RH-72-B CASK LOADING DEMONSTRATION AT BATTELLE MEMORIAL LABORATORIES IN WEST JEFFERSON, OH

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ABSTRACT

The challenge before the people at Battelle is to quickly develop a consistent and safe method to load the Waste Isolation Pilot Plant (WIPP) 72-B cask with waste sealed via welding in a Remotely Handled Transuranic (RH-TRU) canister. Never before had the RH-TRU canister actually been handled remotely and welded remotely in the vertical position as intended by its designers. The Battelle Columbus Laboratories Decommissioning Project (BCLDP) demanded that change; the waste to be moved is up to 200R. However, the timeline for project completion is less than four months and the equipment to complete the work has not been fully developed or tested. The effort will require teamwork from highly qualified and trained entities and the project will be of the highest priority. Once the project is complete, the stage will be set to handle and seal highly radioactive waste in the RH-TRU welded canister for shipment to WIPP.

INTRODUCTION

Battelle teamed with personnel from the Waste Isolation Pilot Plant (WIPP) and Welding Services Incorporated (WSI) to perform a remote loading demonstration of the RH-72-B cask. This was done to prepare for the successful loading of RH-TRU waste into the RH-72-B cask. This demonstration covered: the remote loading of RH-TRU waste liners into the RH-TRU waste container (canister assembly), the remote welding of the lid onto the canister assembly, the remote helium leak testing of the weld, and the remote loading of the waste into the cask and the cask onto the cask trailer.

The challenge for the group was to quickly plan this work, demonstrate the process, identify issues and lessons learned from the demonstration, and incorporate those into the final process to perform the work. This all had to be accomplished in a relatively short time since the BCLDP was put out for competitive bid early in 2003 meaning that the work will be turned over to the new contractor at the end of September 2003. The demonstration and loading of the waste into casks actually must be completed before that time because Battelle will be keeping the TRU waste under their control. In effect, this will leave Battelle with no handling facility to deal with repackaging or reloading this waste, so everything has to be in a shipment ready state by the time of the project turnover.

In order to meet the goal of quick project turnaround, the team had to utilize existing equipment owned by all three groups, and rework it specifically for this project. This meant that minor alterations or additions were made to facilitate its use for work for which it was not originally built and designed. None of the certified equipment was altered, but other equipment was altered to work with the certified equipment.

GENERAL INFORMATION, RH-TRU WASTE CONTAINER [1]

The RH-TRU waste canister used for this project was designed originally by Rockwell Hanford Operations to be used by defense waste generator sites in the United States. The canister is designed to be compatible with the requirements of the Waste Isolation Pilot Plant and the WIPP handling system. Some of the generating sites can not conveniently handle the long container. For these sites, the stacked container design has been made available.

The RH-TRU waste canister is vented through a HEPA filter located in the top assembly. The nominal outside diameter is 26" (64 cm) and the maximum gross weight is set at 8,000 lb (3,624 kg) to accommodate three 55 gallon (208 l) drums maximum per canister (long or stacked). The overall length of the long canister is 121" (307 cm). The single canisters were designed to be stacked in twos and welded together; the overall length of this assembly is also 121" (307 cm). For our work at Battelle – Columbus, two long canisters were utilized to store three 55 gallon (208 l) drums of waste in each assembly. The stacked assembly may no longer be licensed for shipment in the 72-B shipping cask. The canister is designed to meet DOT "Type A" container requirements with some exceptions. The assembly is designed to withstand a 46" (122 cm) drop and temperature ranges from -40°F to 200°F (-40°C to 93°C). All outside surfaces of the canister are painted. The specifications for the RH-TRU waste canister are contained in the table below:

Table I RH-TRU General Specifications

Specification	Long Container	Short Single	Container Stacked
Length (cm)	307	160	307
Outside Diameter (cm)	66	66	66
Nominal Inside Diameter (cm)	64.8	64.8	64.8
Maximum Useful Volume (m^3)	0.90	0.39	0.77
Max Allow Pintle Moment (kg-cm)	9,563	9,563	9,563
Tested Drop Height (cm)	122	122	122
Min. Operating Temperature (°C)	-40	-40	-40
Max. Operating Temperature (°C)	93	93	93
Empty Weight (kg)	799	645	1,290
Maximum Gross Weight (kg)	3,624	1,812	3,624
Empty Weight Open Container (kg)	499	297	594
Weight of Top (kg)	227	227	454
Maximum Useful Load (kg)	2,903	1,290	2,581
HEPA Filter Assembly Minimum Flow Capacity (cc/min)	3,000	3,000	3,000 each

The qualification drop tests were made using a container loaded with steel at ambient temperature. The user contemplating loading of cut process piping, tooling, or other potentially piercing waste should provide methods to immobilize them.

Leak testing is accomplished in the post-welded condition by initially evacuating the canister to a known pressure and back filling the inside of the canister through the filter to a pressure of 30 PSIG (.02 MPa) of helium. With the canister under pressure, the outside surface of the weld is "sniffer probe" tested using a helium mass spectrometer leak detector. For this test, the helium mass spectrometer and the associated test line configuration is calibrated to a maximum sensitivity of 10^{-5} cm^3/sec. No indication of helium leakage beyond this level is acceptable.

The top and bottom assembly utilize a modified version of the American Society of Mechanical Engineers (ASME) flange dome shape. The top dome has a ring welded onto it to serve as a lead retaining ring. Lead is poured into the top and is an option on the bottom used for radiation shielding as well as for protection from internal missiles during a drop event. The top and bottom are protected with "crush rings" made of 5/8" (1.6 cm) steel. These rings serve to protect the pintle on top of the container as well as to stabilize the container while in the upright position. The outside surface of the top crush ring has letters 2" (5 cm) high clearly documenting the identity of the waste container.

The pintle design is identical to that used on the Defense High Level Waste (HLDW) container designed for use on defense waste at Savannah River. This device enables the handling equipment (grapple) to handle either the short or long canister. It also houses the HEPA filter through which the container is vented and the vent/drain port. The top assembly including pintle, crush ring, and dome can be seen in Fig. 1 below.

Fig. 1 Horizontal welded RH-TRU waste container

Prior to loading, the surfaces to be welded must be cleaned and prepared. The canister is designed to be loaded while in the upright vertical position. A loading funnel should be used to protect the mating surface of the lower assembly from damage during loading. After filling, the canister is capped and seal welded using a remote welding method. The weld is visually inspected using a video camera during welding and once welding is complete. Once welding and video inspection are complete, the canister is leak tested. Upon completion of all testing, the welded surfaces are painted.

DEVELOPMENT PHASE

The handling practices and tooling have been developed for similar material shipments at other sites using the RH-TRU container. However in those instances the waste canisters were welded in the horizontal position using Gas Metal Arc Welding. For this project, the development questions involved the welding and helium leak testing methods to be employed. A summary of the issues and their eventual resolution is as follows:

1. *What welding technology was utilized for the application?* We utilized a Gas Tungsten Arc Welding ***(GTAW) Remote Video Mini-Head Welding System*** for the application; this system is shown below in Fig. 2.

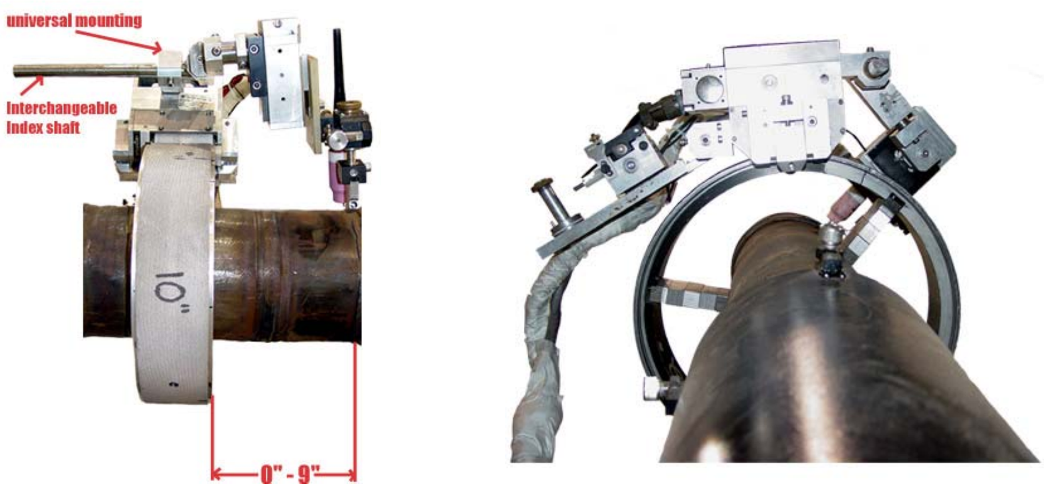

Fig. 2. WSI mini-head mounted for an orbital Wweld on horizontal piping

These units are readily available; WSI owns and maintains over 30 of these units at their facility in Norcross, GA. Due to the availability, WSI will ship a complete back-up unit as a contingency measure. In addition, spare parts are plentiful and a well stocked technician's kit will accompany the equipment in the event that repair is required.

2. *Why GTAW?* Cold wire GTAW is the highest quality weld technology available for this application. Utilization of GTAW will help to ensure fusion is achieved with repeatability and reliability. In addition, there will be virtually no smoke or spatter maximizing the functionality of the remote viewing system during welding. With GTAW, the surface does not require post weld cleaning. Since the arc time is relatively short and minimizing operator input at the canister is the goal, GTAW is the best choice for the application.

3. *What was the welding approach?* We utilized existing WSI Weld Procedure Specifications and Procedure Qualification Records applicable for a 2G (RH-TRU canister resting vertically) partial penetration groove weld with integral backing. The weld required four tack welds, one root pass and a split bead cap (two passes). Each pass required approximately 26 minutes so around 1 ½ hours of arc time was required per canister.

4. *What was the visual inspection approach?* Visual examination occurred during the welding process as required using a video monitor. In addition, the Certified Weld Inspector (CWI) inspected the final weld surface while the welding system is in re-wrap (the systems can not travel greater than 360° due to cable restraints).

5. *How did we mount the welding system?* The welding system was mounted directly to "Shielded Insert" shown on US DOE drawing #411-L-006-W [2]. The weld head, its track and the cable tray was mounted above the "Lifting Trunions", item 5. The cable tray allowed the cabling, which is of significant weight and rigidity, to be handled without interference or binding. The mounting approach solved two significant engineering issues as follows:

   - Welding equipment is mounted only once during the 2-4 canister campaign and neither remote actuation nor alignment is required.
   - The welding cables do not need to be routed and moved with the crane.
   - This will help to minimize dose exposure while simplifying the engineering by eliminating remote cable connection and cable management issues

   This concept significantly reduced the complexity of the design and the potential for failure while maximizing ALARA principles.

6. *How does the system account for eccentricity of the canister with respect to the "Shielded Insert"?* A standard feature of the GTAW Remote Video Mini-Head is "Automatic Voltage Control" (AVC). The equipment constantly measures voltage drop from the tungsten to the work piece continually adjusting the tungsten position to within an acceptable range. The standard stroke of the AVC axis is 1" (2.5 cm), but this will be increased to 2" (5.0 cm), since the canister may not be centered within that radial constraint.

7. *How is the system grounded?* Any welding system for this application must have a ground attached to the work piece during welding; this ground can be connected to either the top or bottom assembly. All paint, dirt and grease must be removed from the grounding contact area. WSI proposed to ground through the top assembly prior to lifting it into position. Preparation of this surface was completed at the same time as the weld preparation of the top and bottom assembly. The ground cable was attached while the lid was being set for each container to be welded. With this approach, difficulties associated with painting the ground contact surface were minimized.

8. *How to ensure that ALARA principles were maximized?* Remote video welding and remote inspection are the primary tools. Pole tooling also was utilized to mount the helium fill mechanism to the lid. However, another factor is pre-job planning. WSI replaced or sharpen the tungsten and ensured that sufficient filler material was available prior to each weld and before the waste was loaded in the RH-TRU canister. If an issue were to arise that involves interaction at the head (i.e. stuck tungsten), the team maximizes advantages related to time, distance and shielding through the utilization of situation specific pre-planning and pole tooling where applicable. The closure team worked closely with Battelle to ensure that dose exposures were as low as reasonably achievable.

9. *How was fit-up ensured?* The lids were match marked to each canister. The canisters arrived assembled and on the "Shipping Pallet" as shown on US DOE drawing #411-L-006-W [2]. Upon receipt, each canister was marked for orientation and compatibility between the top and bottom assembly. This involved scribing a line that extended over the weld area and marking both sides for compatibility (i.e. canisters #1 - 4). One of the two canisters had been damaged during shipment in the weld area. For that canister, WSI re-worked the weld preparation surface within original design specifications using a clamshell type cutting system prior to loading.

10. *How much distance from the top of the "Bottom" assembly to the top of the "Shielded Insert" was required?* We initially estimated this would require from 1" (2.5 cm) to 2" (5 cm) for the gap. The final value determined during testing was 1" (2.5 cm).

11. *How much testing was required?* Although the initial RFP did not require a live welding mock-up, WSI recommended that a welding demonstration be included. Four welding mock-ups were fabricated. The first of these was used for development of welding parameters. The second was used for a Battelle/WIPP witnessed demonstration at WSI in Norcross, GA. The third mock-up was welded at Battelle during the Columbus mock-up phase. The final (fourth) mock-up was fabricated as a spare and was not required.

12. *How did we connect to the lid for Helium pressurization?* The cap was removed during the "Top" assembly preparation. Since the ½" (1.3 cm) inside diameter (ID) surface was used to make the seal, all applicable cleaning measures were implemented. The helium fill line was connected to this surface using an inflatable seal in the ID of the ½" (1.3 cm) hole. These operations were completed prior to mounting the lid onto the lower half of the canister. The pneumatic valve to engage the inflatable seal will be with the welding controls allowing for remote disconnection.

13. *How was the Helium Sniff test completed?* The sniffer probe was mounted to the weldhead in a way that insulated it from the heat generated during the welding process and to ensure both proper stand-off from the work piece and that adequate sample volume was achieved. The probe remained within a distance of 1/8" (.3 cm) from the surface of the canister during the entire sniffer probe helium leak test. The unit was set to alarm at any signal detected greater than 1×10^{-5} cm^3/sec. The helium mass

spectrometer also incorporates a remote digital display showing the helium sample level. The digital display value on the helium mass spectrometer was monitored with the remote surround camera, as the leak test unit must remain near the canister.

DEMONSTRATION PHASE

The primary goal of the demonstration phase was to develop a consistent and safe method to load the WIPP 72-B cask with RH-TRU waste. To achieve this, Battelle would mock-up/demonstrate the remote loading, remote welding, remote leak testing of the 72-B RH-TRU, and loading of the canister into the 72-B cask (shown below).

Fig. 3 WIPP 72-B cask with impact limiters on shipping trailer

BCLDP personnel demonstrated remotely retrieving "mock" TRU drums from storage, removing "mock" TRU liners from the drums, and loading the liners into the canister. The drums will not fit into the canister with the current lifting slings installed, so the removal of the liners versus replacing the existing slings resulted in a lower dose exposure to workers.

The members of the team from WSI demonstrated the installation of the welding and leak testing equipment as well as the actual remote canister welding and leak testing. This included a weld demonstration using a mock-up canister. WIPP personnel demonstrated the cask operations. This entailed removing the cask from the trailer and placing it onto the cask stand. Follow by transferring a "mock" loaded canister from the shielded insert into the cask. Once the canister was in the cask they installed the inner vessel (IV) lid, then sealed and leak tested the inner vessel. Next the outer container (OC) lid was installed, sealed, and leak tested. The cask was loaded back onto the trailer and prepared for shipment back to WIPP.

WORK COMPLETION

The primary objective of the work completion phase was to safely load two WIPP RH-72B casks with welded RH-TRU waste canisters and place them in storage. This work included remote loading, remote welding, remote leak testing, and loading of the canister into the RH-72B cask.

The welding equipment remains mounted to the outside diameter of the shielded insert from the demonstration phase as shown below.

Fig. 4 Welding equipment mounted on the OD of the Sshielding insert while welding an RH-TRU waste container.

The preliminary work for each canister includes preparation of the surface to be welded, the ground contact surface, and the vent port surface. WIPP procedures were also incorporated into a composite BCLDP procedure including site specific information. The cask is unloaded and placed in the vertical position; it is opened and the inner vessel and outer container lids are secured in their appropriate stands during the preliminary work stage. Next the waste container lid is indexed to the proper orientation and fit tested. Finally a test of the helium fill connection is completed using a sealing surface (rubber mat) on the underside of the lid.

Once preparation is complete the following work takes place:

- ✓ BCLDP retrieves the first TRU drum
  - Move drum into shield
  - Remove the TRU liner from the drum
  - Move the liner into the canister
  - HP will check for contamination from transfer
  - Remove rigging and place a spacer into the waste container (spacer was used to protect filter vent on the liner)
- ✓ BCLDP retrieves the second TRU drum and repeats the sequence above
- ✓ BCLDP retrieves the third TRU drum and repeats the sequence above
- ✓ Place lid onto the canister and align for welding
- ✓ Adjust the weld head and perform a dry run with welding equipment
- ✓ Complete remote closure weld and visual inspect via video as required
- ✓ Perform visual inspection of the weld and complete the helium leak testing
- ✓ Paint the weld area, grounding area and contact surfaces for the helium fill
- ✓ Move cask over to cask stand
- ✓ Load welded waste container into RH-72-B cask
- ✓ Install the cask inner vessel lid and support ring (replaces the outer container lid allowing for cask venting in the horizontal position. The outer container lid will be replaced prior to shipping)
- ✓ Load cask onto trailer and transfer to TRU staging pad

CONCLUSION

Even with the restrictions of a tight time frame, the process of remotely loading, welding, and inspecting an RH-TRU waste canister in the vertical position was developed and proven repeatable. The success of this campaign ensures that this waste canister is a viable alternative for the handling of high level waste versus bolted shipping containers. Economics as well as ALARA have demonstrated the obvious feasibility of this method of waste packaging.

REFERENCES

1 "Users Manual For Remote-Handled Transnuclear Waste Container" RHO-RE-MA-07, Rockwell Hanford Operations, September 1984

2 US Department of Energy drawing #X-106-501SNP, Rev. 3, "RH-TRU Waste Canister Assembly Fixed Lid Design"