# Characterization, Certification and Shipment of TRU Waste Speed Bumps and Potholes on the Road to WIPP-10104

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## ABSTRACT

The regulatory framework that governs the characterization, certification, transportation, and emplacement of transuranic waste in the Waste Isolation Pilot Plant (WIPP) is both comprehensive and complex and includes U.S. Department of Energy (DOE) Orders and guidance, Congressionally mandated requirements, a Resource Conservation and Recovery Act permit addressing hazardous chemical constituents in the waste that is administered by the State of New Mexico Environment Department, transportation regulations developed and administered by the Nuclear Regulatory Commission, and a U. S. Environmental Protection Agency inspection program driven by 40 Code of Federal Regulations 194 that focuses on physical and radiological characteristics of the waste.

Compliance with these myriad requirements is verified by a robust system of quality assurance and technical audits administered by the DOE Carlsbad Field Office. Through these audits, and the interface with the regulators that occurs during the audit process, waste generator/storage sites are granted approval to characterize, certify, and ship waste to WIPP.

The experiences of this audit process over the 10+ years of WIPP operation have provided a number of lessons learned for generators, DOE directed auditors and other audit participants. The application of these lessons in the conduct of the audit process itself and through the identification, interaction and consensus resolution of specific technical and regulatory "potholes" and "speed bumps" have resulted a program that consistently provides certified TRU waste, both contact handled (CH) and remote handled (RH), for emplacement in this world class repository.

## INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) was conceived in the 1970s, constructed in the 1980s, and opened in 1999 after years of protracted legal and administrative battles. Located near Carlsbad, NM, in an ancient bedded salt formation 655 meters underground, the WIPP repository is the final resting place for defense-related radioactive waste containing long-lived transuranic (TRU) radionuclides such as plutonium-239 and americium-241 at concentrations greater than 3700 Bq/g (100 nanocuries per gram). In March 2009, the WIPP celebrated 10 years of successful placement of TRU waste. In that time period, approximately 62,000 $m^3$ of waste from numerous sites have been disposed at the repository. The primary source of this waste is nuclear weapons production and related defense work at sites such as the Rocky Flats site near Denver, CO (now closed and remediated), and the Savannah River Site near Aiken, SC, and Los Alamos National Laboratory in Los Alamos, NM, which still have active missions.

Key to WIPP's satisfactory demonstration of compliance with the myriad of requirements is a comprehensive audit program directed by the U.S. Department of Energy's Carlsbad Field Office (DOE/CBFO). This audit program is staffed and administered by the CBFO Technical Assistance Contractor (CTAC) on behalf of the DOE/CBFO. The CTAC contract is currently held by Navarro Research and Engineering, Inc. CTAC has assembled a team of quality assurance personnel with unsurpassed experience in auditing to WIPP requirements specifically, as well as overall quality assurance experience. In addition, CTAC has technical specialists on staff who evaluate waste generator activities such as nondestructive assay and waste examination and development of detailed process knowledge (aka Acceptable Knowledge) for each stream for which the generator is seeking certification. Sampling and analysis of solids and soils waste streams, and headspace gas sampling and analysis of drums of debris waste are also examined by CTAC's technical specialists.

This paper examines the CTAC audit process and experience over the operating history of the WIPP project, highlighting the robustness of the program, which has provided assurance to all stakeholders that the TRU waste emplaced at WIPP will be isolated from humans and the environment in perpetuity. The adaptation of the program to changes, for example, in the Resource Conservation and Recovery Act (RCRA) permit, the implementation of the Central Characterization Program (CCP) and in the certification for disposal of remote-handled TRU waste, is also addressed. Of particular interest are the lessons learned in interacting with generators and stakeholders to address problematic waste streams and more complex compliance requirements and how corrective actions address those rare circumstances when violations of the requirements are identified.

## QUALITY ASSURANCE

The quality assurance requirements applicable to WIPP are defined in the "CBFO Quality Assurance Program Document" (QAPD) [1], first issued in June 1994. The requirements of the CBFO QAPD apply to all "WIPP participants." The CBFO QAPD is based on several upper-tier drivers, the most important of which are described in Table I.

Table I. Major Upper-Tier Requirements for the CBFO QAPD

| Requirement | Controlling Agency | Description |
|---|---|---|
| 40 CFR Part 194.22 | U.S. Environmental Protection Agency (EPA) | This regulation requires DOE to establish a quality assurance program based on American Society of Mechanical Engineers Nuclear Quality Assurance Standard NQA-1-1989, NQA-2a-1990 addenda Part 2.7, and NQA-3-1989 (excluding sections 2.1 (b) and (c) and 17.1. These standards apply to "waste characterization and assumptions" and are therefore applicable to the waste generator/storage sites for characterization and certification of waste for disposal at WIPP. |
| 10 CFR Part 830, Subpart A | DOE | This regulation establishes requirements for quality assurance programs for contractors that affect, or may affect, the nuclear safety of DOE nuclear facilities. Therefore, this regulation applies to the waste |

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|---|---|---|
| | | generator/storage sites for characterization and certification of waste for disposal at WIPP. |
| 10 CFR Part 71, Subpart H | Nuclear Regulatory Commission (NRC) | This regulation describes the quality assurance requirements that apply to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging that are important to safety. Therefore, this regulation applies to the waste generator/storage sites for transportation of TRU waste in NRC-licensed Type B packages such as the TRUPACT-II and the RH 72B. |
| DOE Order 414.1C | DOE | This DOE Order establishes the minimum requirements for quality assurance programs for DOE programs and facilities. |

An important part of the CBFO audit program is the verification of the adequacy, implementation, and effectiveness of the quality assurance programs of the generator/storage sites. At a minimum, each generator/storage site's quality assurance program is audited by CBFO annually, with the assistance of CTAC.

**EPA**

The rules for EPA approval of generator/storage site waste characterization and certification programs are contained in 40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP. The regulations specify how generator/storage site quality assurance programs and the waste characterization program itself is approved by EPA.

To obtain approval of the generator/storage site quality assurance program, EPA may conduct an *audit* of the quality assurance program or *inspect* a CBFO audit of the program. Such an audit or inspection is required initially prior to the generator/storage site shipping waste to WIPP. Generally, EPA has performed inspections of CBFO audits of the generator/storage sites. Although an initial EPA audit or inspection of the quality assurance program is required, the regulations do not specify the frequency of follow-up audits or inspections performed by EPA. Since the initial waste shipments to WIPP, EPA has been performing these follow-up quality assurance audits or inspections annually. EPA inspectors usually accompany the CBFO audit team on the annual recertification audits of the generator/storage sites. The EPA then issues a report with a determination that the audit was properly conducted by CBFO and the generator/storage site quality assurance program is approved.

The approval of the generator/storage site waste characterization program follows a different path. The EPA conducts an initial baseline compliance inspection of the generator/storage site's characterization program. The EPA then places a proposed Baseline Compliance Decision in the Federal Register for public review and comment for a minimum of 45 days. After addressing public comments (if any), the EPA issues a final compliance decision and places it in the public docket. It is of interest to note that the waste stream characteristics of importance to the EPA are the radiological properties of the waste; for example, does the waste in the payload container meet or exceed 100 nanocuries per gram of waste? The EPA also looks for information specific

to the physical characteristics of the waste and, in particular, the presence of ferrous and non-ferrous metal, plastics, rubber, cellulosics, and excess liquid in amounts that could affect the long-term performance of the repository.

Subsequent to a final baseline compliance decision, the generator/storage sites may, and often do, want to make changes to their waste characterization program. This may include deploying a new nondestructive assay system, adding different types of waste (e.g., sludge vs. debris) to the program, or changing the calibration range of an approved nondestructive assay system. After initial approval, these types of changes are sent through a "tiering" process. EPA, in its final compliance decision, will specify what types of changes are considered "Tier 1" or "Tier 2." Tier 1 changes require EPA prior approval before waste characterized using the new process or equipment may be shipped to WIPP. For Tier 2 changes, the CBFO is required to notify EPA, but prior approval is not required.

## NUCLEAR REGULATORY COMMISSION

The NRC regulates the use of Type B packaging. The WIPP program, to date, has used two NRC-licensed packages to ship TRU waste to WIPP, the TRUPACT-II and the RH-72B. The rules for the use of these packages are described in the "Transuranic Waste Authorized Methods of Payload Control" (TRAMPAC) [2, 3] documents approved by the NRC. The TRAMPACs require that CBFO audit the users of these packages before their first use and periodically thereafter. CBFO, with the assistance of CTAC, audits the users of these packages at least annually.

## NEW MEXICO ENVIRONMENT DEPARTMENT

On October 27, 1999, the New Mexico Environment Department (NMED) issued a Hazardous Waste Permit (Permit) [4] for the WIPP, authorizing the storage and disposal of TRU mixed waste. The Permit contains requirements that uniquely incorporate the NMED regulators into the CBFO audits of the generator/storage sites. Permit Attachment B6, Waste Isolation Pilot Plant Permittees' Audit and Surveillance Program, contains the following requirements for Permit-related audits conducted by CBFO:

- Initial audits of generator/storage sites are required prior to shipment of mixed TRU waste to WIPP.
- Annual recertification audits are required.
- NMED may observe these audits.
- Audits will be conducted as specified in the Permit.
- An audit report will be issued to the generator/storage site within 30 days of the completion of the audit.
- A "formal final audit report" will be submitted to NMED after any corrective actions associated with Permit requirements are complete.

- NMED review and approval of the final audit report is required prior to beginning shipments of TRU mixed waste from the generator/storage site to WIPP.

The audit process requirements specified in the Permit are, for the most part, the typical processes used for NQA-1 based audits. These requirements are based on the description of the audit process submitted by the Permittees in their Permit Application. A unique requirement is the final audit report process, which was added by the NMED in the draft Permit and was subsequently included in the final Permit.

Final audit reports are sent to NMED after the completion of any Permit-related corrective actions. The final audit report must include the following:

- A narrative audit report
- A completed Permit-specified checklist that contains 185 questions that require verification of 640 individual characterization program attributes
- Closure documentation for all corrective actions related to Permit requirements
- Examples of implementation of characterization program elements (e.g., batch data reports, training records, acceptable knowledge information regarding the waste)

A typical final audit report will require three copy paper-size boxes of supporting documentation.

While the interest of the EPA is waste stream characterization, the NMED focuses on the physical and chemical properties of the waste and the justification and assignment of RCRA hazardous waste numbers (HWNs). NMED also focuses on identifying and eliminating from the waste stream a list of WIPP-prohibited items including reactive materials, corrosive and ignitable materials, pressurized containers, and unallowable quantities of liquids.

## AUDIT PROCESS

The audit process is composed of the following activities:

- Scheduling
- Planning
- Auditing
- Corrective Action Initiation
- Reporting
- Corrective Action Completion

### Scheduling

Audit scheduling has been a challenge since the opening of WIPP. For an effective waste characterization audit to occur, the generator/storage site needs to perform some actual waste characterization so there is objective evidence to review. Insufficient waste characterization may result in an audit finding of "indeterminate." Since an audit must have been done before the

process of obtaining regulatory approval begins, there is incentive to schedule audits as early as possible in order to continue shipping TRU waste to WIPP.

**Planning**

Once the scope of the audit and at least an approximate start date are decided, audit planning can begin. Selection of the audit team starts with assignment of a lead auditor. The lead auditor must be certified in accordance with NQA-1 requirements. The lead auditors work for CTAC, but are certified by CBFO. The next consideration is the technical scope of the audit. CTAC has qualified technical specialists in the areas of nondestructive assay, radiography, visual examination, acceptable knowledge, transportation, headspace gas sampling and analysis, and solids sampling and analysis. Once the appropriate mix of technical specialists is determined, a quality assurance auditor is assigned to work with a technical specialist. This allows the technical specialist to focus on the technical aspects of the work being audited, while the quality assurance auditor can verify that the quality assurance program is being followed in that particular technical area. Once the composition of the audit team is determined and a date for the audit is set, an audit plan is generated by CTAC and reviewed and approved by CBFO for transmittal to the generator/storage site and the affected regulators.

During the planning stage, prior to the audit team going into the field, the auditors and technical specialists are provided the documents and procedures for their areas of responsibility. These documents are reviewed to ensure they adequately address the upper-tier requirements. This process is referred to as an "adequacy review."

**Auditing**

The audit begins with a pre-audit meeting at the site being audited, attended by the audit team, generator/site personnel, regulators, and other observers. The topics of the meeting include audit scope, basis, schedule, and logistics, and how the audit will be conducted and concerns will be handled.

In caucus meetings held each afternoon, the audit team updates the lead auditor on progress in their assigned areas and any concerns that have been identified. Participation in the caucus is limited to the audit team and the regulators.

Based on the audit guiding strategy of "no surprises," each morning the lead auditor holds a management briefing to update generator/storage site management on audit progress and any concerns that have been identified. When the auditors or technical specialists identify a concern, they brief the generator/storage site personnel involved and the concerns are communicated to management in the morning management meetings.

The audit ends with a post-audit conference where audit results are communicated to the generator/storage site and the regulators.

**Corrective Action Identification**

Concerns identified during the audit are categorized as follows:

- Recommendation – A suggestion directed toward identifying opportunity for improvement and/or enhancing methods of compliance
- Observation – A condition which, if left uncontrolled/uncorrected, *could* lead to a condition adverse to quality (CAQ)
- Corrected During the Audit (CDA) – A minor isolated CAQ requiring only remedial action to correct and for which resolution can be achieved and verified prior to the audit conclusion
- Corrective Action Report (CAR) – A document used to identify and resolve a CAQ and for which actions (in addition to remedial) are required for resolution

Conditions determined to be CAQs are documented on CBFO CARs and transmitted to the generator/storage site. The generator/storage site develops a corrective action plan and submits it to CBFO for approval, whereupon the site implements the corrective actions. CTAC personnel then verify the corrective actions were adequate and recommend to CBFO that the CAR be closed.

**Reporting**

At the completion of the field portion of the audit, the lead auditor prepares an audit report for CBFO review and approval. The report identifies the scope and results of the audit, including any CAQs that were identified.

If the audit requires NMED approval, a final audit report is prepared. As described above, the final audit report cannot be issued until all Permit-related corrective actions are complete.

**Corrective Action Completion**

When the corrective actions are complete, CTAC personnel verify that the corrective actions were adequate and recommend that the CAR be closed by CBFO.

## PROGRAM EVOLUTION

Over the ten-year history of this highly successful DOE program, there have been numerous significant changes in terms of regulatory requirements and process improvements that have impacted the program. Among many that are worthy of elaboration, two have been selected for brief descriptions, the Central Characterization Project, and Remote-Handled Waste.

**Central Characterization Project**

Prior to the opening of the WIPP repository for receipt of waste and for a few years after the initial shipment, each generator site had developed and was implementing its own site-specific characterization and certification programs. This included the preparation and use of numerous

site-specific processes and procedures to effectively demonstrate compliance with regulatory requirements. Early in this decade, DOE/CBFO conceived the concept of the Central Characterization Project (CCP) to assist the generator sites in the characterization and certification of their TRU waste inventory. The CCP works with site personnel to compile a comprehensive process knowledge record for each waste stream. In addition, the CCP operates the characterization equipment used to perform nondestructive assay and real-time radiography, and implements an overarching quality assurance program. The benefits for CTAC, the EPA inspectors, and the NMED observers in interfacing with one organization with a consistent set of procedures and personnel are significant. Furthermore, the CCP has been able to provide support to small generator sites with a limited volume of TRU waste and limited resources to develop a TRU waste certification program. The successful implementation of the CCP has been a substantial contributing factor to "filling the pipeline," in other words, ensuring an optimum number of TRU waste shipments to WIPP.

### Remote-handled TRU Waste

For the first several years of WIPP operation, the certification, characterization, and shipment of TRU waste was limited to contact-handled TRU (CH-TRU) waste. Remote-handled TRU (RH-TRU) waste, for which the dose rate on the surface of the container is equal to or greater than 200 mrem/hr, was not permitted to be shipped to WIPP and was, in fact, listed as a prohibited item in the Permit. In a major revision to the Permit enacted in November 2006, RH-TRU waste was removed as a prohibited item. WIPP received its first shipment of RH-TRU waste from the Idaho National Laboratory in January 2007. To date, more than 300 shipments of RH-TRU waste have been made. Prior to the issuance of the Permit, requirements and processes specifically designed to address some of the unique and challenging issues with regard to the characterization and certification of RH-TRU waste were developed by DOE/CBFO in conjunction with the stakeholders noted in this paper. For example, conventional nondestructive assay as applied to CH-TRU waste to determine radiological properties cannot be used with most RH-TRU waste. Instead, the dose-to-curie (DTC) method is one process that has been developed and applied in which the measured gamma dose at a specified distance from the surface of the waste container emitted by a radionuclide such as cesium-137 is used along with calculated scaling factors to come up with activities for other key radionuclides. This process, along with other techniques and requirements developed for RH-TRU waste characterization and certification, is included in the RH-TRU Waste Characterization Program Implementation Plan [5] and has been especially important in the audits of RH-TRU waste by CTAC and the EPA.

## AUDIT PROCESS LESSONS LEARNED

As of November 2009, the ten-year anniversary of the effective date of the Permit, CBFO, with the assistance of CTAC, had performed 186 audits and 99 surveillances (see Table II).

Table II. Generator/Storage Site Audits Since 1999

| Site | Years | Audits | Surveillances |
|---|---|---|---|
| Argonne National Laboratory | 2001-05 | 4 | 2 |
| Argonne National Lab / Central Characterization Project (CCP) | 2004-09 | 6 | 0 |

| | | | |
|---|---|---|---|
| Battelle Columbus Laboratory | 1999-2005 | 2 | 1 |
| General Electric Vallecitos Nuclear Center / CCP | 2008 | 1 | 0 |
| Hanford Site | 1999-2009 | 17 | 11 |
| Hanford Site / CCP | 2003-09 | 4 | 2 |
| Analytical Laboratories at Idaho National Engineering and Environmental Laboratory | 2005-06 | 3 | 1 |
| Analytical Laboratories at INL / CCP | 2009 | 0 | 1 |
| INL Advanced Mixed Waste Treatment Project (formerly INEEL) | 2003-09 | 16 | 9 |
| Idaho National Engineering and Environmental Laboratory | 1999-2005 | 13 | 15 |
| Idaho National Laboratory / CCP | 2005-09 | 16 | 16 |
| Los Alamos National Laboratory | 1998-2008 | 21 | 12 |
| Los Alamos National Laboratory / CCP | 2004-09 | 9 | 1 |
| Lawrence Livermore National Laboratory | 1999 | 0 | 1 |
| Lawrence Livermore National Laboratory / CCP | 2004-05 | 1 | 1 |
| Nevada Test Site | 1998-99 | 2 | 0 |
| Nevada Test Site / CCP | 2002-05 | 8 | 2 |
| Oak Ridge National Laboratory | 2006 | 2 | 0 |
| Oak Ridge National Laboratory / CCP | 2007-09 | 6 | 0 |
| Rocky Flats Environmental Technology Site | 1998-2005 | 25 | 10 |
| Savannah River Site | 2000-09 | 8 | 4 |
| Savannah River Site / CCP | 2003-09 | 13 | 5 |
| Washington TRU Solutions / CCP | 2001-09 | 9 | 5 |
| Number of sites = 23 | | 186 | 99 |
| Total | | | 285 |

The audit process has resulted in a number of lessons learned that can be distilled into the following guidelines .

- No surprises – Keep the audited organization apprised of audit activities and results as the audit progresses. This is the best way of keeping tempers from flaring. Keep reminding the auditees that they are responsible for keeping their senior management informed. It still occasionally happens that senior managers, who have not been briefed by lower-tier managers, become agitated at post-audit meetings. The audit team leader should remind the attendees at the morning management meetings to keep upper management informed.
- Characterize sufficient waste before the initial audit – As discussed in the section on scheduling, there is always an interest in performing the audit as soon as possible to get the regulatory approval process moving. However, the more limited the population of characterized containers, the more likely small process problems with characterizing those containers will not be considered "isolated." If a limited number of characterized containers are available for audit, even minor errors can result in an unsuccessful assessment of that area.
- If a site cuts corners to meet an accelerated schedule, this will usually show up during the audit and result in additional CAQs.
- TRU waste site personnel should not answer questions from CBFO regulators (NMED, EPA) without a CBFO auditor being present.

- Project-specific programs are more likely to succeed than attempts to adapt existing site-wide processes and procedures.
- Sites should be prepared to provide multiple copies of documents such as data packages, training records, forms, CARs, nonconformance reports, and other objective evidence examined during the audit to support the final audit report that will be submitted to NMED. This will be a substantial amount of copying.
- Sites should not send any documentation directly to the regulators (NMED, EPA).
- Hardcopies of site implementing procedures should be available in the caucus room.
- Initial audits of new sites can involve up to 50 outside personnel (auditors, inspectors, and observers). Sites should be prepared with conference rooms, escorts, and other resources appropriate to groups of that size.
- Sites should assign a "concern coordinator" to track the actions associated with audit team concerns. This will help maximize the number of deficiencies that can be addressed and corrected during the audit and is much preferable to the complexities of the corrective action report process. .
- Don't write several procedures where one will suffice.
- Appropriate resource levels must be provided to program development and program implementation efforts.
- Don't assume that recertification will be any less rigorous than initial certification.
- Do assume that problematic waste streams will migrate to the "back of the warehouse" and present challenges in characterization and certification as the site waste disposition program enters its final days.
- Don't assume that every concern was discovered during initial certification. Audits are a sampling activity and deficiencies can be missed.
- Don't completely rewrite a successful program.
- Don't completely reorganize a successful organization.

## POTHOLES AND SPEEDBUMPS ON THE ROAD TO WIPP

After 285 surveillances and audits, one might assume that few issues remained that had not been identified, discussed and resolved. Nevertheless, there are some aspects of the characterization and certification process that continue to provide opportunities for interesting interactions with auditors and other stakeholders. The generator site staff and/or CCP spent considerable time and thought on these areas in particular to avoid following into the traps of the "pothole" or having progress significantly slowed or stopped by speed bump issues. A few of these have been selected for further discussion

Pothole - The delineation of a TRU waste stream is the first and one of the most important steps in the characterization and certification of TRU waste for ultimate disposal at WIPP. The

generator site compiles process information called Acceptable Knowledge (AK) that assists in identifying the physical, chemical and radiological properties of a population of waste that in many cases was packaged and placed in retrievable storage several years ago. The NMED RCRA permit defines a waste stream as "waste material generated from a single process or from an activity that is similar in material, physical form, and hazardous constituents"[4]. A related guidance document from the EPA that is applied to remote handled (RH) TRU waste, the Waste Characterization Program Implementation Plan [5] defines the waste stream as "waste material generated from a single process or activity, or as waste with similar physical, chemical and radiological properties." The language is sufficiently broad with regard to single process or activity and the use of the word "similar" to allow discussion and sometimes debate regarding how the generator delineates the inventory into a single waste stream. Since there is a significant investment in personnel and paper to certify each stream, there is a clear advantage to compile a TRU waste stream from an existing population of waste containers that is as large as possible, that is, a few large volume streams are seen as better than multiple small volume streams.

Regarding "single process or activity", generator sites may have waste in their inventory from the decommissioning and decontamination (D&D) of a building that contained several glove box lines involved in a number of distinct processes that could have supported, for example, weapons production. The "single activity", however, would be D&D and the generator would compile AK that would bound the physical and chemical parameters of the D&D waste. Some bounds on the physical parameters are provided by the permit which defines Summary Category Groups as S5000 debris waste, S3000 homogeneous solids and S4000 soil/gravel [4]. Additional waste stream physical descriptions required by the permit include waste matrix codes and waste matrix code groups. Problems can arise when the waste in an individual container is a mixture of, for example, S5000 and S3000 materials with the majority category by volume being designated.

The critical aspect of the waste stream delineation is associated then with being able to justify the single process or activity involved and having sufficient information to provide a description of the physical parameters of the waste stream such that real time radiography or visual examination will yield data that supports the designation of individual waste containers as part of the delineated stream with the added knowledge that on a container to container basis, the physical parameters can vary, sometimes widely Generators can help avoid the waste stream delineation pothole by providing clear and consistent documentation from the AK record that reasonably supports all of the elements of the waste stream regulatory definition.

Pothole - Another waste stream characteristic from the definition above that is of particular importance to NMED is the assignment of RCRA hazardous waste numbers (HWNs). Once again the generator initially relies upon the AK record to identify the hazardous chemicals that were or may have been utilized in the process(es) that generated the waste and that therefore may be present in the waste and require assignment of the requisite HWN. Unlike the physical and radiological characteristics developed by AK that can be and are substantiated by real time radiography and non-destructive assay, it is less frequent that the HWNs assigned by AK are substantiated by head space gas sampling and analysis for debris waste and solids sampling and analysis for homogeneous solid waste. Furthermore, results of these characterization tests do not often result in the addition (or removal) of a hazardous waste number. Thus, for HWN assignment, having a complete AK record is particularly important.

Another critical factor regarding the assignment of HWNs is that the waste destined for WIPP is exempt from the requirement to be treated to meet land disposal restrictions (LDR) requirements prior to disposal. This is a huge advantage to the entire WIPP program in that mixed TRU waste does have to go through an often costly and in some cases multi-step treatment process. One of the results of this exemption is the so called "conservative assignment" of hazardous waste numbers. Since there is usually little or no programmatic impact associated with a WIPP HWN assignment, the generator's approach is to examine the AK record and to make assignments based upon the documented presence of a chemical that could might maybe perhaps lead to the respective HWN being assigned. In some cases there may be historical analytical data but in many cases, assignment is made based upon chemical inventories or the mention of a hazardous constituent in a lab notebook. It is also worth noting that as with the waste stream physical characteristics, the HWN application is made for a waste stream population with the knowledge that individual waste containers in the inventory may or may not, for example, contain chunks of lead. The bottom line for avoiding "discussions" during the audit process is to have a logical and credible justification in the AK record for assigning or, as important, not assigning a HWN.

Pothole - The regulatory requirements documents for WIPP list a number of items that are prohibited from being in a TRU waste container certified for WIPP disposal. These range from pressurized containers, sealed containers greater than four liters, explosive, reactive, ignitable or corrosive waste to spent nuclear fuel. However, the prohibition of liquids in excess of what is allowed has been the criterion that has resulted in the majority of prohibited item problems and in some cases notices of violation (NOV), fines and penalties. The language in the permit and the WIPP waste acceptance criteria (WAC) document is as follows, "Waste shall contain as little residual liquid as is reasonably achievable by pouring, pumping, and/or aspirating, and internal containers shall contain less than 1 inch or 2.5 centimeters of liquid in the bottom of the container. The total residual liquid in any payload container (e.g., 55-gallon drum, standard waste box, etc.) shall be less than 1 percent by volume of that container"[6].

The AK record is used by the generator to determine the potential for prohibited amounts liquids to be present but real time radiography is the method used to identify the actual presence of liquids in waste containers and determine if that amount exceeds the allowed limits. A trained RTR operator usually has little difficulty in identifying liquids in a waste container. However there may be issues in identifying prohibited amounts of liquids, especially in inner containers. The generator will err on the conservative side and have containers set aside for treatment if there is any question regarding the amount of liquid present. Furthermore, while RTR can provide information about the presence and amount of liquid present, it is up to the AK record to provide information on the type of liquid, that is, is it water, acid, organic or otherwise.

In some circumstances for liquids absorbed to form a solids matrix, there have been instances where liquid desorbs and can be observed and then is reabsorbed (and disappears). This phenomenon, while not completely understood has resulted in waste containers being examined and reexamined with varying results. Thus today in most cases, containers in a waste stream like the one described will undergo a significant drum by drum examination and perhaps repackaging or addition of absorbent to assure compliance.

The more critical issue has not been with problems in identifying containers with prohibited liquids but in segregating and controlling the containers until they have been treated to remediate the problem. On more than one instance, a drum that had been set aside for remediation was shipped to WIPP and emplaced. While the impact of the small amount of emplaced liquid is nil, the more important issue is the failure of procedures established to prevent such an occurrence including "hold tags" placed on the container and an electronic "do not ship" hold in the generator site container management data base. After these incidents, system wide modifications were made to assure that the errors would not be repeated, including a more substantial physical hold tag along with a more robust system for electronic lockout. In addition, many sites now have a dedicated area that is either reserved for approved containers or provides segregation for containers that cannot be shipped.

Speed Bump - For most contact handled waste, the non-destructive assay equipment in combination with AK that may provide, for example, potential isotopic distributions, is able to yield a relatively accurate assessment of the radiological properties of the waste container, including the amounts of the WIPP 10 tracked radionuclides, the fissile gram equivalents, decay heat and whether the container contents exceed the 100 nCi/g lower limit for TRU waste. However, for remote handled waste, these gamma spec and/or neutron interrogation technologies cannot be applied. The process used to date is called "dose-to-curie" in which scaling factors are developed for the radionuclides of interest using a gamma emitting radionuclide as the "measured radionuclide". Dose measurements are taken at one meter from the container in multiple quadrants. Using special software like Microshield® combined with knowledge of the waste matrix, the measurements can be converted to an activity from which activities for the other radionuclides of interest can be calculated. The challenging aspect clearly is not in taking the dose measurements but in coming up with appropriate scaling factors that can and will be applied to each drum in the waste stream inventory.

Most of the RH TRU waste certified to date has been from irradiated fuel examination. The basic strategy has been to identify the various fuel pins and their initial compositions, establish estimates for the respective burn-ups and then use ORIGEN 2 to model the ending radionuclide concentrations. From this data, mean scaling factors can be developed in conjunction with a number of assumptions, such as the even distribution of waste to each container and twists that will ultimately lead to a set of scaling factors that are applied to the waste stream as a whole. All that remains at that point is to take dose measurements on each waste container and apply the scaling factors to derive the specific radionuclide activities. While the reasoning and rationale may be somewhat complex and perhaps a bit convoluted, the process can be justified and defended. Furthermore, no one has developed a better plan. In a few cases, some destructive sampling and analysis has been carried out and the results have been used to supplement the process described above.

Speed Bump - In some cases for RH TRU waste, the certification and characterization process is conducted on waste containers that have been previously packaged and sealed and will not or can not be reopened. In most of those circumstances, CCP personnel trained in RTR have been able to review video tapes of the original packaging activity and become satisfied with the results as documented by the generator. In some instances a review of the tapes has revealed a prohibited item that the generator did not identify during packaging.

A more complex circumstance arose for an RH TRU waste stream for which video tapes were not available. The packaging of the waste had been conducted and documented by two generator site technicians. They had created container input forms for each of the inner containers that were then placed in 30 gallon drums and ultimately sealed in canisters to be loaded into an RH 72B shipping cask. The contents of each container were described in some detail and the input forms had been signed in almost every case by both technicians. However, there were no video tapes to observe to determine if any prohibited items had been overlooked. The WCPIP provides four methodologies for the qualification of AK such as this and those are 1) confirmatory testing such as the use of RTR, 2) demonstration of NQA-1 equivalency for the packaging activities 3) the use of corroborative data (to date untested method) and 4) peer review. Peer review was selected. This process was proceduralized but had never been used. The peer review team was selected and conducted an extensive review of the waste input forms and supporting relevant documentation. The team issued a report which determined that the data was indeed qualified and could be used in the characterization and certification process for that waste stream.

Speed Bump - The packaging of CH TRU waste containers in the TRUPACT II shipping container and the packaging of RH TRU waste in the 72B shipping cask represent activities that are not technically challenging, nor are they complex from a regulatory compliance perspective. However, the procedures are very prescriptive. They require that specific activities and processes be conducted just as described in the procedures, in the order described in the procedures, with tools as described in the procedures and in a manner that exactly mirrors the procedures. The result of this precision is a shipping container carrying significant quantities of long lived radionuclides that will provide safe transport to WIPP. The downside is that during transportation audits conducted by CTAC there can be numerous opportunities for minor non-compliance issues.

Speed Bump - The RCRA permit requires that at least ten waste containers from an S5000 debris stream have their waste contents examined by headspace gas(HSG) sampling and analysis. The ten drums must be selected randomly from the waste stream inventory. Each waste container must have had an opportunity to be selected. Potential problems arise when the inventory is indeterminate, frequently the case when the waste is being recovered from a retrievable storage mode, having been emplaced in earthen cover years ago prior to the opening of WIPP. In such a circumstance, the inventory is unknown and placeholders must be used in the random selection process. In addition, the site must always assure that if the inventory is smaller than anticipated or if funding for the program is pulled, there will be a sufficient number of "contingency drums" available to complete the sampling requirements of the permit. Considerable thought is given to the details of this process.

## CONCLUSION

In the nearly eleven years of auditing of generator sites characterization, certification and shipping activities leading to a significant volume of TRU waste being emplaced safely at WIPP, all parties have worked, sometimes in concert, sometimes not, to develop and enhance the program. While issues still arise, they tend to be fewer in number and consequence. However, the work is still far from routine and in the management of radioactive waste, the more

problematic waste is always left for "later". For the WIPP program, "later" at many sites is here and with it comes new challenges for all involved.

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