricted hazardous waste, as required under 40 CFR Part 268. Both these regulations require a demonstration of the long-term performance of the WIPP repository.

To obtain the necessary data to demonstrate compliance with these regulations, wastes will be placed under-

ground only for the purpose of conducting tests to determine more precisely the impacts of the waste on the repository environment. Initially, DOE plans to conduct experimental tests in the WIPP during a Test Phase of approximately 5 years. DOE plans to conduct these tests at the WIPP to assess the rates and potential of gas generation from radiolytic, microbial, and chemical processes. These experiments include unmodified and modified transuranic (TRU) wastes in bin-scale and alcove tests (1,2). The results of these and other tests will determine what additional measures, if any, are needed to comply with applicable regulations. Information on the chemical, physical, and radiochemical properties of TRU waste is necessary for the interpretation of experimental results.

## REGULATORY FRAMEWORK

As the TRU waste program has evolved DOE has responded to the need to operate the WIPP in compliance with a number of DOE Orders and regulations that pertain to waste characterization. This section includes a brief overview of the requirements and describes those aspects of various DOE Orders and regulations with respect to waste characterization requirements.

### Waste Acceptance Criteria

In compliance with DOE Order 5820.2A, "Radioactive Waste Management," DOE established the WIPP Waste Acceptance Criteria (WAC) that define the requirements for the safe handling and long-term disposal of TRU wastes at the WIPP facility. DOE generator/storage facilities certify their wastes in accordance with these requirements prior to shipment to the WIPP. These criteria have been revised over time to reflect DOE's current understanding of the repository environment and changing regulatory requirements. In fact, the WAC is currently under revision.

### Transportation Requirements

For the TRU waste program, the Nuclear Regulatory Commission (NRC) has issued a Certificate of Compliance (C of C) to DOE for the design of the Transuranic Package Transporter (TRUPACT-II). It is the responsibility of the DOE WIPP Project Office to assure that the activities of all users of the TRUPACT-II comply with the requirements of 10 CFR Part 71, the TRUPACT-II Safety Analysis Report (SARP), the C of C, and DOE Orders 1540.1 and 1540.2 which reference NRC and Department of Transportation (DOT) regulations. The TRUPACT-II SARP establishes the waste payload and packaging restrictions for CH TRU waste shipment to the WIPP. The restrictions apply to both the radionuclide and chemical components of the waste in terms of compatibility with the TRUPACT-II design to ensure the integrity of the Type B package during transport. These requirements are currently being incorporated into the WAC.

### Atomic Energy Act

The authority of the EPA to establish radiation protection standards that apply to disposal activities and defense activities under the jurisdiction of the DOE derives from the Atomic Energy Act. The 40 CFR Part 191 Standards are divided into the following two subparts: Subpart A, "Standards for Management and Storage" and Subpart B, "Standards for Disposal." Although Subpart B of the Standard was remanded to the EPA by the U.S. Court of Appeals for the First Circuit, the Agreement for Consultation and Cooperation between DOE and the State of New Mexico (1981) commits the WIPP Project to evaluate compliance with the Standard as first promulgated until a revised Standard becomes available.

Subpart B applies primarily after decommissioning of the repository and limits cumulative releases of radioactive materials to the accessible environment for 10,000 years. Subpart B also limits both annual radiation doses to members of the public in the accessible environment and radioactive contamination of certain sources of ground water for 1,000 years after disposal. The WIPP Performance Assessment process that DOE will use to demonstrate compliance with these requirements involves scenario development and screening, performance modeling, and consequence analysis. The primary purpose of the bin-scale and alcove tests is to provide relevant data and technical information on the rates and potential of gas generation to the WIPP Performance Assessment program for predictive modeling studies.

### Resource Conservation and Recovery Act

The EPA published a notice of its determination that wastes containing both hazardous and radioactive contam-

inants were subject to regulation under RCRA on July 3, 1986 (51 FR 24504). The DOE issued a final "by-product material" interpretative rule on May 1, 1987, in which the DOE concluded that the term "by-product material" refers only to the radioactive components of nuclear waste streams. The hazardous chemical components of TRU mixed waste are subject to regulation under RCRA. The State of New Mexico received authorization over radioactive mixed waste from EPA on July 25, 1990.

With regard to the WIPP facility, two aspects of RCRA waste characterization requirements have had a major influence on DOE's TRU waste management program. The RCRA regulations in 40 CFR 265.13 require that anyone who treats, stores, or disposes of hazardous waste must obtain a "detailed chemical and physical analysis of a representative sample of the waste." DOE has characterized its TRU mixed waste primarily using knowledge of the process from which the waste was derived as provided for in 40 CFR 262.11 (c)(2).

Federal regulations incorporate by reference the sample collection and analytical procedures specified in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (40 CFR 260.11). These methods are routinely used in the sampling and analysis of hazardous waste, but the feasibility or effectiveness of applying them to radioactive mixed waste has not yet been proven for TRU mixed wastes. Considerations include the performance of specified equipment in a radioactive environment, the increase in waste volume that results from the sample dilution and special handling required in some analyses, and the limited availability of commercial laboratories licensed to receive TRU samples. DOE is working to develop radioactive mixed waste capabilities at its facilities as well as establishing more detailed process knowledge that will allow for flexibility in complying with the RCRA waste characterization requirements, consistent with the goal of protecting human health and the environment.

In addition, the EPA land disposal restriction requirements in 40 CFR 268.7 set forth waste analysis requirements to determine if waste to be land disposed meets the treatment standards. DOE submitted a No-Migration Variance Petition (3) to EPA for the disposal of untreated, restricted wastes at the WIPP in compliance with 40 CFR 268.6. In response to DOE's Petition, EPA granted a final Conditional No-Migration Determination for the WIPP in November, 1990 (55 FR 47700). As a result of this determination, DOE may place a limited amount of untreated hazardous waste subject to the land disposal restrictions in the WIPP for the purpose of testing and experimentation. The determination imposes several conditions related to waste characterization requirements related to demonstrating the comparability of wastes used in the tests to those described in the Petition as well as

flammability testing to ensure that no-migration of hazardous constituents occurs during such placement. EPA also expects DOE to obtain more detailed waste characterization information through sampling and analysis prior to any future evaluation of a no-migration demonstration for the WIPP disposal phase.

### WIPP WASTE CHARACTERIZATION PROGRAM OVERVIEW

DOE is developing the experimental program and the subsequent Waste Characterization Program Plan and Quality Assurance Program Plan (QAPP) in phases based on experimental requirements and the development of analytical methods to adequately characterize the wastes. Because of the importance of waste characterization information to the many aspects of the TRU waste program and the need to comply with the DOE policy to minimize potential exposures to radioactivity in accordance with As Low As Reasonably Achievable (ALARA), a system-wide program is imperative.

The WIPP Waste Characterization Program is multifaceted and will provide data necessary to meet a number of objectives. From a programmatic viewpoint, it encompasses the characterization of TRU wastes at DOE generator/storage sites prior to waste emplacement in the WIPP repository for experimental purposes during the Test Phase.

Information on waste properties will be obtained from the WIPP Waste Characterization Program, bin- and alcove tests, and laboratory experiments. These activities will result in information on the radiochemical and physical properties of the waste, and the radiolytic, chemical and microbial processes that may influence long-term repository behavior.

The Rocky Flats Plant and the Idaho National Engineering Laboratory will provide the majority of the waste used in the bin-scale and alcove tests. At the conclusion of the test program, during the operational phase, the other DOE generator/storage facilities will be required to characterize their TRU wastes to demonstrate the comparability of each waste form to those used in the experiments. Because the bin-scale and alcove tests are designed to evaluate the potential and rates of gas generation, the variables that must be compared are those that may influence these processes (Table I).

TABLE I

#### Controlling Gas Generation Variables

1. Cellulosics
2. Plastics
3. Rubber
4. Corroding metal/steel
5. Corroding metal/aluminum
6. Noncorroding metal
7. Solid inorganics
8. Inorganic sludges
9. Cements
10. Other organics
11. Total Alpha

The specific parameters and number of wastes that must be sampled to demonstrate comparability of the experimental waste to the total WIPP TRU waste inventory will be determined by Sandia National Laboratories (SNL). This determination will be based on a statistically-valid sampling plan and results obtained from the bin-scale and alcove tests. A detailed description of the methodology and the quantities and types of wastes that will be included in the test program is included in Molecke and Lappin, 1990 (4).

In addition, each DOE generator/storage facility will be required to evaluate its TRU waste inventory and determine the applicable analyses required for RCRA waste characterization of each waste stream. The specific wastes and the number of containers that must be sampled to obtain a representative sample of each waste stream will be determined by each generator/storage facility based on process knowledge and a statistically-valid sampling program.

#### WIPP BIN PREP TASK FORCE

The Bin Prep Task Force was established by DOE/EM-30 in June, 1990 to coordinate and schedule activities related to the preparation of test bins of TRU waste at the DOE generator/storage facilities and the initiation of the Test Phase at the WIPP. The Task Force is managed by DOE/EM-34 and currently includes participants from DOE WIPP Project Office, DOE Rocky Flats Operations, DOE Idaho Operations, and their supporting contractors. The objectives of the Task Force are to track the current status of all activities related to TRU waste characterization and bin preparation, to inform program participants of current regulatory requirements, to resolve operational and programmatic issues related to bin preparation, and to provide an interface between DOE/EM-30 and program participants.

Because the Task Force includes personnel involved in DOE facilities' operations, waste management, and regulatory compliance, the Task Force addresses many aspects of TRU waste operations pertaining to bin preparation that

are necessary to initiate the WIPP Test Phase in compliance with all regulatory and programmatic requirements. A main focus of the Task Force, to date, has been on implementation of SNL's requirements for the types and quantities of wastes that are needed for the initial bin-scale tests. Parallel to the types and quantities of wastes is the need to adequately characterize them based on SNL Test Plan requirements. The Task Force also has been evaluating DOE facilities' capability to characterize the waste in accordance with RCRA requirements. Operationally, the various facilities' management, participating in the program, provide regular, status reports on required permits, transportation capabilities (e.g., TRUPACT-II loading facilities), the standard operating procedures for implementation of the requirements for bin preparation.

The Task Force has also initiated a number of tours of the analytical laboratory and TRU waste management facilities at the Rocky Flats Plant, Idaho National Engineering Laboratory, and Argonne National Laboratory-West. Each DOE site has unique operational and organizational aspects, therefore the coordination of efforts between these sites is essential to ensure consistency in the program. Because program priorities may change rapidly in response to regulatory or programmatic requirements, the Task Force ensures that the on-going work is responsive to these changes. Regulatory and technical requirements related to bin preparation are addressed through the dissemination of current information concerning changes in requirements related to bin preparation.

#### **PROGRAM PLAN FOR CHARACTERIZATION OF WIPP EXPERIMENTAL WASTES**

The purpose of the Program Plan is to define the activities required to characterize TRU experimental wastes prior to conducting the bin-scale and alcove tests in the WIPP. The Program Plan addresses the waste characterization requirements in support of performance assessment and RCRA waste characterization requirements. The current scope of the Program Plan includes determining the isotopic distribution and assay of test wastes; verifying process knowledge on the physical form of the wastes through the use of Real-Time Radiography (RTR) and visual inspection; sampling and analyzing headspace gases within waste containers for volatile organic compounds and other gases that can give an indication of the dominant process(es) occurring in the drum (e.g., radiolysis or microbial degradation); and sludge analyses for RCRA-regulated, volatile organic compounds and metals, as well as major cations, anions, and pH that may influence radionuclide solubilities. Sampling and analytical methods for sludges are not currently available and must be developed by DOE for TRU wastes.

One goal of the program is to characterize waste used in the bin-scale and alcove tests to demonstrate that the waste gas generation properties are comparable to all the CH TRU waste in the DOE system to be sent to the WIPP. To achieve this goal, all sites will have to generate waste characterization data for comparison with the results of the tests. The basis for this comparison is process knowledge on the chemical and physical composition of the waste in terms of gas generation controlling variables as defined by SNL (Table I). If waste is found in the system that is not represented by the test wastes, then the non-representative waste may be 1) processed so that it falls within the envelope of gas generation controlling variables, 2) tested under the conditions of the experimental waste and the results included in the performance assessment evaluations, or 3) accepted after a demonstration based on bounding analysis and knowledge of the waste form that the waste can be included in the performance assessment evaluations without testing.

The Program Plan includes an overview of the types and quantities of wastes required by SNL for the initial bin-scale tests, as well as, a statistical sample of wastes to be included in the alcove tests. The size of the population of wastes that must be characterized for the alcove tests will depend on the results from the characterization of wastes used in the bin-scale tests and the gas generation test results.

The Program Plan includes the characterization of the types and concentrations of gases relevant to the gas generation tests (e.g., hydrogen, methane, and carbon dioxide) and volatile organic compounds in the headspace of waste containers. This data will be used to address a number of objectives. In compliance with 40 CFR Part 268, DOE will be required to demonstrate that hazardous constituents will not exceed health-based limits at the WIPP unit boundary during the operational phase. Data on the concentrations of volatile organic compounds (VOCs) in the headspace of TRU waste containers is needed to confirm the assumptions made in the No-Migration Variance Petition (1) concerning the potential releases of hazardous constituents.

In addition, data on the concentrations of VOCs as well as inorganic gases, will be used to demonstrate that flammable concentrations of hazardous constituents do not exist in the containers of TRU waste to be sent to the WIPP. Data on the types and quantities of inorganic gases will also be used in support of the bin-scale tests to provide information on the initial dominant processes (i.e., radiolytic, chemical, or microbiological) occurring in the waste.

#### **QUALITY ASSURANCE PROGRAM PLAN**

In compliance with DOE Order 5700.6B, "Quality Assurance," DOE has prepared the Quality Assurance Program Plan (QAPP) for the WIPP Experimental-Waste Characterization Program that addresses the American So-

ciety of Mechanical Engineers (ASME) NQA-1 (5) requirements as well as the EPA QAMS-005 guidelines (6). The QAPP will be issued and controlled by DOE/EM-30. The QAPP includes a description of the quality assurance/quality control (QA/QC) requirements for characterization of wastes used in the bin-scale and alcove tests as well as the wastes received at the WIPP during the operational phase. It provides detailed performance standards to ensure that all data generated during TRU waste characterization activities will be of acceptable and documented quality.

The QAPP establishes quality assurance objectives designed to ensure that programmatic data quality objectives will be met. Performance based standards allow DOE sites to implement any appropriate method of sampling and analysis that meets all the specified requirements. Acceptable protocols for volatile organic compound analysis, gas analysis, headspace gas sampling, RTR, visual examination, and radioassay are provided in a companion Guidance Manual.

Acceptable levels of performance will be demonstrated through the implementation of a Performance Demonstration Program, administered by the DOE WIPP Project Office. Single blind samples will be supplied to participating analytical laboratories prior to sample receipt, and semi-annually, thereafter. Satisfactory performance is required for continued participation.

The QAPP also establishes the performance criteria for site-specific quality assurance project plan (QAPjP) preparation, review, and approval. Detailed operational plans for waste characterization activities will be formalized in the

site QAPjPs. The QAPjPs will provide details regarding the implementation of QAPP requirements at each DOE site.

### CONCLUSIONS

Prior to initiation of the operational phase at the WIPP, the DOE must comply with the Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level, and Transuranic Radioactive Wastes as required under 40 CFR Part 191, Subpart B and the RCRA, Land Disposal Restrictions for management of restricted hazardous waste, as required under 40 CFR Part 268. Both these regulations require a demonstration of the long-term performance of the WIPP repository.

To obtain the necessary data to demonstrate compliance with these regulations, wastes will be placed underground for the purpose of conducting tests to determine more precisely the impacts of the waste on the repository environment. The results of these and other tests will determine what additional measures, if any, are needed to comply with applicable regulations. Information on the chemical, physical, and radiochemical properties of TRU waste is necessary for the interpretation of experimental results.

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