Overcoming Challenges to Dispose of a Shielded Container in the Waste Isolation Pilot Plant (WIPP) – 14348

Steve Kouba *, Russell Patterson **, James Rhoades **, Ed Gulbransen ***, Cynthia Rock ****, Daniel Pancake *****
* URS Corporation
** US DOE, Carlsbad Field Office
*** Nuclear Waste Partnership LLC
**** Argonne National Laboratory
***** ANTECH / Argonne National Laboratory

ABSTRACT

The concept of shipping transuranic waste streams with a high dose rate in containers that could be handled by workers as contact handled transuranic waste has been in the works for several years and has been the subject of past Waste Management papers. Full approval has been obtained from the U.S. Nuclear Regulatory Commission to transport the shielded container in Type B HalfPACTs. The U. S. Environmental Protection Agency (EPA) has approved a planned change request to emplace shielded containers at the Waste Isolation Pilot Plant (WIPP). New Mexico Environment Department has subsequently approved a Class 2 modification to the Hazardous Waste Facility Permit. This paper will focus on two final challenges related to obtaining regulatory approval from the EPA and include how project management principles were used to identify and address each of these unique challenges. The concept of packaging remote handled transuranic waste in containers that can be shipped and handled as contact handled waste has far reaching strategic impacts on dealing with the United State's nuclear waste disposal issues.

INTRODUCTION

The shielded container design has 2.54-centimeter (1-inch) thick lead shielding sandwiched between a double-walled steel shell with a 7.62-centimeter (3-inch) thick lid and 7.62-centimeter (3-inch) thick base (see Fig. 1). The design of the lead-shielded container has passed drop testing for U.S. Department of Transportation Type 7A specifications and for the U. S. Nuclear Regulatory Commission Type B specifications for shipping in the HalfPACT transportation package. The results from testing required by the two regulatory organizations ensure that the shielded container is safe for transportation and handling and will prevent releases under the most severe accident conditions.

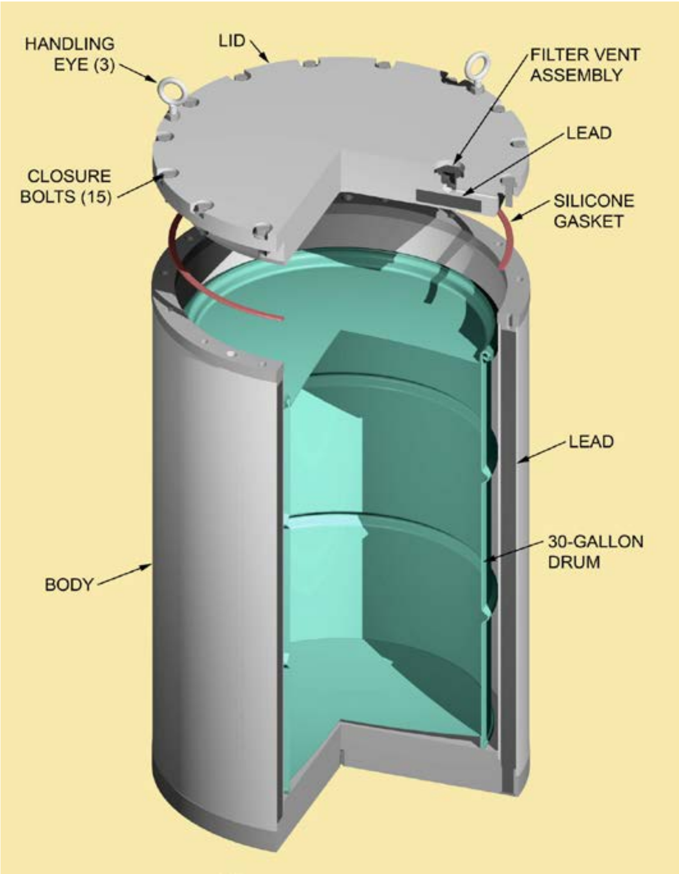

Fig 1. Isometric of the Shielded Container

The U.S. Department of Energy (DOE) submitted a planned change request to the U.S. Environmental Protection Agency (EPA) in November 2007, for authorization to use shielded containers for the management and emplacement of some remote-handled (RH) transuranic (TRU) waste as contact-handled (CH) TRU waste. This container is sufficient to shield a portion of the RH TRU waste inventory down to a dose rate of less than 2 millisievert/hour (200 millirem/hour) at the surface of the container. The shielded containers will be emplaced side-by-side with CH TRU waste, on the floor of the WIPP repository, but these waste streams will remain designated as RH TRU waste in the facility's Waste Data System tracking database. It is important to note that the EPA required the NRC approval for transporting the shielded container before they approved the use of the shielded container. The EPA issued their technical approval to emplace shielded containers at the WIPP on August 8, 2011 with one condition. The EPA's conditional approval required the DOE to demonstrate a consistent complex wide procedure to ensure that the shielded container surface dose rate be in compliance with the Land Withdrawal Act's CH TRU waste limit of 2 millisievert/hour (200 millirem/hour).

The New Mexico Environment Department approved the DOE's Class 2 permit modification to the WIPP's Hazardous Waste Facility Permit on November 1, 2012. This approval allowed the Permittee's the use of shielded containers for managing RH TRU mixed waste as CH TRU mixed waste.
This paper will focus on resolving the following two final challenges, defining a consistent process that identifies the maximum dose rate and resolving measurement uncertainty. The use of the shielded

containers will enable DOE to significantly increase the efficiency of transportation and disposal operations of RH TRU waste. The concept of packaging RH waste in containers that can be shipped and handled as CH waste has far reaching strategic impacts on managing the United States nuclear waste disposal issues.

PROGRAMMATIC DESCRIPTION

A couple of programmatic drivers elevated the timely completion of packaging, transporting and disposing shielded containers. The DOE formalized the importance of completing this activity in the Carlsbad Field Office Fiscal Year 2013 Work Plan [1]. This Plan includes a work scope assumption to, “Provide regulatory compliance resources to receive regulatory approval to use the shielded container and emplace the first shielded container in the underground.” This Plan also includes a milestone to emplace the first shielded container in the WIPP underground by September 30, 2013. Even though some fraction of the RH TRU waste will be handled as if it were CH TRU waste, these containers will still be recorded as RH TRU waste in the WIPP Waste Data System, and the volume of the waste will be counted against the limit of 250,000 cubic feet (7,080 cubic meters) of RH TRU waste, as set by the Consultation and Cooperation Agreement between the DOE and the state of New Mexico. In addition, the DOE, in their contract with the WIPP Management and Operating Contractor (Nuclear Waste Partnership LLC), incentivized on-time and on-budget site infrastructure projects. The shielded container project qualified as an infrastructure project.

One of the first activities of the project was to define a project team that included members of the local DOE office, the WIPP Management and Operating Contractor (Nuclear Waste Partnership LLC), Carlsbad Technical Assistance Contractor (Portage, Inc.), Sandia National Laboratory, Los Alamos National Laboratory, Argonne National Laboratory and selected subcontractor staff for these organizations. This integrated project teams was one of the first WIPP project teams that included more than one or two organizations. This project included scope that impacted almost every WIPP organization. In the project management world, it is important to include all stakeholder organizations to ensure buy-in and improve implementation effectiveness.

The scope assigned to the project team was to emplace up to nine shielded containers from Argonne National Laboratory in the WIPP repository by no later than September 30, 2013. A Project Execution Plan [2] was written to assign responsibility to the project team, as well as to expand the functional definition of each element of organizational scope, identify team members by name and by organization, identify the source and amount of funding, create a detailed schedule, describe regulatory expectations, identify interrelationships and project dependencies, define quality assurance program elements, determine the type of readiness activity required by U.S. Department of Energy Orders, analyze potential risks for impact, define environmental health and safety parameters, and identify existing procedures needing revision. The scope of this Project Execution Plan was limited to waste generated and packaged at Argonne National Laboratory. Preparations for shipments from additional sites and for activities after this single shipment will be covered under a new or revised Project Execution Plan. The timing of preparing and issuing the Project Execution Plan is consistent with planning phase activities defined by accepted project management practices.

CONSISTENT DOSE RATE MEASUREMENT PROCESS

The EPA's August 8, 2011 [3], approval to emplace shielded containers at the WIPP contained one condition. The EPA's conditional approval required the DOE to demonstrate a consistent complex wide procedure to ensure that the shielded container surface dose rate be in compliance with the Land Withdrawal Act's CH TRU waste limit of 2 millisievert/hour (200 millirem/hour). The EPA had observed differences among generator site procedures, such as how radiation control staff measured surface dose rates on CH containers. Satisfactorily resolving the EPA's issues required numerous telephone and face-to-face discussions. The art of effectively communicating with management, stakeholders and regulators, is a critical element of any successful project that effectively implements sound project management principles. The steps used to gain the EPA's trust and approval is described in the following text.

Based on the EPA's Technical Support Document (issued with their August 8, 2011 conditional approval) [4], the driver for the conditional approval was a concern that "all shielded containers have surface dose rates of less than 2 millisievert/hour (200 millirem/hour)." Initially, the DOE revised their procedure [5] to make measurements and collect surface dose rate measurements consistent with EPA's recommendations for consistency and standardization, as contained in the EPA Technical Support Document [4]. Then DOE and Argonne National Laboratory provided a step-by-step demonstration to the EPA of the measurement procedure during actual shielded container loading, closure (fig. 2) and monitoring operations (figs.3 and 4) After discussions between the DOE and the EPA, it was agreed that additional documentation in three areas needed to be satisfactorily resolved before the EPA lifted their conditional approval. The issues included: (1) define measurement uncertainty relative to the 2 millisievert/hour (200 millirem/hour) surface dose rate limit for the shielded containers, (2) ensure that the DOE's dose rate measurement procedure captures the maximum surface dose rate on the shielded container, and (3) provide an explanation of the dose reduction modeling used to help determine payload contents of the shielded containers that will ensure a maximum dose rate limit of less than 2 millisievert/hour (200 millirem/hour) on the outside surface of a loaded shielded container.

Fig 2 – Central Characterization Program Mobile Loading Team finishing closure of the shielded container prior to measurement

Fig. 3 – Argonne National Laboratory Rad Con Technicians taking beta, gamma surface dose rate measurements

Fig. 4 – Taking neutron surface dose rate measurements on the bottom of the shielded container

The EPA reviewed the revised procedure for making surface dose rate measurements and additional documentation provided by the DOE, observed the actual loading of a shielded container at Argonne National Laboratory and considered stakeholder comments. Based on these reviews, the EPA determined that the DOE had met the condition placed on the use of shielded containers as described in the EPA's August 8, 2011 letter. On September 3, 2013, the EPA issued a letter authorizing the DOE to ship waste from approved waste streams using the shielded container.

Uncertainty for Surface Dose Rate Measurements

Measurement uncertainty becomes relevant when a TRU waste container is sufficiently close to the WIPP Land Withdrawal Act regulatory limit of 200 millirem/hour (2 millisievert/hour). This value determines if the container is classified as either CH TRU or RH TRU waste. The maximum surface dose rate also determines into what final container the waste is packaged, which NRC Type B package the container is transported, how the waste is handled at the WIPP and where the waste is emplaced in the WIPP repository. The WIPP Land Withdrawal Act [6] defines contact handled transuranic waste as transuranic waste with a surface dose rate not greater than 200 millirem/hour (2 millisievert/hour) and remote handled transuranic waste as transuranic waste with a surface dose rate of 200 millirem/hour (2 millisievert/hour) or greater.

Surface dose rate measurements to verify regulatory compliance have been performed on containers with radioactive materials transported on public highways for over 50 years. In developing the DOE's position for measurement uncertainty, it was important to review historical regulatory decisions and be consistent with previous regulatory precedence. With regard to transportation package radiation limits, the U.S. Department of Transportation notes that the limits apply to "help to ensure that transport personnel do not receive significant doses, even frequently handling a large number of packages." [7]

Additionally, the U.S. Nuclear Regulatory Commission maintains a Health Physics Positions (HPPOS) Database that is a compilation of NRC staff positions on a wide range of topics involving radiation protection (health physics). HPPOS-223 PDR-9111220129 (1990) [8], "Consideration of Measurement Uncertainty When Measuring Radiation Levels Approaching Regulatory Limits" states:

> *The NRC position is that the result of a valid measurement obtained by a method that provides a reasonable demonstration of compliance or noncompliance should be accepted and that the uncertainty inherent in that measured value need not be considered in determining compliance or non-compliance with a regulatory limit. Thus, only the measured value (and not the sum of the measured value and its uncertainty) need be less that the value of the limit to demonstrate compliance with the limit."*

The surface dose measurement process at TRU waste generator sites is controlled by the procedure, "*Central Characterization Program Shielded Container Assembly Loading*" [5]. The instrument calibration process at the generator sites is in compliance with ANSI N323-1007, *American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments* [9] and is controlled by each site's radiation control program that is designed to comply with DOE requirements. The instrument calibration process includes periodic calibration of instrumentation using a National Institute of Standards and Technology traceable source and daily source checks. The DOE's Central Characterization Program works with each site's Radiological Control Technicians to ensure that they understand the procedure noted above and the proper technique to perform measurements on the entire surface of the shielded container.

Maximum Dose Rate

Based on EPA's review of the initial dose rate measurement procedure, it was not clear to the EPA how the DOE would ensure that maximum dose rate would be captured on the outside of the shielded container.

The June 13, 2013, step-by-step demonstration of the surface dose rate measurement procedure showed that, in practice, dose rate measurements are taken over the entire outer surface of the shielded container.

The WIPP TRU Waste Acceptance Criteria compliance for a surface dose rate measurement on an individual container is met at the generator sites. The Central Characterization Program procedure describes the process for determining the maximum surface dose rate of a shielded container.

The surface of the shielded container is divided into 14 sections for surface dose measurement. The cylindrical surface of the container is divided into four quadrants with three sections (top, middle, and bottom) per quadrant, or a total of 12 sections on the cylindrical surface. The top and bottom of the container are two additional sections, for a total of 14 sections. Figure 5 is a diagram showing the location of each of the 14 sections. Within each section, the generator site radiation control technician will search for the (local) maximum radiation dose rate and record this value. The maximum of the 14 values for the individual sections is taken as the dose rate of record for the WIPP's Waste Data System tracking database. Procedure CCP-TP-081, *Shielded Container Assembly Loading* [5], is consistent with this approach. The Central Characterization Program procedure governing surface dose measurements for the DOE complex was modified to require the radiation control technician to search for the local maximum measurement within each section. Data from the nine shielded containers emplaced in the WIPP show the maximum surface dose rate was 1.2 millisievert/hour (120 millirem/hour).   Note, total dose rate is the sum of the beta/gamma and neutron dose rates. Neutron dose rate was less than 5 micorsieverts/hour (0.5 millirem/lhour) for all measurements.

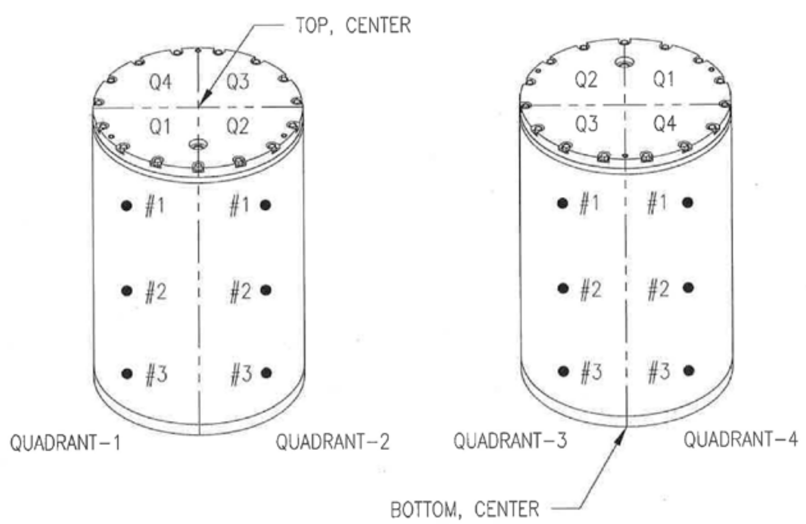

Fig. 5 – Contact Dose Rate Survey Locations

The surface dose rate measurement of record is performed on a single container at the generator site prior to it being placed in a payload assembly of three shielded containers. At the WIPP, radiation dose rate surveys are performed, in accordance with approved procedures, on the payload assemblies at 30 centimeters for the purpose of determining radiological posting for worker safety (i.e., 10 CFR 835, *Occupational Radiation Protection).* WIPP radiation control technicians survey the entire payload assembly; individual containers are not surveyed at the WIPP.

Dose Reduction Modeling

The EPA requested that the DOE provide an explanation of the dose reduction modeling used to determine attenuation capability of the shielded containers to ensure a maximum dose rate limit of less than 2 millisievert/hour (200 millirem/hour) on the outside surface of a loaded shielded container.

The DOE's Central Characterization Program modeled the attenuation capability of the shielded container with the goal of defining an administrative maximum surface dose rate for potential 30-gallon containers to be loaded into a shielded container assembly. The shielding capability is expressed as a dose reduction factor, which is defined as the unshielded surface dose rate on the 30-gallon drum divided by the dose rate on the surface of the shielded container.

The dose reduction factor was derived from calculations with the Monte Carlo N-Particle (MCNP5) software [10]. MCNP5 can simulate particle interactions involving neutrons, photons and electrons and is primarily used for the simulation of nuclear processes. Multiple models were created with MCNP5 to simulate a variety of homogeneous and heterogeneous source configurations. The most restrictive model postulated that all the activity is concentrated in a single point source located at the inside edge of the 30-gallon container, although this configuration is not typical of RH waste. This model has a dose reduction factor of 25. Due to operational efficiencies and As Low As Reasonably Achievable concerns of potentially having to remove a 30-gallon container from a shielded container if the surface dose rate measurement of record exceeds 2 millisievert/hour (200 millirem/hour), the proposed dose reduction factor for container evaluation was reduced by an additional 20%, down to a dose reduction factor of 20, to provide defense-in-depth that removal of a 30-gallon container from an shielded container would not be necessary. This dose reduction model is applied by taking the highest measured surface dose rate of the unshielded 30-gallon container and dividing it by the dose reduction factor of 20. If the result is less than 2 millisievert/hour (200 millirem/hour), then the RH container becomes a candidate to load into a shielded container for shipment.

The DOE may modify the administrative dose reduction factor as warranted as additional data is collected to ensure optimal loading efficiency for future shielded containers. Given the conservatism in the MCNP5 modeling parameters, source distribution, and operational efficiencies implemented, the DOE never expects to load waste into a shielded container that would exceed a surface dose rate of 2 millisievert/hour (200 millirem/hour).

PACKAGING THE WASTE AT THE GENERATOR SITE

When the project team was initially formed, the site that would characterize and package the first shipment of shielded containers had not yet been determined. Very early in the process, Argonne National Laboratory volunteered to be the first generator site to load and ship in this new container. In addition to supporting the enhancement of capabilities offered through the national transuranic waste program, Argonne viewed the project as an opportunity to remove more containers of RH waste from their site. Argonne is in the process of completely deinventorying the Alpha Gamma Hot Cell Facility and the shipment of RH TRU waste in the shielded containers enabled them to exceed their planned shipping volume, advancing their nuclear footprint reduction goals. Their challenge was to load nine 30-gallon drums into shielded containers that would meet all the regulatory requirements for transporting in the HalfPACT and ultimate emplacement in the WIPP. Again, the project management communication process became significant, especially with the physical separation between the Argonne National Laboratory and the WIPP.

Once it was determined that Argonne National Laboratory would load the first shielded containers to be emplaced in the WIPP, project team members were identified and the project schedule was modified to include Argonne National Laboratory activities. Detailed scheduling that identified interdependencies between Argonne National Laboratory and the WIPP were identified.

The following generator site readiness activities were noteworthy in the preparation process and framed the path forward for the Argonne Project Team:

- Receive 30-gallon drums with non-standard lid closures
- Revise Alpha-Gamma Hot Cell Facility Operating procedures and conduct dry runs
- Package the drums at Alpha-Gamma Hot Cell Facility (see Figure 6)
- Perform characterization activities. Transfer the drums to the Building 331 Radioactive Waste Storage Facility
- Revise the Building 331 Radioactive Waste Storage Facility procedures and conduct dry runs
- Perform dose-to-curie measurements on the container
- Package the 30 gallon drums into the shielded container
- Collect data and model dose on outside of shielded container
- Perform field radiation measurement on the surface of the shielded containers
- Certify containers for shipment
- Pass CBFO transportation surveillance

Fig. 6 – Argonne Hot Cell Technicians closing the 30 gallon drum lid that contains 2 -7 gallon cans in a sealed pouch. The 30 gallon drum is in a shielded Gated Cask (photo courtesy DOE/Argonne).

The challenge for the generator site was to evaluate the performance characteristics of the shielded container package, in order to provide a population of compliant RH TRU waste materials that would comply with all regulatory aspects of the shielded containers, once loaded. Modeling was performed by both the Central Characterization Program Transportation group and the Argonne Project staff, in order to define the maximum radiological content of each shielded container, which would drive the in-cell packaging evolutions in the Alpha-Gamma Hot Cell Facility. Once the unshielded dose rate maximum value was established (approximately 55 millisievert/hour (5.5 rem/hour), based on the Alpha-Gamma Hot Cell Facility Debris isotopic distribution), all of the inner cans were packaged and dose rates confirmed prior to out loading the material from the cell.

In the months leading up to the actual packaging evolution, Argonne personnel worked closely with Central Characterization Program staff to identify the population of RH TRU debris that would be packaged. The packaging parameters were based on the physical and radiological characteristics of the material, and how the waste would meet the shielded container loading and performance criteria (e.g., wattage limits, TRUCON codes, etc.). In addition, the shielded containers were designed to accept 30-gallon drums with lever-lock ring closures, and not side-ring bolt closures. Argonne transitioned the entire Alpha-Gamma Hot Cell Facility RH TRU packaging configuration to comply with the new requirements for closure devises, gaskets, and drum HEPA filters.

Eleven 30-gallon drums of RH TRU debris were out loaded from the AGHCF, and staged in the loading and storage facility. As is accurate with all modeling activities, the Project assumption was that a single drum on the high end of the dose rate range might fail to meet the “as packaged” surface dose rate requirements for the shielded container (<2 millisievert/hour (200 millirem/hour)). Full mock-ups and dry runs were in place and executed prior to loading the first shielded container with an actual RH TRU drum. All nine of the shielded containers were successfully loaded, and successfully dose rated. One full loading evolution was performed for the EPA, Central Characterization Program, Project personnel and the Project Manager, prior to completing the other eight.

The successful demonstration of the Shielded Container Program at Argonne will likely provide an additional avenue for RH TRU disposition to the WIPP at many sites that are in the process of deactivation. As a follow-up activity, Argonne is beginning to work with other RH TRU generating programs, around the DOE, to assess interest and applicability of these containers. Additional cost efficiencies could be realized, should an economy of scale be established for increasing the size and impact of the Shielded Container Program.

CONCLUSIONS

The WIPP received the first shipment of shielded containers on September 15, 2013, and the last shielded container was emplaced in the WIPP on September 21, 2013 (see Figure 7). These shielded containers are loaded with RH-TRU waste, but the lead shielding allows these containers to be handled as CH-TRU waste at the WIPP repository. All nine shielded containers and the Half-PACTs used to transport the containers to the WIPP were in full compliance with all transportation requirements from the Nuclear Regulatory Commission and the Department of Transportation. Additionally, the shielded containers met all WIPP Waste Acceptance Criteria and the surface dose rates were well within the limits for CH-TRU waste containers. Worker safety and protection of human health and the environment are always the first priorities of the WIPP, and the use of shielded containers is instrumental for continuing WIPP’s mission.

Fig. 7 – Six shielded containers staged for final emplacement in the WIPP repository

The success of emplacing the first shielded containers in the WIPP translates into some significant strategic victories. Most notable is the reduction in the number of shipments. Transporting nine shielded containers in Type B HalfPACTs required only one shipment. Whereas, if the same 30-gallon drums were transported in Type B 72B casks, three shipments would be required. Less shipments result in less risk in all phases of the process, from loading at the generator site, to transportation, to emplacement at WIPP. In addition, because the Hazardous Waste Facility Permit with the New Mexico Environment Department establishes a permitted disposal capacity, WIPP will not exceed the permitted volumes by the use of shielded containers. The footprint of a shielded container "three-pack" is smaller than any other waste container. Therefore, it can be emplaced in an "interstitial space" which in normal operating circumstances would be void of waste, thus further increasing waste disposal efficiency.

REFERENCES

[1] *Fiscal Year 2013 Work Plan*. U.S. Department of Energy, Carlsbad Field Office. Carlsbad, NM. March 2013.

[2] WP 02-PC.08, Revision 1. *Shielded Container Shipping and Disposal Project Execution Plan.* Nuclear Waste Partnership, LLC. Carlsbad, NM. March 2013.

[3] Edwards to Ziemianski letter dated August 8, 2011.

[4] EPA Shielded Container Technical Support Document. *Review of DOE Planned Change Request for Shielded Containers for Remote-Handled Transuranic Waste*. Sandy Cohen and Associates. Vienna, Virginia. December 29, 2010.

[5] CCP-TP-081. *Central Characterization Program Shielded Container Assembly Loading.* Nuclear Waste Partnership, LLC. Carlsbad, NM. April 16, 2013.

[6] Land Withdrawal Act (Pub. L. 102-579, 106 stat. 4777, as amended by Pub. L. 104-201, 110 stat. 2422).

[7] U.S. Department of Transportation. *Radioactive Material Regulations Review*. U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration. Washington, DC. December 2008.

[8] NRC (U.S. Nuclear Regulatory Commission), 1990. *Consideration of Measurement Uncertainty When Measuring Radiation Levels Approaching Regulatory Limits.* Memorandum from John W. N. Hickey, Chief, Operations Branch, Division of Industrial and Medical Nuclear Safety, Office of the Nuclear Material Safety & Safeguards, and LeMoine J. Cunningham, Chief, Radiation Protection Branch, Division of Radiation Protection and Emergency Preparedness, Office of Nuclear Reactor Regulation. U.S. Nuclear Regulatory Commission, Washington, D.C. . August 3, 1990. A copy of the memorandum is available at: http://www.nrc.gov/about -nrc/radiation/products-vou/hppos/hppos223.html

[9] ANSI N323-1007. *American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.* Washington, DC.

[10] J.E. Sweezy, et.al. *MCNP – A General Monte Carlo N Particle Transport Code, Version 5, Volume 1: Overview and Theory and Volume 2: User's Guide*. Los Alamos, NM, February 2008.