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CHALLENGES IN RH-TRU WASTE MANAGEMENT: INTEGRATION OF REGULATORY AND SAFETY REQUIREMENTS

Clayton Gist, Chuan-Fu Wu
DOE Carlsbad Field Office

Miriam Whatley, Susan Scott
Westinghouse Waste Isolation Division

L. Richie Spangler
R. F. Weston

ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is establishing a remote-handled transuranic (RH-TRU) waste management program in support of the Department of Energy (DOE) objective of beginning RH-TRU waste disposal operations in 2002. The program incorporates lessons learned from contact-handled TRU (CH-TRU) waste management and recommendations from the National Academy of Sciences (NAS), the Nuclear Regulatory Commission (NRC), the Environmental Protection Agency (EPA) and the Environmental Evaluation Group (EEG). The principle of maintaining radiation exposure to levels that are as low as reasonably achievable (ALARA) in waste management activities is also incorporated as in documents such as: the NAS WIPP Committee's interim report on "*Improving Operations and Long-Term Safety of the WIPP,"* April 2000 (1); and the "*Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste,"* November 1997 (2).

This paper focuses on the approach to integrate regulatory and safety requirements for RH-TRU waste characterization, while protecting the workers, the public and the environment.

INTRODUCTION

The WIPP was sited, designed and constructed to permanently dispose of the nations defense-generated transuranic (TRU) waste. The DOE inventory comprises two categories of TRU waste: contact-handled (CH) and remote-handled (RH) waste. RH-TRU waste is anticipated to comprise approximately 4% of the total volume of waste to be disposed at the WIPP.

CH-TRU waste primarily emits alpha radiation and can be handled under controlled conditions without any shielding beyond the container itself. The maximum radiation dose rate at the container surface is 200 millirems per hour. RH-TRU waste emits gamma and neutron radiation and contains radionuclides with relatively short half-lives (typically 30 years or less) and must be handled and transported in

shielded casks to minimize radiation exposure to workers and the environment. RH waste has a surface dose rate of 200 millirems or more per hour (3).

The WIPP site is currently receiving only CH-TRU waste. The WIPP Land Withdrawal Act (3), Consultation and Cooperation Agreement with the State of New Mexico (4), and the environmental impact statements (5) prepared for WIPP clearly anticipated disposal of defense-related RH-TRU as well as CH-TRU, but one regulatory hurdle remains -- the definition of a satisfactory waste characterization program; one that meets the EPA's Compliance Certification, long-term disposal requirements (6,7) and addresses the Resource Conservation Recovery Act requirements contained in 20.4.1.500 NMAC (New Mexico Administrative Code) incorporating 40 CFR Part 264 (8).

To develop an appropriate characterization program for RH-TRU waste, the DOE Carlsbad Field Office is not following the CH waste characterization program as a model. Instead, DOE is using the following strategy:

- Build the characterization program solidly on the applicable regulatory requirements and guidance - determine what data are required to meet regulatory obligations.

- Maintaining radiation exposure ALARA. Impose no characterization requirements or technique for meeting a characterization requirement on a generator/storage site that increases radiation exposure to workers when it is possible to satisfy the requirement without adding this risk.

- Recognize and compensate for any technology limitation associated with characterization activities performed in a high radiation field environment.

- Apply lessons learned from the original permitting process, both with the EPA and the New Mexico Environment Department (NMED). Thoroughly scrutinize the administrative record to ensure that concerns expressed by the regulating entities in the past are not ignored.

A recent report issued by the National Academy of Science (NAS) supports the plan above. In this report, the NAS criticizes the DOE stating that "DOE should eliminate self-imposed waste characterization requirements that lack a legal or safety basis" (1). By going back to first principles in the regulations that govern the WIPP, the DOE hopes to ensure that only those items that can be directly related to a legal and/or safety basis are incorporated into the RH-TRU characterization program.

Baseline Characterization Requirements

Though the basic requirement for an approved RH-TRU waste characterization program lies in compliance with EPA and NMED disposal requirements, these requirements do not represent the

complete picture. Therefore, at the onset of the development of the program, DOE brought together a group of technical and regulatory experts to determine the requirements that would drive RH characterization. These requirements will ensure the safe transport of waste to the WIPP and safe management of waste at the WIPP with appropriate quality assurance rigor in addition to ensuring safe long-term disposal performance.

The team prepared a requirements table that directly correlated all of the waste-related attributes to the fundamental requirements. This activity included prescribing a specific compliance method only if it was stated as part of the regulatory requirement. The group's approach was to question everything. It would not be good enough to copy a requirement from another document into the table, for instance from the CH Waste Acceptance Criteria (WAC), without confirming that the regulatory requirement was traceable to the standard shown, that it clearly applied to the RH-TRU characterization program, that the compliance method was appropriately listed, and that only the requirement that was the most restrictive pertaining to a given waste parameter appeared. Subjective best management practices were not introduced into the table -- the idea was to define *exactly* what must be done to meet the legal requirements for RH-TRU characterization.

In one sense the RH-TRU characterization requirements table could not be completed because certain regulatory limits affecting characterization could not be cited from some final statutory requirement. In particular, these were disposal characterization requirements that will come from a new EPA compliance determination for RH-TRU waste and a modification to the Hazardous Waste Facility Permit (HWFP) (9). In these cases, the team inserted baseline characterization requirements that meet the higher-tiered requirements contained in 40 CFR Part191 (1) and 40 CFR Part 194 (8) and 20.4.1.500 NMAC incorporating 40 CFR 264 (9), while considering what would be acceptable for the Compliance Certification and the HWFP.

This last step was the most difficult and involved understanding the source regulations that drove the original disposal permitting of WIPP, understanding the fundamentals associated with the disposal waste characterization program including the operational and closure period performance of the facility and the long-term performance of the facility. The team would see that the long-term disposal characterization requirements and the RCRA disposal characterization requirements had areas that were alike.

Together these drivers require a characterization program that provides data on the radiological, chemical and physical properties of the waste necessary to safely manage, store, and dispose of it.

Long-Term Disposal Standards

On May 13, 1998 the EPA announced it was certifying that WIPP complied with the disposal regulations set forth at Subpart B and C of 40 CFR Part 191. In the certification process, the EPA determined that RH-TRU waste was represented adequately in WIPP's Performance Assessment (PA) and that the resulting complementary cumulative distribution function (CCDF) curves were below EPA standards. Further, EPA found that DOE's knowledge of the stored, projected, and disposal inventory

of RH-TRU waste was sufficient for PA because they had provided site-specific information regarding waste components which may be important to repository performance.

However, the EPA also determined that DOE did not define any waste characterization methods for RH-TRU waste, nor was there discussion specific to how DOE will quantify the RH-TRU waste. Therefore, to initiate RH-TRU waste disposal, DOE must define the program, and EPA must be able to approve this program and its associated quality assurance requirements through the EPA's formal audit/inspection process, allowing for public comment. The basic requirements for the EPA characterization program will be that the assumptions and conditions used in the Compliance Certification Application (CCA) for RH are met (7).

In the Compliance Certification administrative record the EPA has indicated the willingness to allow DOE flexibility in choosing appropriate characterization methods for RH waste. In the EPA Response to Comment Document, response to comments 6.C.1 and 6.C.2, EPA states:

> *"The Agency leaves the choice of characterization method(s) to the Department to allow flexibility for selecting the method appropriate for the waste stream in question. Ultimately, as part of its certification determination, the Agency will determine if the chosen methods are adequate and provide the level of detail necessary to confirm the conditions under which compliance is demonstrated through performance assessment".*

The EPA also states:

> *"…The EPA is also requiring DOE to submit evidence which demonstrates that only waste whose contents lie within limits used to demonstrate compliance are allowed to be disposed of at the WIPP. In doing so, DOE must take into account the uncertainty of the characterization method used, showing, that at the upper end of measurement uncertainty bands, the waste still lies within the limits. In this way, the EPA provides DOE the flexibility to address the challenges of diverse waste characterization, but requires that all steps in this process which may affect the demonstration of compliance are considered and addressed. The EPA believes this is an appropriate balance between flexibility and prescriptiveness…"*

In summary, the EPA will require characterization methods for RH-TRU waste that:

- provide meaningful data for the parameter being measured,
- provide data that are sensitive to the overall system model, and
- have understandable uncertainty.

Hazardous Waste Facility Permit

The NMED issued the WIPP a Hazardous Waste Facility Permit (HWFP) (9) in October 1999. In the WIPP Permit Application, DOE had requested authority to store and dispose both CH and RH-TRU waste at the WIPP; however, the Permit (Module II.C.3.h) prohibits DOE from accepting RH-TRU mixed waste at the WIPP. This prohibition was founded in the NMED's concerns that DOE had not demonstrated that RH-TRU waste could be successfully characterized in the same way as CH-TRU waste, a premise contained in the Permit Application. Specifically, the NMED indicated in written testimony on the Permit that many of the characterization techniques used for CH-TRU waste may not be applicable to RH-TRU waste. Therefore, to initiate RH-TRU mixed disposal at WIPP, the NMED must approve a modification to the permit incorporating a Waste Analysis Plan for RH-RU waste. In addition, the permit modification request must define the procedures for the storage and management of RH waste in the RH Bay of the Waste Handling Building.

RCRA requirements for waste analysis are found in 20.4.1.500 NMAC, incorporating 40 CFR Part 264.13. Owners or operators of hazardous waste disposal units are required to know the content of their wastes as follows:

> *Before an owner or operator treats, stores, or disposes of any hazardous wastes, he must obtain a detailed chemical and physical analysis of a representative sample of the wastes; at a minimum, the analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with this part and Part 268 of this chapter. The analysis may include data developed under Part 261 of this chapter, and existing published or documented data on the hazardous waste or on hazardous waste generated from similar processes (8).*

Flexibility under the RCRA regulations enters the picture when one considers the type of disposal unit the WIPP is. The WIPP facility is a "miscellaneous unit" under RCRA. The definition for a miscellaneous unit is found in 40 CFR Part 260.10 and may be summarized as follows: a miscellaneous unit is a waste management unit that *cannot* be categorized as one of

several other types of waste management units, i.e., it is *not* a container, *not* a tank, *not* a landfill, etc. Because of the unique properties associated with a miscellaneous disposal unit, the NMED must establish permit conditions including waste characterization requirements that "contain such terms and provisions as necessary to protect human health and the environment" (20.4.1.500 NMAC, incorporating 40 CFR Part 264.601).

The *appropriate* characterization requirements are then ultimately related to how well the repository will perform during the operational and post closure periods to safely isolate the waste. Data collected for RCRA compliance will demonstrate that waste emplaced at the WIPP is within the safety envelope established for the WIPP through the scientific evaluation of the repository performance (10).

Understanding the Implications of a Performance Based Approach

Simply defined, a "performance-based" approach means determining whether quantitative or qualitative data are needed and only collecting data relative to "the site decision". To interpret the appropriate performance-based approach the WIPP team looked to two EPA guidance documents. This guidance covers the testing of mixed waste and "performance-based" waste characterization.

In 1997, the EPA and NRC published guidance on the testing requirements for mixed waste in the *Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste* (62 FR 62079). This guidance emphasizes the use of process knowledge, whenever possible, to determine if a waste is hazardous as a way to avoid unnecessary radiation exposures. The NRC/EPA guidance also emphasizes flexibility in the RCRA requirements so that the ALARA concept can be incorporated into mixed waste testing activities. This guidance states:

> *The use of waste knowledge alone is appropriate for wastes that have physical properties that are not conducive to taking a laboratory sample or performing laboratory analysis. As such, the use of waste knowledge alone may be the most appropriate method to characterize mixed waste streams where increased radiation exposures are a concern (2).*

Although specific to low-level waste (LLW), the NRC/EPA guidance was developed to address the radiation exposure concern related to sampling, workup, and analysis of mixed

waste. Since workers are at greater risk to radiation exposure when handling RH-TRU waste due to the associated higher radiation levels than when they are handling LLW; this guidance was considered to contain pertinent recommendations for RH-TRU waste. This guidance also provides acceptable testing protocols "when testing is conducted" due to a lack of waste or process information, but restates that hazardous waste determinations based on generator knowledge can be used to reduce the sampling of mixed waste and prevent unnecessary exposure to radiation.

The concept of a performance-based measurement system (PBMS) was in its early stages of development at about the time the original characterization program for the WIPP was being developed. Since that time, the EPA Office of Solid Waste and Emergency Response (EPA OSWER) has published implementation standards for the PBMS and has integrated this approach into its guidance (11,12).

Test Methods for the Evaluation of Solid Waste, Phyisical/Chemical Methods, 3rd ed. as amended (SW-846), the EPA guidance typically used for characterizing hazardous waste, describes fourteen citations in the RCRA program where the use of SW-846 methods is mandatory (Update II, 60 FR 3089). As stated in the *Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste* (62 FR 62079) (2): "In all other cases, the RCRA program functions under what we call the Performance Based Measurement System (PBMS) approach to monitoring." The EPA clarified this approach in the final Federal Register Notice that promulgated Update III of SW-846 (13).

In light of the newer guidance, some of the older guidance was reevaluated for its applicability. The EPA guidance document *Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes* (OSWER 9938.4-03) (14) was published at the time that the original WIPP waste characterization program was being developed. This guidance document recommends Acceptable Knowledge (AK) as a characterization method and lists situations where it may be appropriate. Situations applicable to RH-TRU waste from this list include:

- Health and safety risks to personnel would not justify sampling and analysis (e.g., radioactive mixed waste).

- Physical nature of the waste does not lend itself to taking a laboratory sample.

Incorporating the Regulatory Drivers and Guidance in the RH-TRU Waste Characterization Program

Based on the evaluation of the regulatory drivers and the new regulatory guidance, the proposed RH-TRU waste characterization program incorporates a PBMS approach to ensure the regulatory requirements are met, while protecting workers from unnecessary radiation exposure. The PBMS approach is incorporated in the RH-TRU waste characterization program by establishing the data quality objectives (DQOs) and waste parameters that are necessary to ensure that all information that must be known to store or dispose of the RH-TRU waste is collected. The approach also includes the allowable methods for each parameter and the method-specific quality assurance objectives (QAOs) that are necessary to ensure that facility performance, worker safety, and public safety are maintained.

The *US EPA Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process* (15) specifies the following process for establishing DQOs:

1) Clarify the study objective;
2) Define the most appropriate type of data to collect;
3) Determine the most appropriate conditions from which to collect the data; and
4) Specify acceptable levels of decision error that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

This process was followed for establishing the DQOs proposed in the RH-TRU waste characterization program:

1) Evaluate the facility performance data requirements needed to ensure facility performance and protection of human health and the environment (i.e., study objective);
2) Define specific waste parameter data (i.e., appropriate type of data to collect);
3) Determine characterization technique(s) to use (i.e., appropriate conditions from which to collect the data); and
4) Specify quantity and quality of the data in the individual method QAOs for precision, accuracy, completeness, comparability, and representativeness based on how each of these QAOs can be applied to the individual method (i.e., acceptable levels of decision error).

To evaluate the facility performance data requirements needed to ensure facility performance and protection of human health and the environment for the RH-TRU program, Sandia National Laboratory looked at how well the WIPP repository would perform specifically relating to RH-

TRU waste (i.e., filled to the legal RH waste maximum of 7,080 cubic meters). Sensitivity analyses were conducted on radioactive and non-radioactive waste components recognized by EPA as most impactive to repository long-term performance (10).

Building upon the accepted baseline assumptions in the CCA, Sandia assigned "extraordinary" assumptions or bounding limits to ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am, the four most prevalent radionuclides. These radionuclides were analyzed because they are the radioactive components in RH-TRU and RH-TRU mixed waste that present the largest fraction of the total expected WIPP waste TRU curie content.

Sandia's studies also evaluated non-radioactive impacts to long-term repository performance. Results from WIPP's CCA and validating Performance Assessment Validation Test (PAVT) indicated that three non-radioactive waste components could potentially impact repository performance: free water, biodegradables, and corrodible metals (11).

Assuming, for example, that EPA standards allow for 1% free water per drum of waste, Sandia bounding limits assumed 50% water per drum. Similar bounding assumptions were applied to biodegradables (plastics, cellulosics, rubber), and finally to metals. The repository showed no adverse response when subject to such bounding maximum values.

In addition to those performance standards set the by the EPA, the WIPP HWFP sets limitations on the allowable emissions from underground rooms containing waste. This environmental performance standard consists of controlling volatile organic compound (VOC) emissions to ensure safety to workers and the public. The standard for VOC emissions is based on container headspace gas concentrations (gases accumulated at the top of the waste container from waste decay and in-transit agitation), filter type, the number of emitting containers and the mine ventilation rate in the WIPP underground.

DOE has evaluated the maximum potential for VOC emissions from RH-TRU waste. Again, bounding limits were applied to total underground disposal room emissions from RH-TRU waste. RH waste canisters were assumed to be filled to saturation with the VOCs of concern.

Contributions to VOC emissions from RH-TRU were so small that the CBFO would propose reducing the permit's overall limit on VOC emissions rate by the bounding amount that could be generated by RH waste rather than ensure compliance through sampling. This would: 1) eliminate the need for direct measurements of the headspace gases, 2) ensure the safety of workers who would otherwise have to conduct headspace sampling, and 3) ensure compliance with the HWFP environmental performance standards.

The CBFO intends to use the bounding analysis available within Sandia studies and the calculations pertaining to RH-TRU VOC emissions to minimize the number of waste parameters that must be reported. This is consistent with the performance-based approach and is protective because of the conservatism built into the RCRA and Sandia studies.

Preparing the RH-TRU Waste Characterization Program

An appropriate RH-TRU characterization program must provide data on the radiological, chemical and physical properties of the waste necessary to manage, store, and dispose of the waste in accordance with regulations. The next step is to define specific waste parameter data that is necessary based on the evaluation of the facility performance and regulatory requirements.

As discussed earlier, the results of the performance assessment and VOC emissions modeling focusing on RH-TRU waste show that only a limited amount of waste parameter data is necessary to ensure facility performance and protection of human health and the environment.

In laying out the proposed characterization program for RH-TRU waste, the CBFO has determined that the long-term disposal and RCRA requirements can be met by determining the physical form and volume of the waste, applying required hazardous waste codes, verifying that there are no prohibited items in the waste and obtaining information on the total TRU curie content of the waste.

At this point, the CBFO must determine the actual characterization techniques that should be applied for determining the waste parameters that have been identified. The CBFO believes that determining the appropriate characterization techniques must also consider:

- Potential risks to workers from radiation exposure, and

- Technologies available to characterize RH waste.

In those instances, where it is possible, the CBFO believes that the characterization information should be obtained through review and audit of existing knowledge of the waste (i.e., acceptable knowledge [AK]) in order to reduce/eliminate potential risks to workers.

AK is the documented knowledge of the processes and materials that generated the waste supported by accompanying records; administrative and quality controls associated with those

processes; and sampling and analytical data obtained on the waste outside of the RCRA program.

In those cases where knowledge of the waste is limited, other characterization techniques must be applied. The existing HWFP provides characterization techniques for characterizing CH-TRU waste. Some of these techniques may be applied to the RH-TRU waste characterization program; however, others are not applicable due to technology limitations.

Based on the required waste parameters, radiography and visual examination characterization techniques may be used to supplement limited AK. Radioassay or radiochemistry could also be used to supplement limited AK. Due to the technology limitations associated with characterizing RH-TRU waste, these techniques may be inappropriate for use with some containers. In those cases where the these measurements are needed to supplement limited AK documentation, the CBFO believes the generator sites should use randomly selected containers from a sub-population of the waste containers to gather data that would be applied to the waste stream as a whole.

The final step to preparing the RH-TRU waste characterization program is to identify the QAOs associated with each of the characterization techniques. The CBFO has developed individual QAOs for each of the characterization methods based on the robustness of the facility performance and technology limitations of the characterization methods. These method-specific QAOs are part of the proposed permit modifications to the HWFP and the proposed RH-TRU Waste Acceptance Criteria.

CONCLUSION

The approach to CBFO's proposed RH-TRU characterization program is fundamentally based on the NAS, National Research Council recommendation that "DOE should eliminate self-imposed waste characterization requirements that lack a legal or safety basis." In the spirit of this recommendation, the RH-TRU waste characterization program was developed by going back to "first principles" in the regulations that govern the WIPP in order to ensure that only those items that can be directly related to a legal and/or safety basis are incorporated.

The CBFO is not using the CH-TRU waste characterization program as a model, but going back to the foundational needs for a waste characterization program. This is accomplished with the performance-based approach in mind to ensure that any data collected are truly pertinent to what must be known to safely manage and dispose of this waste at WIPP.

The CBFO understands that there are other considerations its regulators must consider that are outside of what is legally necessary to ensure safety and compliance, namely these regulators are accountable to address public concerns and must have confidence in the DOE's ability to accurately document its waste contents. Therefore, the time frame for approval of the RH-TRU waste characterization program is unknown.

The proposed RH-TRU characterization program differs from the CH-TRU characterization program on many fronts, most notably as follows:

- It is possible to meet all of the disposal characterization requirements using AK.
- Headspace gas sampling and analysis are not proposed.
- Solids sampling and analysis are not proposed.
- It is not required to track the quantities of specific radionuclides or measure/estimate the material parameter weights including cellulosics, plastics, and rubber.

In essence, CBFO believes that a compliant waste characterization program for RH-TRU waste should only require knowledge of total TRU curie content and total emplaced waste volume, physical waste form, hazardous waste codes and the absence of prohibited items. However different the program may be from that presented in the CH-TRU waste analysis plan, the CBFO believes that the approach being taken is fundamentally sound. The approach is based on meeting the safety and legal requirements and serving the nation's taxpayers by not expending funds to collect data that add no additional benefit to environmental or public safety.

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