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Nevada Test Site Perspective on Characterization and Loading of Legacy Transuranic Drums Utilizing the Central Characterization Project

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ABSTRACT

The Nevada Test Site (NTS) has successfully completed a multi-year effort to characterize and ship 1860 legacy transuranic (TRU) waste drums for disposal at the Waste Isolation Pilot Plant (WIPP), a permanent TRU disposal site. This has been a cooperative effort among the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), the U.S. Department of Energy, Carlsbad Field Office (DOE/CBFO), the NTS Management and Operations (M&O) contractor Bechtel Nevada (BN), and various contractors under the Central Characterization Project (CCP) umbrella. The success is due primarily to the diligence, perseverance, and hard work of each of the contractors, the DOE/CBFO, and NNSA/NSO, along with the support of the U.S. Department of Energy, Headquarters (DOE/HQ). This paper presents, from an NTS perspective, the challenges and successes of utilizing the CCP for obtaining a certified characterization program, sharing responsibilities for characterization, data validation, and loading of TRU waste with BN to achieve disposal at WIPP from a Small Quantity Site (SQS) such as the NTS.

The challenges in this effort arose from two general sources. First, the arrangement of DOE/CBFO contractors under the CCP performing work and certifying waste at the NTS within a Hazard Category 2 (HazCat 2) non-reactor nuclear facility operated by BN, presented difficult

challenges. The nuclear safety authorization basis, safety liability and responsibility, conduct of operations, allocation and scheduling of resources, and other issues were particularly demanding. The program-level and field coordination needed for the closely interrelated characterization tasks was extensive and required considerable effort by all parties.

The second source of challenge was the legacy waste itself. None of the waste was generated at the NTS. The waste was generated at Lawrence Livermore National Laboratory (LLNL), Lawrence Berkeley Laboratory (LBL), Lynchburg, Rocky Flats Environmental Technology Site (RFETS), and a variety of other sites over 20 years ago, making the development of Acceptable Knowledge a significant and problematic effort. In addition, the characterization requirements, and data quality objectives for shipment and WIPP disposal today, were non-existent when this waste was generated, resulting in real-time adjustments to unexpected conditions.

INTRODUCTION

The purpose of this paper is to present the Nevada Test Site (NTS) perspective on the use of the Central Characterization Project (CCP) to disposition transuranic (TRU) waste from Small Quantity Sites (SQSs). Some of the NTS challenges are comparable to future challenges at other SQSs and major U.S. Department of Energy (DOE) sites using CCP. Some challenges are only applicable to characterization and loading operations within a radiological or HazCat 2 facility, and some are unique to NTS TRU characterization and loading.

The NTS has successfully completed a multi-year effort to characterize and ship 1860 legacy TRU Waste drums for disposal at the Waste Isolation Pilot Plant (WIPP). Characterization began in 2001 [1]. This has been a cooperative effort among the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), the U.S. Department of Energy Carlsbad Field Office (DOE/CBFO), the NTS Management and Operations (M&O) contractor Bechtel Nevada (BN), and various contractors under the CCP umbrella.

The success of the project is due primarily to the diligence, perseverance, and hard work of each of the contractors, the DOE/CBFO, and NNSA/NSO, along with the continued support of the U.S. Department of Energy, Headquarters (DOE/HQ). Significant and noteworthy contributions were made on a frequent basis by federal employees and contractors alike.

The challenges in this effort arose from two general sources. First, the integration of BN and the contractors under the CCP to achieve WIPP-compliant characterization and loading within a Hazard Category 2 (HazCat 2) non-reactor nuclear facility at the NTS was very difficult. Major challenges were addressed in roles and responsibilities, safety authorization basis, safety liability and responsibility, conduct of operations, allocation and scheduling of resources and other issues. The program-level and field coordination needed for the closely interrelated characterization tasks was extensive and required considerable effort by all parties. Integral to this effort was close cooperation between NNSA/NSO and DOE/CBFO.

Second, the legacy TRU waste presented significant challenges due to the numerous generators, the range and poor documentation of the generating activities, and the age of the waste. Very little of the waste was generated at the NTS. The waste was generated at Lawrence Livermore

National Laboratory (LLNL), Lawrence Berkeley Laboratory (LBL), Lynchburg, and Rocky Flats Environmental Technology Site (RFETS) among a variety of other sites. Most of the waste was generated over 20 years ago. The quality assurance rigor required in today's waste management environment was nonexistent when this waste was generated. This lack of quality data made the development of Acceptable Knowledge documentation a significant and problematic effort. It also led to "moments of discovery" throughout the process resulting in real-time adjustments to cost and schedule from unexpected conditions.

The NTS experience of using the CCP to disposition TRU waste to WIPP is unique and was based on the strength of the waste program at the NTS (how much could be done on site); the volume and type of wastes to be processed, and the availability of funded resources. The decision for SQSs to use the CCP was encouraged by DOE/HQ and DOE/CBFO to make characterization of small quantities of waste more cost efficient for the complex.

This paper will not attempt to delineate the complete WIPP characterization process nor the entire chronicle of the NTS experience. It will present a brief overview of NTS TRU operations and the integrated team that processed the waste. This will be followed by a synopsis of challenges and how well or poorly they were handled, and potential considerations for other SQSs, using CCP to help deliver their TRU to WIPP.

OVERVIEW OF NTS TRU CHARACTERIZATION AND LOADING

The Nevada Test Site

The NTS is a remote site that is buffered for public access by vast, federally owned land masses. A unique national resource, the NTS is a massive outdoor laboratory and national experimental center that cannot be duplicated. Larger than the state of Rhode Island, its it is approximately 1,375 square miles (3,561 square kilometers or 880,000 acres), make this one of the largest secured areas in the United States. The NTS is located in southern Nevada about 65 miles (105 kilometers) northwest of Las Vegas. The site varies from 28-35 miles (45-56 kilometers) in width (east-west) and from 40-55 miles (64-88 kilometers) in length (north-south). The NTS is bordered on three sides by the Nevada Test and Training Range, another federally owned, restricted area. This restricted area provides a buffer zone to the north and east between the test area and land that is open to the public. The combination of the Nevada Test and Training Range and the NTS is one of the largest unpopulated land areas in the United States, comprising some 5,470 square miles (14,200 square kilometers).

TRU Waste Management Operations

TRU waste is managed at the NTS within the Area 5 Radioactive Waste Management Complex (RWMC). The TRU facilities consist of the Waste Examination Facility (WEF), the TRU Pad, and the TRU Pad Cover Building (TPCB). The WEF is comprised of the Visual Examination and Repackaging Building (VERB), the Drum Holding Area, Sprung Instant Structure (SIS) for headspace gas sampling and thermal conditioning of drums, and an area for vendor (CCP) characterization trailers. For long-term storage, the NTS utilizes the TRU Pad and the TPCB. The TPCB is a high-clearance, bermed, fabric-covered frame structure without electric lighting or an HVAC system. The TRU Pad hosts an outdoor area for loading trailer-mounted TRUPACT-II containers using the CCP Mobile Loading Unit (MLU).

Originally, all TRU facilities were categorized as radiological facilities. Starting in 2003, all TRU operations (including characterization and loading) within the RWMC were conducted under a Area 5 Documented Safety Analysis (DSA) and the associated Technical Safety Requirements (TSR) for TRU activities compliant with 10 Code of Federal Regulations 830 Subparts A and B (10CFR830). All TRU facilities are currently operated as HazCat 2 non-reactor nuclear facilities, with the exception of the VERB. Due to the construction, age, and history of the VERB, it was difficult and time/cost prohibitive to develop a determination that the VERB had the requisite structural rigor as a HazCat 2 facility to mitigate the seismic risk in the geographic area. Therefore, the VERB is operated as a Hazard Category 3, non-reactor nuclear facility, with limited allowable radioactive inventory.

The CCP Non-Destructive Examination (NDE) unit and the Non-Destructive Assay (NDA) unit are trailer-mounted mobile units operated as segments of the WEF, under the DSA, with specific controls and individual radioactive inventory limits. The units were used to characterize 55-gallon drums. The NDE unit was used to visually represent the drum contents (by shape) to provide data to assure conformation with the Waste Stream Profile and identify prohibited items for removal in the glovebox. The NDA unit was used to develop a radioactive isotopic inventory of the drum. The NDE and NDA units are also referred to respectively as the Real-Time Radiography (RTR) and Segmented Gamma Scanner (SGS) units.

The CCP Headspace Gas Sampling (HSGS) unit was installed in the SIS and used to pull headspace gas samples for volatile organic compounds (hydrogen and methane analysis) through the drum lid. The drill assembly in an explosive-proof chamber of the unit was also used to perforate unvented drum lids and install a filtered vent. Commonly, drums were vented, placed back in storage to meet Drum Aging Criteria (DAC), and reprocessed in the unit to obtain a gas sample. The remaining area in the SIS was used to store drums in a temperature controlled environment for the requisite thermal conditioning prior to sampling.

In addition to the drill assembly in the HSGS unit, a pneumatic driver attached to the drum lid, and activated by a corded pendant switch, was used to safely install a combination sample port and filter vent. Use of this system was a time-saving practice when the HSGS was unavailable or a headspace gas sample was not needed. While the optional remote control switch could not be used due to competing radio frequencies from nearby U.S. Air Force activities, the corded switch allowed the unit to be safely operated from a distance, to mitigate the effects to workers from a potential deflagration or explosive event.

Within the VERB, BN operates a glovebox capable of handling input and output of 55 and 85 gal drums. This glovebox has a split design allowing drum repackaging to occur on one side, while segregated items are safely stored on the other side. It features 14 sets of glove ports, high-efficiency particulate air (HEPA) filtration and negative pressure, a CO₂ fire suppression system to extinguish Class A fires, a drum lifting mechanism and port for introducing 55-gallon and 85-gallon drums to the glovebox, and a material exit port to a 55-gallon drum. A full audio and video system was installed to record glovebox operations. The glovebox is contained within a Secondary Containment Structure (SCS) room that provides additional and separate HEPA filtration and negative pressure. The SCS is used as secondary containment for glovebox operations and for TRU open container evolutions that do not require the glovebox.

The glovebox was used to verify the NDE results on a statistical population of drums, to perform physical verification of the drum contents in lieu of NDE, and for prohibited item removal (PIR). NDE, NDA, HSG, and VE together comprise the needed activities to characterize drums for disposal, in accordance with the WIPP Waste acceptance Criteria and the Resource Conservation and Recovery Act permit for the WIPP disposal site.

The field processes were staffed by the respective owners of the resources: the individual CCP contractors staffed the NDE, NDA, and HSGS processes; BN staffed the VERB glovebox. BN provided drum handling, Radiological Control Technicians (RCTs), drum storage, maintenance, calibration, and typical facility support functions.

Organizational Roles and Responsibilities

The integrated organizational roles and responsibilities specific to corporate structure, nuclear operations, and safety management were developed for this work based on three interrelated needs. First, an agreed-to corporate structure to identify who would be responsible for which functions and who could authorize work was required. Work authorization was established through work-scope agreements between BN and NNSA/NSO and among DOE/CBFO and the CCP contractors through the CCP integration contractor, Washington TRU Solutions (WTS). BN and WTS formalized their working relationship with a Memorandum of Understanding, an Interface Agreement, and a Statement of Work

Second, all parties needed to maintain and adhere to the rigorous conduct-of-operations protocols required for operations within nuclear facilities. BN, as the facility manager, held the primary responsibility for nuclear facility safety while each contractor held responsibility for the safety of their employees.

Finally, the NTS had responsibilities as the waste owner and data generator for Visual Examination and Prohibited Item removal in the very prescriptive WIPP certification and shipping protocols. All characterization data is the responsibility of the NTS as the waste owner. The CCP, as the WIPP certification holder and shipping coordinator, held primary responsibility for meeting the characterization requirements under the CCP certified waste characterization program. The roles and responsibilities structure for these last two needs was accomplished through modification of BN and CCP procedures, identification of key positions within the Interface Agreement, and development of co-signed procedures held by both BN and CCP.

CHALLENGES

The challenges in this effort arose from two general sources: the integration of BN and the contractors under the CCP, and the legacy TRU waste itself.

The challenges presented here may be generic to any site where the M&O contractor is working with CCP contractors to achieve certification of TRU waste for disposal at WIPP. The degree of difficulty in many cases, however, is specific to the NTS. For instance, a site where CCP provides all of the characterization functions will have fewer integration issues with the certification process (although the M&O still has responsibilities as the waste generator) and

lessened operational complexity than the NTS, but these will still be challenges requiring attention by the M&O, CCP, and DOE.

Integration

Roles and Responsibilities

The roles and responsibilities are intricate and this complexity is compounded by the lack of a single contractual document that links the participating contractors and DOE offices. The effort and cost of interfaces is easily underestimated and is the single most important key to successfully shipping TRU waste to WIPP. BN and CCP entered into zero-sum contracts, a Memorandum of Understanding, an Interface Agreement, a Statement of Work, and comprehensive cross-contractor procedures to establish the necessary flow of communication, authority, and accountability among contractors.

Clear decision and communication protocols were also needed between NNSA/NSO (that has oversight for BN at the NTS) and DOE/CBFO (that holds the CCP contract and schedules WIPP shipments). Frequent involvement by NNSA/NSO with DOE/CBFO and DOE/HQ was a significant contribution to the success of the project.

Safety and Safety Liability

Safety is the responsibility of everyone involved with the project. As the M&O, BN shared the responsibility and liability for CCP operations in a dual role with CCP. Safety liability for CCP operations cannot be deflected to CCP only. This was a difficult challenge. BN needed to maintain the strong Integrated Safety Management (ISM) structure that has resulted to date in over seven million hours without a Lost Time Accident. CCP needed to retain control of safety for its personnel and equipment at the NTS. To accomplish these objectives, a dual concurrence was required on all documents and procedures involving the performance of field work, and a zero-sum contract was signed establishing CCP as a subcontractor to BN to give CCP status within the ISM structure for safety and work control documents in place at the NTS.

Authorization Basis

CCP TRU waste characterization activities were performed under site safety authorization basis (AB) documents at the NTS. During the initial campaign, only a limited number of containers were available for characterization at each facility due to activity limits for a radiological facility. Operating as a radiological facility was not a cost effective way to manage the characterization activities at the NTS based on the TRU inventory at the NTS. BN implemented a new DSA with associated TSR, compliant with 10CFR830, and re-categorized the TRU facilities as HazCat 2/3 radioactive non-reactor nuclear facilities. The CCP equipment was demobilize to other sites while the NTS implemented the new DSA resulting in a break in characterization episodes. CCP processes were required to undergo formal Management Self Assessments and graded Operational Readiness Reviews to demonstrate compliance with the new AB, a challenge that was overlooked until deployment for the next campaign. Part of the characterization production gap between January 2003 and May 2004 is attributed to the effort by both BN and CCP to implement the new DSA (Figure 1). Also shown in Figure 1 is a significant increase in the overall number of characterization actions per quarter (after implementation of the new DSA)

due largely to the increase in allowable radioactive material limits, as the TRU facilities transitioned from radiological facilities to HazCat 2 facilities.

The TSR for TRU activities also evoked stringent controls on training, maintenance, in-service inspections, equipment specifications, testing and modifications, procurement, and other requirements that CCP was mandated to follow to perform compliant operations. For example, CCP personnel were required to take DSA training. The CCP training program was measured against the training program requirements in the DSA. Maintenance interfaces were evaluated and placed in the Interface Document. This had a significant cost-and-schedule impact.

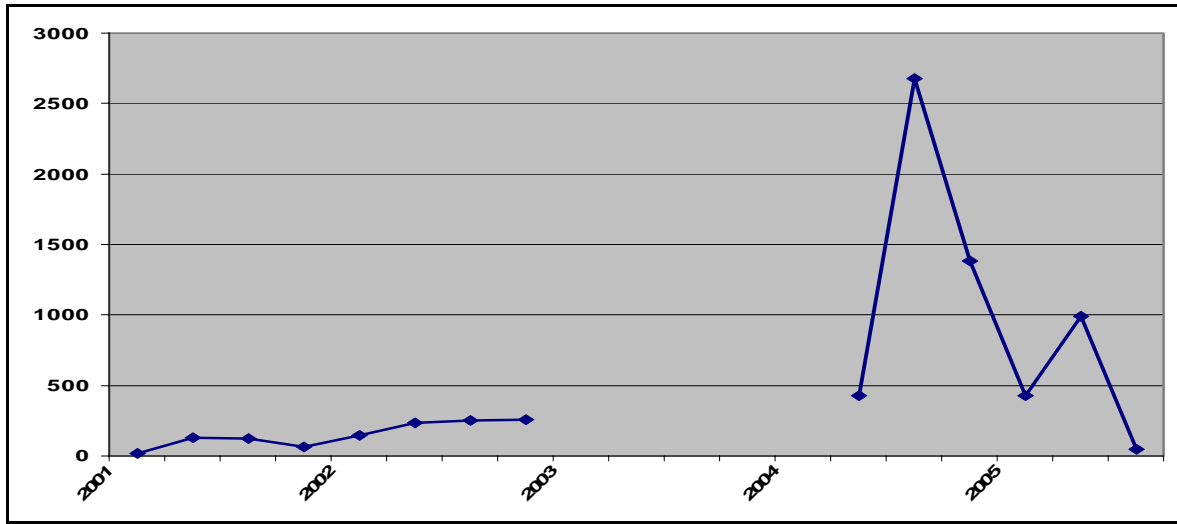


Fig. 1. TRU characterization actions per quarter

The CCP holds the authorization to certify drums for transportation and disposal of NTS TRU waste to WIPP. The CCP and BN each had responsibilities for the characterization data generated by their respective processes. To fulfill the positions required for certification, the Interface Agreement and co-signed procedures identified the appropriate CCP and BN personnel and positions for data generation and generator validation of data. CCP provided the required personnel for project-level validation, verification, and final certification of the waste for shipment and disposal.

Document Control

Transfer of documents and data between BN and CCP required more formalization. It was accomplished through personal commitment by the project personnel rather than a rigorous transfer protocol. Efforts at other sites might include a single point for document management for CCP and the M&O to improve data transfer, verification, and feedback in order to track revisions, concurrences, and agreements.

Legacy TRU Waste Characterization

Operational Complexity

The single most important factor in this characterization success was achieving a high degree of communication and integrated scheduling of interrelated field tasks. To achieve success in the

field, BN dedicated two full-time people and CCP dedicated one person at the NTS and one in Carlsbad to coordinate the interrelated field processes. In addition, four to five people at BN, CCP, and NNSA/NSO spent about one-half of their time to coordinate logistics in support of field work. In addition to attending a general Plan of the Day meeting of Area 5 operations, a separate TRU field operations meeting was held daily, and a weekly joint teleconference was held between the CCP and BN offices and their field personnel. Notwithstanding these efforts, Figure 1 shows a high degree of variability in the number of characterization actions over time. In an optimal production environment, it would be advantageous to complete a characterization evolution for the entire population on drums before continuing, or at least to develop a stockpile of drums that have been through one process and are waiting for another. It would also be helpful to always process drums sequentially (e.g., RTR to PIR to NDA to headspace gas sampling to VE).

At the NTS, stockpiling was achieved, to some degree, but the characterization operation was often in a “just in time” delivery mode from one process to another. The NTS starting TRU inventory (about 1600 drums) was relatively small compared to major sites with thousands of drums, which allow the characterization processes to operate relatively independent of each other. Many SQSs will have even smaller quantities of drums than the NTS.

Another element to “just in time” delivery is the interrelated nature of the processes. For instance, a drum needing headspace gas sampling needs to be closed longer than the DAC time. The DAC clock cannot start until after the PIR evolution is completed. The PIR determination is based on the RTR data. The RTR might not be done until the NDA analysis determines the radioisotope inventory. Unvented drums are not permitted in the NDA unit, so the NDA of the drum may not have been started until the drum was vented in the HSGS unit. The permutations on this example were numerous at the NTS and were further compounded by the removal of large percentages of the drum contents during PIR or repackaging, causing the NDA and HSGS process to be redone (See Rejected and Rerun Drums).

Finally, discoveries were made that were adverse to characterization production. Drums scheduled for characterization fell out, due to less than TRU radioisotope limits during NDA. Unacceptable Volatile Organic Compound (VOC) and hydrogen limits were reported during HSGS analysis. Poor drum integrity was discovered as drums were inspected in storage prior to movement to the characterization venues. Surface exposure levels were recorded making drums Remote Handled (by the WIPP definition) rather than Contact Handled. Prohibited items or contents incompatible with the Waste Stream (prohibited from disposal at WIPP) discovered during RTR were also in evidence. There were critical equipment failures, since much of the equipment represented a single-point failure for the process, as will be common at other SQSs.

Scheduled maintenance required several days at the glovebox, which resulted in a lack of feedstock for the other processes. Duplication of systems and readily available spare parts would have been helpful in keeping critical systems in top working order, but this is not always possible or cost effective. There were some lapses by the team in early identification of a pending problem with keeping feedstock for the processes. All of these “discoveries,” whether preventable or not, resulted in less than optimal characterization throughput.

To summarize this challenge, characterization was successfully completed with a high level of integration and cooperation among all parties; however, efficiency and productivity could have been enhanced. While more of these problems could have been mitigated through better management of maintenance, training, replicate systems, thermal conditioning, and drum-aging criteria, some of the work inefficiencies are simply a function of small quantities of available drums in inventory that do not allow stockpiling of feedstock for interrelated processes.

Shared Federal Resources

SQSs must be adaptable to change in the nationally controlled resources. DOE sites with large quantities of TRU waste often have priority in completing DOE commitments that necessitate changes in availability of characterization and shipping resources. At the NTS when CCP resources were unavailable, some field personnel were shifted to other tasks within the Waste Management scope (primarily Low Level Waste disposal operations) and other tasks at the NTS. However, the cost of project overhead and maintaining facilities and core capabilities in a state of readiness with respect to training, maintenance, inspections, and other tasks required by the TSR for the facilities continued to be incurred. Some of the gap in characterization production between January 2003 and May 2004, and the shipping delay until November 2005 for drums certified in September 2005, was due to lack of resources. Conversely, CCP resources were sometimes held at the NTS to the detriment of characterization at other sites.

Acceptable Knowledge

Acceptable Knowledge (AK) documents developed to the requisite strength required by the WIPP guidelines are a significant and time-consuming part of the characterization process. The AK document starts as a historical record of the waste, but must be amended to include new information from the characterization activities, if the data conflicts with or is omitted from the existing document. The legacy waste at the NTS was generated at LLNL, LBL, Lynchburg, RFETS, and a variety of other sites over 20 years ago, making the development of AK a significant and problematic effort. The disposal requirements for TRU waste and quality assurance rigor required in today's environment were non-existent at the time the waste was generated, resulting in real-time adjustments to unexpected conditions and many changes to the AK documents. The most notable adjustments were the changes in the definition of homogeneous solids for the S3900 waste stream, greater than expected quantities of plastics and homogeneous materials that forced drums into new waste streams, much less than expected radioactive material quantities in some drums, discovery of chemical compounds not identified in original AK documents, and the presence of reactive compounds that were originally reported as expended.

Figure 2 shows a typical assemblage of material from an NTS legacy debris drum. This particular drum was from LBL and contained reactive compounds that were unreported in the AK. The reactive compound within a vial in this drum rapidly oxidized upon contact with air and initiated a small Class A fire involving the combustible wastes nearby in the glovebox. (Note the small scorch marks in the lower left of Figure 2.) The CO₂ fire suppression system within the glovebox quickly extinguished the flame with no injury or uptake to personnel and no damage or contamination of equipment.

Rejected and Rerun Drums

Early on in the characterization process it was evident that the projected reject rate for drums of 5 to 10 percent was too low and the actual rate would be 30 percent or higher. The lack of a comprehensive historical AK, and stringent controls during waste generation, contributed to the increase, although a waste generator in the 1970s could not have foreseen the stringent requirements for 21st century waste disposal. This resulted in a large increase in the number of drums processed through the glovebox for PIR, or repackage to reposition radioactive material in a drum to reduce the surface exposure rate and change the classification of a drum from Remote-Handled (not allowed for WIPP disposal under NTS certification) to Contact-Handled. Rejected drums and containers were identified throughout the process from initial physical inspection through to development of the final loading manifest.



Fig. 2. Contents of legacy Lawrence Berkley Laboratory drum in the NTS VERB glovebox

Project success was accomplished through the diligence, hard work, and innovation of the combined project personnel, as most of the drums for disposal at WIPP were successfully processed. The downside is rework of these containers was very expensive and time-consuming. The NTS was left with a population of about 80 drums that could not go to WIPP and range from relatively easy disposition as low-level waste (LLW) or mixed low-level waste (MLLW) at the NTS to very difficult disposition as WIPP Remote-Handled TRU, high VOC TRU, or radioactive non-TRU waste that cannot be classified as LLW or MLLW. In addition to these drums, 78 homogeneous solids drums are awaiting shipment offsite for sampling and certification prior to WIPP disposal.

As shown in Figure 1, nearly 7,200 characterization actions were completed on a shipped quantity of 1,860 drums, or about 3.86 characterizations per drum. Considering that every drum was required to go through HSGS, NDA, and either RTR or Visual Examination in lieu of RTR and including Visual Examination to confirm RTR, the minimum number of activities is around 3.05 characterizations per drum, or about 5,700 characterizations. The approximately 1,500 additional activities are attributed to reruns of NDA and HSGS once the contents of a previously

characterized drum were altered through PIR or repackaging, pre-screening of drums through NDA (to allow more drums in each of the process areas than if the generator assumptions or early NDA data was used), and rerun of drums after a change in calibration, a change in acceptance criteria (NDA), or loss of data.

Classified Material as TRU Waste

Special considerations for characterization, transport, and disposal need to be made for materials that carry a security classification. The NTS achieved a unique and innovative success in compliant, cost-effective disposal at WIPP of some of the classified inventory through the use of a waste declaration. Not all classified materials are eligible for WIPP disposal. These materials need to be identified early in the planning process, will require additional work controls, and are handled on a case-by-case basis by DOE.

CONCLUSION

The success of the effort is due to diligence, perseverance, knowledge, and hard work of dedicated personnel from the assembled team. Integration and communication among NNSA/NSO, DOE/CBFO, BN, and various contractors under the CCP umbrella was essential. The process is intrinsically difficult and challenges arose throughout: from preparing for the first deployment of CCP resources on site until the disposal of the final shipment at WIPP. Attention to the challenges and experiences at the NTS will benefit SQSs using CCP to dispose of their TRU waste at WIPP.

REFERENCES

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