

CONTACT HANDLED TRANSURANIC WASTE CHARACTERIZATION REQUIREMENTS AT THE WASTE ISOLATION PILOT PLANT

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) was designed and built by the U.S. Department of Energy (DOE) for the permanent disposal of the nation's defense transuranic waste. Protection of the safety, health, and the environment relies in part on the quality and completeness of the information about the waste that is shipped to the WIPP. Waste characterization requirements are specified the Waste Acceptance Criteria (WAC), the U.S. Environmental Protection Agency (EPA) Certificate for disposal, the U.S. Nuclear Regulatory Commission (NRC) Certificate for transportation, and the New Mexico Environment Department (NMED) Hazardous Waste Facility Permit (HWFP).

The Environmental Evaluation Group (EEG) has provided extensive technical reviews of these measures over many years. Our reviews have considered the need for a requirement as well as whether a proposed change is justified. EEG's views on waste acceptance criteria and waste characterization continue to evolve.

Any proposed relaxation of waste characterization requirements needs to be evaluated in sufficient detail to convince the regulatory agencies, the EEG, and others, that the modification is justified. Implicit in this approach is the understanding that any changes need to be made in a step-by-step transparent process and through existing regulatory procedures of the NMED, the EPA, and the NRC. This approach requires adequate justification and has worked effectively to obtain approval for a number of changes from all three outside regulatory agencies.

EEG has found that the waste characterization requirements from the three regulatory agencies and the DOE contain considerable overlap (i.e., contain the same requirements). The HWFP and Appendix A of the CH WAC are the more prescriptive for specifying compliance. When considering a requirement change to either of these documents, the effect of the change on all requirements, including those issued by other agencies, should be noted and evaluated for its potential impact across agencies. This paper identifies areas where it might be appropriate for the DOE to pursue reductions in waste characterization requirements through the appropriate permit or certificate change process.

INTRODUCTION

The Waste Isolation Pilot Plant was built by the U.S. Department of Energy for the permanent disposal of the nation's defense transuranic (TRU) waste. The waste is packaged at the generator or storage sites and transported to the geologic repository located in southeast New Mexico. The WIPP Land Withdrawal Act specifies a disposal capacity of 176,000 cubic meters of TRU waste [1]. As of January 2004 approximately 17,000 cubic meters of CH TRU waste has been permanently emplaced [2]. Protection of the safety, health, and the environment from WIPP operations relies in part on the quality and completeness of the information about the waste that is shipped to the WIPP. This quality and completeness is created through the waste characterization requirements established in various regulatory documents.

Waste characterization requirements are specified by the three WIPP regulatory agencies and the DOE: (1) the New Mexico Environment Department (NMED) through the Hazardous Waste Facility Permit (HWFP), (2) the U.S. Environmental Protection Agency (EPA) through the transuranic waste disposal Certification, (3) the U.S. Nuclear Regulatory Commission (NRC) through the TRUPACT II Authorized Methods for Payload Control (TRAMPAC), and (4) the Department of Energy (DOE) through the Waste Acceptance Criteria (WAC). A number of the waste characterization requirements are included in more than one set of requirements. Of the four agencies, the requirements of the NMED for the Hazardous Waste Facility Permit tend to be the most prescriptive.

All waste characterization requirements were, at the time they were proposed and put in place, believed to be important for the protection of the worker safety, public health and the environment. The current waste characterization requirements were developed through much technical discussion, reference to accepted standards and codes, and considerable effort by DOE employees, DOE contractors, regulatory agency staff, regulatory agency contractors, the staff of the Environmental Evaluation Group (EEG), interested organizations, and members of the public.

The Environmental Evaluation Group was created by the State of New Mexico and the Department of Energy in 1978 to provide a technical review of the WIPP facility to ensure the protection of the public health and safety of the people of New Mexico. Since its formation, the EEG has recognized the importance of transuranic waste acceptance criteria and waste characterization to the operation of the WIPP.

The DOE began shipping contact handled TRU waste to WIPP in March 1999. EEG's views on the waste acceptance criteria and waste characterization have evolved to reflect what has been learned about the waste at the sites in DOE complex. The basis for EEG's understanding of the issues stems from its focus on operational issues since WIPP began receiving waste, participation as observers in waste characterization audits at the generator sites, review and comment on proposed changes to waste acceptance criteria, EEG's comparison of risks due to various constituents in the waste, EEG's response to questions from National Academy of Science (NAS) WIPP committees, and EEG's detailed technical review of every Class 2 and Class 3 Permit Modification Request proposed by the DOE to the New Mexico Environment Department.

This paper summarizes: (1) the development of waste characterization requirements, (2) the EEG approach to waste characterization requirements, (3) overlap of the requirements across agencies, and (4) EEG recommendations for waste characterization requirements. Supporting detail can be found in EEG-86 issued in September 2003 [3]. The report is available on EEG's web site (<http://www.eeg.org>).

HISTORY OF WASTE CHARACTERIZATION REQUIREMENTS

The DOE was self-regulating (except for the U.S. Department of Transportation shipping requirements) for all waste characterization criteria prior to 1989. The DOE, through its Orders and policies as far back as 1979 began to develop criteria protective of worker and public health and safety for anticipated operations at the WIPP. The criteria in the original WAC included limitations on: free liquids; pyrophoric, toxic and corrosive materials; explosive and compressed gas; gas generation and criticality. Container and certification requirements were also included [4]. Subsequent revisions of the WAC have consolidated into this one document requirements by each regulatory agency as these requirements became applicable. In April 2002 the WAC was revised to contain only criteria for CH TRU waste [5]. Up to this time the WAC covered both CH TRU and remote-handled (RH) TRU waste.

The first set of requirements from a regulatory agency came from the NRC issuance of the Certificate of Compliance (C of C) of the TRUPACT-II Type B Package (NRC 71-9218) in 1989 [6]. These

requirements included physical, nuclear and chemical properties and are included in the TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) [7]. Many of the properties were similar to those already in the WAC. In addition, there were extensive requirements dealing with control of the concentration of hydrogen, methane, and flammable volatile organic chemical (VOC) concentrations. Quality assurance (QA) requirements for packaging were also specified in the TRAMPAC.

The 1992 Land Withdrawal Act (LWA) specified that waste coming to WIPP must be transuranic waste (defined in the LWA as, "waste containing more than 100 nanoCuries of alpha emitting transuranic isotopes per gram of waste with half-lives greater than 20 years.") [8]. Moreover, it was limited to waste generated by atomic energy defense activities of the United States. The LWA also specified a regulatory role for the EPA in ensuring long-term compliance of the WIPP repository. This role for EPA led to several additional waste characterization criteria.

EPA waste characterization requirements provide the most stringent requirements for quantification of radionuclides and also include several other requirements. The official methodology for radionuclide assay is primarily non-destructive assay (NDA) and is contained in Appendix A of the CH WAC [9]. Modifications to Appendix A require EPA approval. The NDA methodology prescribed in Appendix A is also used in quantifying NRC and DOE radiological requirements.

The HWFP became effective in December 1999 [10]. The HWFP adds several waste characterization requirements and provides specific details of procedures that must be applied in meeting the requirements. Several requirements originally established in NRC and EPA criteria are included in the NMED's HWFP, and the methodology for meeting these requirements is quite prescriptive.

EEG Philosophy on Waste Characterization Requirements

Since waste emplacement began in March 1999, DOE has been seeking relief from some waste characterization requirements. Claims have been made that removal of unnecessary waste characterization requirements can increase shipping rates to WIPP [11]. The EEG focus is on health, safety, and environmental considerations, not schedule implications.

Minimizing the risk and exposure to workers performing waste characterization and minimizing the costs due to characterization are two other issues often discussed by the DOE when proposing reductions in waste characterization requirements. The EEG has seen no evidence that radiation doses to waste characterization workers are significant and, in the absence of data indicating otherwise, should not be a justification for eliminating or reducing a waste characterization requirement. Appendix E of a recent NAS WIPP committee report shows that the total radiation doses for activities including waste characterization are quite low [12].

"During calendar year 2002, the Savannah River Site processed and characterized 3,774 CH-TRU waste drums for transportation to the WIPP. The collective dose to the 83 persons processing, characterizing, or transporting these drums was 2,694 person-millirem". The average dose was about 33 mrem per person [13].

"In 2002, 215 persons (including waste handlers, on-site transporters, and others involved in drum processing) were monitored at the Rocky Flats Environmental Technology Site. Of these, 205 had measurable exposures. The collective dose to all monitored persons was 36,800 person-millirem," or an average of about 171 millirem per person [14]. Based upon an effort to streamline the characterization process, it appears that the cumulative dose per shipment has been reduced from 250 millirem in 2000 to 50 millirem in 2003. [15].

Costs of waste characterization are significant and it would be desirable to continue to reduce or eliminate those requirements where it is prudent. Few of the waste characterization requirements can be evaluated exclusively by a traditional cost/benefit comparison. A rigorous evaluation through the regulatory process is the best way to decide on changes in the waste characterization requirements.

Since 1999 the EEG has stated its belief that the overall waste characterization requirements are excessive. Any proposed relaxation needs to be evaluated in sufficient detail to convince regulatory agencies, the EEG, and stakeholders that the modification is justified. Changes need to be made in a transparent, step-by-step approach and through the existing regulatory procedures of NMED, EPA, and NRC. This approach requires adequate justification and has worked effectively to get approval for a number of changes from all three regulatory agencies. Moreover, as noted by the DOE, the regulatory agencies have indicated a preference for this approach.

Shortly after the WIPP began receiving waste in 1999, the EEG published calculations comparing the risks from the hazardous constituents and the radioactive constituents in the WIPP inventory [16]. The carcinogenic risks were quite low for both categories, with the expected carcinogenic risk from the hazardous constituents four orders of magnitude less than the expected risk from the radiological constituents to workers from routine operations and operational accidents. Prudence suggests that mitigating the relatively small risk from the non-radiological constituents should not be the primary cost in waste characterization. Waste characterization efforts should focus on reducing the risk of release of radiological constituents.

The EEG recognizes that considerable uncertainty exists in the characteristics of wastes that may come to WIPP in the future. For this reason, the EEG's evaluations of waste characterization requirements attempt to also address the potential future characterization needs for presently uncharacterized waste streams.

The relaxation of audit and Quality Assurance and Quality Control (QA/QC) requirements is not an appropriate way to reduce any regulatory burden.

OVERLAP OF WASTE CHARACTERIZATION REQUIREMENTS

The EEG has found that the waste characterization requirements from the three regulatory agencies and the DOE contain considerable overlap (i.e., contain the same requirements). Despite this overlap, the methods to be used for meeting these requirements are somewhat different. The most complete methods of reaching compliance when requirements coincide are usually those found in the HWFP (NMED) and the 40 CFR 194 (EPA) radioassay compliance implementation found in Appendix A of the CH WAC (DOE).

For example, the maximum of 325 fissile gram equivalent (FGE) requirement in each TRUPACT-II is in the TRAMPAC. Yet, the most complete waste characterization method to ensure compliance with this requirement is specified in Appendix A of the CH WAC, where radionuclide measurement requirements are specified to meet the 40 CFR 194.24 criteria.

Similarly, requirements for limitation of liquids to less than 1% by volume in waste containers are specified by the waste characterization requirements of each agency—as part of the TRAMPAC (free liquids), 40 CFR 194.24 (free water), the HWFP (residual liquid), and the CH WAC (free water, residual liquid, currently total residual liquid). For the purposes of this paper, EEG refers to all of these as the “presence of liquids.” The most complete method for determining the presence of liquids, however, is the HWFP requirement that each container must undergo either radiography or visual examination.

A change in one set of requirements could have implications for other requirements. For example, if headspace gas (HSG) sampling and analysis was eliminated as a HWFP requirement, it would be necessary to use an alternate methodology to ensure adequate control of flammable gas requirements in the TRAMPAC. Alternate methods exist in the TRAMPAC for flammable gas determination, but it is important to have appropriate QA to sustain an adequate level of assurance.

The overlap of requirements of each agency inherently complicates change. When DOE is considering a requirement change in either the HWFP or Appendix A of the CH WAC, the effect on all requirements, including those issued by other regulatory agencies, should be noted and evaluated for its impact on requirements across agencies.

EEG's reviews of the HWFP and proposed permit modification requests (PMRs) included detailed technical evaluations of whether the HWFP or a PMR would accomplish the required regulatory objectives. However, with our review of modification requests to the HWFP, we have also evaluated the effect that changes would have on existing requirements of the NRC, the EPA, and DOE (in the CH WAC). The HWFP is usually the most prescriptive in specifying how the requirement will be met. The prescriptiveness of the HWFP increases the assurance that the requirements of the other regulatory agencies will be satisfactorily met.

The DOE has submitted many Class 2 and Class 3 Permit Modification Requests to NMED WIPP Hazardous Waste Facility Permit. Some have been accepted, some rejected, some withdrawn, and some are pending. DOE has secured relief from a number of requirements. For example, by using the permit modification process, the DOE has obtained a reduction of the headspace gas sampling requirement for thermally treated waste from Rocky Flats Environmental Technology Site (RFETS), a reduction in the visual examination requirement for waste from RFETS, and a reduction in headspace gas analysis for waste from the Idaho National Engineering and Environmental Laboratory (INEEL). These reductions in waste characterization requirements saved \$30 million, saved \$19 million, and allowed DOE to meet a deadline to remove 3100 m³ from INEEL, respectively. From the time of application through the time of approval, these changes were each achieved in four months or less.

RECOMMENDED WASTE CHARACTERIZATION REQUIREMENTS

Based on our reviews, EEG offers the following observations and recommendations for waste characterization requirements. The cost figures quoted below were provided by a recent DOE study [17] and are used in this paper as provided, without offering any opinion on their accuracy.

Acceptable Knowledge

Acceptable Knowledge (AK) is the principle waste characterization technique for all of the regulatory agencies. AK is one of the least costly of the waste characterization techniques at \$87/container. This information is developed on a waste stream basis rather than for individual containers. It is the compilation of all useful knowledge about a particular waste stream. The NMED HWFP requires AK to be organized in a report on each waste stream, from general facility information (areas and facilities) to specific information for the waste stream (description of the generating process to include buildings, process flow diagrams, material inputs, types and quantities generated, and storage locations). An overall AK summary report is generated after records are found, documents are indexed, and applicable waste and facility information has been organized. AK is necessary and should be retained. At this time EEG supports the use of the HWFP AK requirements since they are the most explicit.

Headspace Gas Sampling and Analysis

Headspace gas (HSG) is measured both to meet transportation requirements and to meet HWFP requirements. The HWFP requires HSG be conducted on 100% of all non-thermally treated waste containers. Some thermally treated waste streams have been approved for lesser sampling through the permit modification process. At \$620/container, headspace gas sampling and analysis is one of the more expensive costs-per-container waste characterization techniques. These techniques can be viewed as confirmation of AK or as a process for discovering deviations from the currently known AK.

The method is used to ensure compliance with the Room Based Concentration Limits, although compliance is also established by sampling of the air from the underground rooms. Since HSG is required by the HWFP, it is a direct and convenient (but not the only) way of assuring that flammable gas concentration limits in the TRAMPAC are met.

One of EEG's concerns about the complete elimination of HSG sampling is that knowledge of the waste may be much less certain on retrievably stored waste which has not yet been characterized. Our primary concern is with organic sludges and older waste containers where knowledge of the waste is of lesser quality.

It is desirable to maintain a comprehensive HSG program for WIPP CH TRU waste. However, it should be possible to require less than 100% headspace gas sampling in some cases.

Drum Age Criteria

Drum Age Criteria (DAC) is necessary to ensure that Headspace Gas sampling of waste containers will measure gas concentrations that are at least 90% of equilibrium. The times to reach that concentration vary widely, currently from 4 days to 283 days, depending on the waste type, packaging configuration, and the container filters.

Physically, the DAC is an integral part of the sampling process for headspace gases, but when treated as an isolated cost, meeting DAC requirement costs \$32/container.

Using the permit modification process, the DOE succeeded in obtaining changes to the initial DAC values in the HWFP, but it took three submittals before this was achieved. Details can be found elsewhere (EEG-86).

The DAC is also used by DOE to meet the TRUPACT-II requirements when flammable gases are to be actually measured. Hence, DAC values are required in both the HWFP and the TRAMPAC. The EEG supports this requirement.

Real Time Radiography

All CH TRU waste containers destined for WIPP are required by the HWFP to undergo either radiography or visual examination. Usually retrieved wastes undergo Real Time Radiography (RTR) and newly generated wastes are examined by visual examination. RTR has been a very effective means of verifying AK and discovering prohibited items in waste containers. It is also used to show compliance with several EPA and TRAMPAC requirements.

The overall radiography program is an important part of the WIPP waste characterization program and should be retained. It may be possible to reduce some of the detailed procedural requirements in the HWFP.

Visual Examination for Retrievably Stored Waste

A small percentage (normally 1-2%) of retrievably stored waste is required by the HWFP to undergo visual examination for confirmation of RTR. The Visual Examination (VE) process has the potential for slightly greater personal radiation exposure than the other waste characterization requirements, although the EEG has seen no data to indicate that exposures are significant enough to justify reducing the requirement. The DOE has been successful in modifying the HWFP on retrievably stored visual examination and this would be the preferred process for seeking further reductions.

Visual Examination for Newly Generated Waste

VE is the method DOE usually prefers for newly generated waste because it can be done at the time the waste container is being filled. The EEG has not objected to any part of this requirement except to state that the requirement for two trained VE operators to perform the visual process "may be overkill" and that a single verification should be adequate.

Homogeneous Sampling and Analysis

About 0.5% of the inventory will undergo coring, sampling and analysis. This is among the most expensive of the characterization process at a per drum cost of \$24,000 for coring and \$63,000 for analysis. The DOE has successfully pursued changes to the HWFP on homogeneous sampling and analysis issues, the major change being to add to the statistical quality control method initially required for newly generated homogenous wastes so that the retrievably stored process could also be used. Quality control requirements for semi-volatile organic compounds (SVOC) specific analytes (pyridines and cresols) were changed in a permit modification request. One of the first HWFP permit modification requests successfully altered the requirement for core sampling to allow one sample to be taken from the core rather than the three samples from each core that was previously required.

EEG continues to believe that the homogeneous sampling and analysis are unnecessary characterization requirements in the HWFP. Our principal reason for this position is that the data are not used for any additional regulatory control. Metals releases from accidents or long-term processes would be controlled by radionuclide control requirements. Volatile organic compound (VOC) concentrations and semi-volatile organic compound concentrations can be determined by headspace gas sampling or the Confirmatory VOC Monitoring Plan.

Level II Management and Waste Certification HWFP Requirements

The DOE has listed these management and certification requirements as characterization activities in a recent cost analysis [18]. EEG has only recently commented on these requirements [19]. Our recent evaluation indicates that the required procedures are very detailed and somewhat redundant. This may be one of the areas to which the general EEG comment, "We believe waste characterization requirements are excessive," applies.

Characterization Support HWFP Requirements

The HWFP requires the DOE to conduct an audit and surveillance program to ensure that waste characterization sites conduct waste characterization activities in accordance with the HWFP Waste Analysis Plan and that the information supplied by each site is managed properly (records management). The HWFP also requires specific training for all areas discussed above. The EPA criteria also require these activities, as does the DOE itself.

EEG remains supportive of the WIPP audit and surveillance program. EEG does not believe the relaxation of audit requirements and QA/QC is an appropriate way to reduce the regulatory burden.

EPA Non-Radiological Requirements

EPA limits the total amount of free water in the repository to 1685m³, which is equivalent to an average of 1% of the volume of a waste container. This limitation reflects the assumptions DOE used for waste room modeling in its application to EPA [20]. This requirement could be satisfied by a repository (or waste panel) average rather than on each waste container. However, transportation, HWFP, and WIPP Operations and Safety requirements all limit free water to 1% on each container.

EEG believes the free water limit of 1% on each container should not be changed since it is required for the transportation, HWFP, and WIPP criteria, and is probably the most cost-effective way to ensure the EPA's requirement is met.

The EPA has a minimum requirement for the quantity of ferrous metals in the repository, to maintain a reducing chemical environment in the repository in order to minimize radionuclide mobility. Waste drums and other containers provide more than the minimum ferrous metals requirement. The ferrous metal requirement can continue to be met by counting waste containers emplaced in the repository and multiplying the number of containers by the amount of iron in each container.

The presence of cellulose, plastic, and rubber could cause generation of gas in sealed repository rooms which could affect the release of radionuclides from the repository. Because of this potential, the EPA has set a maximum repository limit on the kilograms of CPR. At present the mass of CPR is estimated or measured in each container during either radiography or visual examination.

EPA's residual liquids, non-ferrous metal and cellulose, plastic and rubber requirements should remain and can continue to be determined as they are now, by the RTR and VE requirements of the HWFP. However, the required CPR data could be provided to EPA on a waste stream rather than individual container basis.

EPA Radiological Requirements

The EEG agrees with the radioassay requirements for contact-handled transuranic waste specified in Appendix A of the CH WAC and the current procedures for modifying the document.

Current requirements for reporting the 10 required radionuclides should remain. One important radionuclide not included in the 10 required radionuclides is ²⁴¹Pu. It is the primary contributor to total WIPP activity (60% of the activity emplaced to date) and it decays with a 14.4 year half-life to ²⁴¹Am, which is an important radionuclide. The sites are reporting ²⁴¹Pu now, although not required to do so, and this reporting should continue.

The current requirement that all radioassay should be performed by WIPP-certified assay systems should be maintained.

Justification for less than 100% quantification and determination of isotopic ratios may be possible for some, but certainly not all, waste streams.

NRC Container Properties

Most container properties involve weights and listing of acceptable containers. However, NRC has three container properties for which compliance is verified by meeting the waste characterization requirements of the current HWFP. These are:

- (1) Filter vents are required in each waste container.
- (2) Residual liquids shall not be more than 1% of the volume in any payload container. This is verified by RTR, VE, or AK.
- (3) Sealed containers greater than four liters (nominal) are prohibited unless in waste material Type II.2 packaged in a metal container. Compliance is determined by RTR, VE, or AK.

The TRAMPAC requirements for residual liquids, filter vents, and the sealed container prohibition should be retained.

NRC Nuclear Properties

In order to ensure that nuclear criticality will not occur during shipments it is necessary to limit the FGE in individual waste containers. This requires quantification of all fissile radionuclides. Although a number of transuranic radionuclides can be fissionable, the most important ones at WIPP are ^{239}Pu , ^{235}U , and ^{233}U . Therefore, it is necessary to determine the quantity of these three radionuclides through the non destructive assay. Requirements in Appendix A of the CH WAC are currently used to satisfy all NRC radioassay requirements even though this is not mandated by the TRAMPAC. All nuclear property requirements should be retained and Appendix A of the CH WAC methodology should be used.

NRC Gas Generation Requirements

Requirements for measuring the chemical, payload classification, and radionuclide concentrations necessary to ensure hydrogen gas concentration criteria are met must be retained. There have been many changes, via the Certificate of Compliance (C of C) revision process, which have allowed additional containers to be shipped without changing the hydrogen gas criteria and additional changes may be justifiable in the future.

The flammable gas concentration limit of ≤ 500 ppm should be retained as described in the current revision of the TRAMPAC. Alternate methods (with appropriate QA) will be necessary if future changes to the HWFP affects the use of HSG sampling as the method for meeting this criteria.

WIPP Waste Acceptance Criteria

The WAC has served a useful historic purpose in developing initial criteria that have been adopted by the other three regulatory agencies. Currently it is a useful document for listing most of the requirements from all four sets of criteria. It would be more useful if the technical justification for each criteria or requirement were restored.

The unique role of the WAC in including any necessary operational safety and health requirements not included elsewhere is very important and must be constantly evaluated via the technical safety requirements (TSR) portion of the CH TRU Safety Analysis Report [21], and any necessary changes incorporated into the CH WAC.

SUMMARY OBSERVATION AND RECOMMENDATIONS

EEG's views on waste acceptance criteria and waste characterization continue to evolve. Shortly after the WIPP began receiving waste in 1999, the EEG published calculations comparing the risks from the hazardous constituents and the radioactive constituents in the WIPP inventory. The carcinogenic risks were quite low for both categories, with the expected carcinogenic risk from the hazardous constituents four orders of magnitude less than the expected risk from the radiological constituents to workers from routine operations and operational accidents. Prudence suggests that mitigating the relatively small risk from the non-radiological constituents should not be the primary cost in waste characterization. Waste characterization efforts should focus on reducing the risk of release of radiological constituents.

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