White Paper

Improvements in the RCRA Waste Characterization Program

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Section 1

Introduction and Summary

The Waste Isolation Pilot Plant (WIPP) is a geological repository near Carlsbad, New Mexico, which is used for permanent disposal of transuranic (TRU) radioactive waste. It is permitted under the Resource Conservation and Recovery Act (RCRA), as applied by the state of New Mexico, an authorized state under RCRA. The New Mexico Environment Department (NMED) issued the “WIPP Hazardous Waste Facility Permit” (the “Permit”) on October 27, 1999.

A key element of the Permit relates to extensive waste characterization requirements placed on waste generators who intend to send TRU wastes to the WIPP. These waste characterization requirements have proven to be very costly, on the order of $10,000 to $20,000 per container of waste material. Characterization is also time-consuming, and there can be safety concerns related to some characterization activities.

There has now been over three years experience with the Permit, including the generator characterization and subsequent disposal of about 40,000 containers of waste at the WIPP. Based on this experience, as well as my own management background with the national RCRA program, it is proposed that five major areas related to waste characterization be considered for improvements in order to increase program efficiency.

These five areas are (1) clarification of permit requirements, (2) a statistical approach to container characterization, (3) sampling methods and quality assurance, (4) audit and surveillance processes, and (5) “acceptable knowledge” activities. These five areas are outlined below, and are discussed in more detail in subsequent sections.

Clarification of Permit Requirements

There are many complex Permit requirements which have proven difficult to apply in a consistent manner by generators as they characterize their wastes for shipment to WIPP. It is therefore proposed that a concise, “plain English” guidance document be prepared to assist generators and others in better understanding key Permit requirements.

Included in the document would be a brief summary of key characterization experience to date in order to illustrate Permit requirements which have not been clear or consistently applied. This would be followed by suggested interpretation of important Permit terminology and processes.

This clarification activity should be coordinated with, and perhaps included within, the “methods manual” which RSI/LANL are to prepare for WIPP in FY 03.
Statistical Approach to Container Characterization

The Permit requires characterization of each waste container destined for disposal at WIPP. This “container-based” process is much different than the national RCRA approach which is more “waste stream-based.”

Specifically, the Permit approach involves radiographing or visually examining the contents of each container in order to ensure that no “prohibited items” are sent to WIPP, as well as verifying waste forms. Waste characterization also requires collecting and analyzing headspace gases from waste containers to identify the type and concentration of volatile organic compounds (VOCs).

In practice, this detailed analysis of each drum has proven to be quite time-consuming and expensive. Since over 800,000 drum equivalents are planned for disposal at WIPP, it would be much more efficient to test representative samples of the containers in a waste stream, as is the normal process under RCRA.

The basic objective in RCRA is that enough characterization must be done to ensure that the contents of a container are sufficiently understood to manage the waste safely. This is usually achieved by knowledge of the process by which the waste was generated, along with representative sampling of the waste streams involved.

Therefore, it is proposed that, rather than characterizing each container, statistical analysis be applied to select a representative number of containers for detailed analysis. This representative sample approach would involve using existing knowledge of the particular type of waste in order to select the appropriate sample size for representative testing.

Finally, it is recognized that the characterization of every container is required by the Permit largely due to the fact that, unlike the normal RCRA approach, the waste containers will not be selectively tested again to confirm their contents upon arrival at WIPP. Notwithstanding this issue, it is still believed that the RCRA approach to representative sampling is more than adequate for containers being placed in a geological repository.

Sampling Methods and Quality Assurance

The Permit contains numerous details regarding the implementation of various characterization methods. This specific language is not consistent with the normal RCRA practice, which usually references EPA-approved methods. The Permit’s specificity limits the flexibility of those attempting to characterize particular waste streams.

After the characterization data have been collected, these data are subjected to seven levels of data review and validation as required by the Permit. These reviews are
to ensure the technical defensibility and quality of the data collected for each characterization activity. This is a lengthy and tedious task, which can take much longer than the data collection itself. It is proposed to consolidate this review and validation process into two reviews, one technical and one related to quality assurance.

It is important to note that the national RCRA program allows considerable flexibility in applying data validation and quality assurance programs. The important principle is to see that data are of high quality and are carefully reviewed.

Audit and Surveillance

The WIPP must conduct an annual audit and surveillance program in order to ensure that the operator of each site that plans to ship TRU waste to the WIPP facility characterize its wastes in accordance with the Permit.

After review of the current audit program, it is recommended that the following steps be taken to improve the audit process:

- Many of the QA elements related to RCRA audits are self-imposed because the Permit does not require an “NQA-1” approach. Therefore, the audit program should be evaluated against relevant EPA Quality Assurance guidance to determine if the Permit’s goals can be met using a less complex approach.

- Take more credit for generator site QA assessment activities to meet the Permit’s obligations. For example, if a site QA assessment shows that the program meets the requirements of the Permit, then an in-depth evaluation of training would not be performed by WIPP.

- Restructure the annual follow-up audits to focus less on “reinventing” the initial audit and more on the assessment of the generator site QA process and its effectiveness. Specifically, this can include a “sample” of the program as opposed to an audit of all its aspects.

Acceptable Knowledge Activities

The Permit requires a detailed description of waste generating processes and other information to be compiled to develop a very large “acceptable knowledge” database. This is not consistent with the national RCRA program where this type of information is only used to better understand where hazardous waste exists and to assist in its characterization. On the other hand, the goal of the Permit seems to be to develop a large acceptable knowledge data base, whether needed for waste characterization or not.
In particular, it appears that the Permit is requiring the collection of unnecessary information on legacy wastes. In such cases, the generator sites are usually already aware that they may need to collect additional characterization data (other than AK information) to identify waste stream contents in accordance with RCRA. However, according to the Permit, exhaustive AK information must still be collected.

In addition, overly conservative interpretations of the Permit requirements have led to additional pressures for even more AK information.

It is recommended that acceptable, or “process,” knowledge be collected and used in the manner intended by RCRA. That is, information on waste-generating processes would be collected only as needed to help in the determination of which RCRA hazardous wastes and which “prohibited items” are likely to be present in a particular waste stream.
Section 2

Clarification of Permit Requirements

Improvement of the Permit began shortly after it was issued. For example, modifications to correct inconsistent language and to better align waste characterization activities with EPA practice were made using NMED’s administrative process. Significant cost reductions were achieved by reducing headspace gas sampling requirements for waste that has undergone thermal processes. Cost and paperwork reductions have been obtained by allowing headspace gas samples to be composited for analysis.

Notwithstanding these improvements, there is significant opportunity to gain additional efficiencies by clarifying the permit requirements that relate to waste characterization.

The idea would be to develop a brief document that clarifies, in plain English, the key permit requirements that relate to waste characterization. This document should be coordinated with, or perhaps included within, a “methods manual” which RSI/LANL are to prepare for WIPP in FY 03. A possible workshop to discuss the clarified subjects is also proposed.

Operating Experience

After operating the WIPP in accordance with the Permit since November 1999 the generator sites responsible for waste characterization have had, and continue to have, numerous questions with regard to specific elements of the Permit.

In order to allow the sites to begin shipping under the newly issued Permit, the WIPP submitted several modifications to the Permit aimed at making Permit requirements consistent. The WIPP also developed certain “clarifications” because the Permit requirements were unclear or even contradictory in some cases.

In addition, a Permit "hotline" was established so sites could ask questions about Permit requirements. Also, daily and weekly conference calls were conducted with the sites and auditors to discuss issues of common concern. Many of the concerns voiced on the hotline were not associated with how to perform a required activity, but what does the requirement or term mean?

In the first few months after the Permit was issued generator sites submitted over 300 inquiries on specific waste characterization topics, seeking clarifications and guidance. Written guidance was provided covering the following types of topics:
• Solids sampling and analysis
• Headspace gas sampling and analysis
• Radiography
• Visual examination and testing
• Submission and content of data reports
• Data validation and verification
• Training and qualifications
• Equipment calibration, cleaning, and maintenance
• Acceptable Knowledge
• Sample control
• Legal defensibility of procedures
• Non-conformance reporting
• Tentatively identified compounds
• Repackaging waste
• Control charting
• Field Reference Standards
• Waste stream designation

Some of these clarifications ultimately were submitted as changes to the Permit. Also, the hotline is still used extensively to request definitions or to clarify specific terms or techniques. Often these questions are site or waste stream-specific, but that is not to say that another site, or a newcomer to the program, will readily understand a given Permit requirement.

**Definition of Terms**

It is therefore proposed that a concise glossary of terms and characterization techniques be developed as part of the planned “methods manual,” including such items as the following:

• Free liquids/Residual liquid
• Layer of confinement
• Sealed container
• Waste Stream
• Waste Lot
• Newly Generated Waste
• Retrievably Stored Waste
• Repackaged Waste
• Sealed container
• Tentatively Identified Compounds
• Miscertification Rate
• Zero air
• Humidification of gases
Clarification Document

It is recommended that a brief (perhaps 30-50 page) document be prepared to include the type of definitions noted above, as well as generally clarifying the Permit requirements related to waste characterization. Information and topics gleaned from the hotline and other sources noted above would be included.

Suggested workshop

In addition to the preparation of the above document, it is proposed that a 1-2 day workshop be held to discuss the clarification information in more detail with relevant personnel.
Section 3

Statistical Approach to Waste Characterization

The Permit specifies a container-based approach to waste characterization. This is unlike the normal RCRA approach which focuses on the characteristics of waste streams, using primarily “process knowledge” and representative sampling of wastes.

Specifically, the Permit requires the following waste characterization processes to be applied to waste streams that are destined for disposal at the WIPP:

- Assembly and evaluation of “acceptable knowledge” (AK) on a waste stream basis
- Either radiography or visual examination (VE) of every container in a waste stream
- Headspace gas sampling and analysis of every container in the waste stream (except under certain conditions)
- Statistical sampling of containers in homogeneous solid and soil/gravel waste streams

These characterization processes result in verifying the absence of “prohibited items”; estimating waste material parameter weights; measuring the type and concentration of volatile organic compounds (VOCs) in the headspace gas of containers; and measuring the type and concentration of VOCs, SVOCs, and metals in homogeneous waste forms.

In practice, this detailed analysis of each drum has proven to be very time-consuming and expensive. Since over 800,000 drum equivalents are planned for disposal at WIPP, it would be much more efficient to test a representative sample of the containers within a specific waste stream.

Therefore, it is proposed that statistical analyses be applied to select a representative number of containers for radiography or visual examination as well as headspace gas sampling and analysis. This representative sample approach would involve using knowledge of the particular type of waste to select the appropriate sample size for representative testing.

Problem Discussion

National RCRA standards require that wastes be characterized on a waste stream basis. Because elements of waste streams usually have similar physical and chemical
properties, RCRA only requires a generator to obtain representative samples of the waste stream. EPA guidance manuals specify methods for evaluating whether or not a representative sample has been collected and adjusting the number of samples to ensure the results are representative of the waste stream. The amount of sampling ultimately conducted is typically based on the information known about the waste (i.e., the "acceptable knowledge" information) and feedback from the initial samples.

The typical approach to meeting the characterization requirements under RCRA starts with a generator site assembling records on the process(es) that generated the waste (i.e., AK information). The generator usually samples a small initial percentage of the waste to verify the presence of the constituents known to be used or produced. In many cases, this initial sample is based on the amount of AK information that is already known about the waste.

The generator site then evaluates the data collected to determine if the results are representative of the waste stream. This evaluation typically follows the statistical approach recommended in the EPA guidance (SW-846 methods manual). The statistical approach is iterative in that additional samples must be collected when less is known about the waste and/or the waste is not homogeneous.

On the other hand, the Permit includes a sampling program that is not consistent with the sampling programs typically found under RCRA. In the Permit, 100% of the waste containers must be sampled regardless of what is known about the waste stream, including its homogeneity. The Permit also contains stringent requirements for assembling and evaluating AK information on a waste stream basis.

However, this AK information is not used sufficiently to define the sampling program, except to determine whether the waste should be subject to solids sampling. There is no tangible benefit to using 100% sampling on waste streams that are homogeneous and are well known due to the availability of AK information.

**Recommended Approach**

To summarize, there are two key aspects of a typical RCRA characterization program that are missing in the WIPP sampling program. These are:

- Little credit is taken for the information collected during the AK process in determining the appropriate starting point for the sampling program.

- 100% of the containers require testing rather than a statistically representative sample.

Statistical sampling will require a list of criteria for establishing when statistical sampling would be appropriate and a description of the specific statistical approach that would be applied to each of the characterization techniques. In order to demonstrate the
viability of a statistical approach to the regulators, an effort should be undertaken to evaluate the characterization data collected to date and determine how a statistical approach would be best applied to the characterization methods. The evaluation would include an analysis of results of headspace gas, estimated waste material parameter weights, and prohibited item activities.

Based on the analysis of the data that exists, a specific statistical program should be developed to establish the following characterization information on a waste stream basis:

1. Waste material parameter weights using a statistical upper bound based on results from radiography and visual examination activities.

2. Ensuring that prohibited items are not present based on AK information that is confirmed by the results from statistical radiography or visual examination

3. Establishing the type and concentration of VOCs in the headspace gas of containers using a statistical upper bound based on results from headspace gas sampling and analysis
Section 4

Sampling Methods and Quality Assurance

The Permit contains very detailed sampling, analysis, and quality assurance (QA) requirements. A more typical RCRA approach is to reference EPA-endorsed sampling and analysis methods from the EPA guidance manual (SW-846 methods manual) and to prescribe a technical and quality assurance data review.

The Permit contains detailed requirements for the following four waste characterization techniques that would not typically be included in a RCRA permit:

- Radiography
- Visual examination (VE)
- Headspace gas sampling
- Homogeneous solid and soil/gravel sampling

The samples collected during headspace gas, homogeneous solid, and soil/gravel sampling are analyzed in the laboratory using EPA methods referenced by the Permit. Once the data have been collected, the Permit requires data validation at seven different levels as part of the QA requirements. These prescriptive data validation requirements are far beyond what is typically found in RCRA. A typical permit only requires review to ensure that the data are technically sound and that the quality assurance requirements are met.

Problem Discussion

The national RCRA standards require that waste be characterized prior to disposal. However, these standards usually do not include specific characterization method requirements. Typically, RCRA permits only reference nationally-recognized waste characterization methods, such as those found in EPA guidance manuals. These guidance manuals include flexible implementation that allows the generator site to adapt to changing conditions with their waste, while ensuring quality data.

The national RCRA standards do not contain specific requirements for data validation. Therefore, any data validation required is provided in a facility’s permit. Typically, the permit would contain general technical and quality requirements to ensure that the data are technically defensible and have been quality assured. To this end, data used for RCRA compliance typically undergo a comprehensive technical review and a quality assurance review.

The Permit contains references to nationally recognized waste characterization methods from the SW-846 methods manual for laboratory procedures. However, in all other cases (e.g., sample collection, waste examination) the Permit contains detailed
implementation requirements. These detailed implementation requirements limit
generator/storage sites to using older methods and sometimes invalid techniques for
collecting and analyzing samples.

The purpose of collecting the data is to make regulatory decisions about the waste
with a high degree of confidence. Many times improvements are identified in the
characterization methods that would result in efficiencies or higher quality data.
However, they cannot be implemented because of the Permit’s specificity.

Once the data have been collected, the Permit contains detailed requirements for
quality assurance and data validation. The quality assurance requirements are based on
characterization techniques for TRU waste that began development over 15 years ago. At
that time, the characterization techniques were newly developed from research projects
that did not have a proven track record. Because of this, rigorous quality assurance
processes were included to demonstrate the feasibility of using the newly developed
techniques to produce quality data.

The development of the Permit application began shortly after the
characterization techniques were developed. Therefore, the rigorous quality assurance
processes associated with the original research and development of the techniques were
included as part of the permit application.

In addition to the overly rigorous quality assurance requirements, the data
validation requirements are also based on the early development of the characterization
methods. These data validation requirements result in seven levels of data review in
comparison to the two reviews (i.e., technical and quality assurance) typically conducted
under RCRA. These seven levels of review are redundant and unnecessary to meet the
RCRA objectives of good quality, technically defensible data for making compliance
decisions.

Recommended Approach

It is now almost 10 years after the permit application was originally submitted and
the Permit has been implemented for over 3 years. Over this time tens of thousands of
data points have been collected, which could be used to demonstrate the effectiveness of
the waste characterization techniques to produce quality data. These data points should be
compiled and evaluated to determine if alternative quality assurance processes could be
applied.

The approach to improving the characterization methods in the Permit should be viewed as a two-step process:

1) Improvement of the methods through permit modifications and
2) Elimination of the specific method language from the permit.
The improvement of the methods in the Permit has been ongoing through the use of various permit modifications. This effort should continue in order to improve the individual methods that are found within the permit and to eliminate those methods that are not applicable (e.g., the use of SW-846 Method 8260 for analysis of formaldehyde).

The WIPP should consider the development of a mixed waste methods guidance manual (similar to the SW-846 methods manual) in cooperation with the EPA. Once the EPA adopts this manual, it could be used as a basis for eliminating the specific methods from the Permit.
Section 5

Audit and Surveillance Processes

The RCRA standards require that a disposal facility verify that the identity of the waste received matches the waste on the accompanying manifest. The approach typically taken at RCRA disposal facilities is to perform independent testing on a statistical percentage of the waste received, also known as “fingerprinting.” The use of audit and surveillance programs is not typically used for this purpose.

On the other hand, the Permit does not include independent testing of the waste and instead requires the use of a detailed audit and surveillance program to verify the waste characterization activities that occur at generator sites. The Permit audit program is implemented through a multi-step process that involves the WIPP, the NMED, the EPA, and other interested parties.

The Permit requires the audit of applicable procedures and processes used by the generator site to characterize waste in accordance with the Permit. Specifically, the Permit provides considerable detail with regard to the manner in which the audit is to be conducted, including the use of NMED-supplied audit checklists.

Problem Discussion

National RCRA standards do not contain specific requirements for audits or surveillances of generator sites. Instead, the requirements specify that the disposal facility must be able to verify the identity of the waste they receive. This is typically accomplished by performing a limited analysis of the waste received. This normally encompasses physical and chemical tests of a statistical portion of the waste received to “verify” all of the waste.

This testing only serves to verify that the waste is what the generator site intended to ship. It does not provide an independent verification of all activities used by the generator site to demonstrate compliance with the waste acceptance criteria. In this way, the typical RCRA program relies on the quality assurance program at the generator sites to ensure that the overall requirements are met.

However, the Permit requires that the waste be characterized at the generator site prior to shipment to the WIPP with no independent verification at the WIPP facility. In order to accommodate this approach the WIPP controls the characterization process in both content and execution, through an extensive quality assurance program. The principle tool for monitoring the activities of the generator sites is the audit and surveillance program, which is required in the Permit to meet the waste “verification” requirements of RCRA. This audit and surveillance program has three fundamental requirements:
The audit program must be able to determine that the sites are implementing the applicable portions of the Permit.

The audit program must provide a process that the NMED can witness to assure adherence to the Permit requirements.

The audit program must produce a document that the NMED can review and approve, also ensuring compliance with the applicable portions of the Permit.

The implementation of the Permit audit program is in accordance with the requirements of a DOE document referred to as the “QAPD.” The QAPD is written to be consistent with the American Nuclear Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) NQA-1 requirements.

The NMED did not include these internal QA requirements in the Permit, nor did they include the QAPD as a reference document for the generator site audit program. In fact, the NMED specifically deleted the references to this type of detailed information from the final Permit because these are “not RCRA requirements”. However, the consequences of implementing an NQA-1 process has resulted in the following:

- An audit process that is much more complex than a plain reading of the Permit would require.

- An audit process that does not fully use the “graded approach” embodied in NQA-1.

- An audit process that audits ongoing programs at the same level of detail as the initial audit of those programs.

- An audit process that does not take full advantage of the ongoing NQA-1 program at the generator site.

**Recommended Approach**

The following recommendations are made to address the audit program.

1. Systematically evaluate how (and if) each current Permit audit requirement can be met with less complexity than what is currently required. For example, the elements of the WIPP program could be evaluated against programs implemented under EPA’s “Guidance on Technical Audits and Related Assessments” to determine if the Permit’s goals can be met using a less complicated approach.

2. Take more credit for generator site QA assessment activities to meet the Permit’s obligations. For example, if a site QA assessment of personnel training shows
that the program meets the requirements of the Permit, then an in-depth evaluation of training would not be performed by WIPP.

3. Restructure the follow-up audits to focus less on “reinventing” the initial audit and more on the assessment of the generator site QA process and its effectiveness. Specifically, this can include a “sample” of the program as opposed to an audit of all aspects of the program.
Section 6

Acceptable Knowledge Activities

The Permit contains detailed requirements for collecting, auditing, and approving acceptable knowledge (AK) information on a waste stream basis. The AK information required is very prescriptive and often is not relevant to the characterization objectives. This is unlike the normal RCRA approach, which focuses on the information required to determine the characteristics of waste streams.

Specifically, the Permit requires three categories of AK information to be collected: 1) “required” information, 2) supplemental information, and 3) administrative controls information. This information is then used to determine the hazardous waste numbers, physical form, and absence of prohibited items for the waste stream.

In practice, this collection of AK information has evolved into the development of a comprehensive database of all information associated with the waste stream, regardless of whether or not it is useful in making regulatory decisions. In addition, once this time-consuming and expensive process is completed, the only effect the AK information has on the sampling program is to determine whether or not to perform solids sampling based on the physical form of the waste stream.

Therefore, it is proposed that the AK process be reworked to make it more consistent with the application of AK information that is typical under RCRA. This reworking would include reinterpreting the existing requirements to allow more reasonable implementation and ultimately revising the AK requirements to align them with typical RCRA application.

Problem Discussion

Standard RCRA practice allows for the use of knowledge of the waste and the processes that generated the waste to assign hazardous waste numbers, determine if a waste is “listed” or exhibits any toxicity characteristics, and determine if a waste is incompatible or prohibited. The normal purpose of AK is to compile the information that needs to be known about the waste and afford the generator a method by which they can do this without excessive sampling and analysis.

In some cases (e.g., mixed waste), the EPA recommends using AK as the only characterization technique for performing these functions. Typically, the amount of information that is collected is not driven by the amount available; rather it is based on what information must be known in order to make the required regulatory decisions. Once sufficient information is collected to make a decision, the AK process can usually be terminated.
In cases where the information necessary to make a regulatory decision is not available in the records, sampling and analysis is typically necessary. This process also includes the use of a “good-faith effort” when sampling and analysis is not appropriate, such as with some debris wastes.

There are two key problems in the Permit’s requirements for AK. The basis of the problems stem from the AK requirements which result in compiling large amounts of unnecessary information that is not used to make any regulatory determinations.

First, overly-conservative interpretation and implementation of the Permit has driven generators to collect very large amounts of information. The regulatory value of much of the information collected, however, is not clearly defined. Compiling the information necessary to meet the conservative interpretations of the Permit can also result in review of often-meaningless information in order to ensure that all such information is “complete and accurate.”

Second, in addition to over-interpretation of the Permit requirements, the Permit contains explicit requirements for collecting redundant and unused information. Part of the data collection effort includes the requirement for supplemental AK information. The supplemental AK information process must be followed even if the assembled information contains enough data to make a regulatory decision. Standard RCRA practices do not distinguish between AK and supplemental AK, but instead require the collection of the information necessary to make the necessary regulatory determinations.

**Recommended Approach**

The conservative interpretation of the Permit and its level of detail results in an abundance of AK information, much of which is not used. Limiting the required AK to information that is relevant to making hazardous waste determinations and other WIPP-specific requirements would increase program efficiency and meet RCRA standards. Specific recommendations for improving the AK process are:

1. Evaluate whether conservative interpretations of the Permit language is driving sites to collect data beyond that required by the Permit.

2. Eliminate the distinctions between the various types of AK information listed in the Permit. Establish AK requirements such that information would only be collected and audited if it were useful for:
   
   a. Making hazardous waste determinations (e.g. making a determination that a waste is “listed”)
   
   b. Determining the absence of prohibited items (e.g., demonstrating that the administrative controls requirements are met)
c. Identifying the physical form of the waste

3. Explicitly tie the AK information collected to the approach used to perform all waste characterization activities rather than just the requirement to perform solids sampling on certain physical waste forms