Development and Application of an Oversize Reusable DOT 7A Type A Overpack Container at the Y-12 National Security Complex - 13150

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ABSTRACT

Waste Management personnel at the Y-12 National Security Complex (Y-12) are concluding a multi-year effort to dispose of a large backlog of low-level waste. Six containers presented a particularly difficult technical challenge in that they each contained large robust equipment (mostly salt baths) with elevated levels of highly enriched uranium (exceeding U.S. Department of Transportation (DOT) fissile-excepted quantities). The equipment was larger than the standard 1.2 m × 1.2 m × 1.8 m (4 ft × 4 ft × 6 ft) DOT Specification 7A Type A box and would have been very difficult to size-reduce because of several inches of steel plate (along with insulating block and concrete) in the equipment design. A critical breakthrough for the success of the project involved procuring and developing two oversize reusable DOT Specification 7A Type A (fissile tested) containers (referred to as the CTI Model 7AF-690-SC) that could be used as overpacks for the original boxes of equipment. The 7A Type A overpack containers are approximately 3.5 m long × 2.7 m wide × 2.8 m high (11.7 ft × 8.9 ft × 9.2 ft) with a maximum gross weight of 10,660 kg (23,500 lb) and a payload capacity of 6,804 kg (15,000 lbs). The boxes were designed and fabricated using a split cavity design that allowed the gasketed and bolted closure to lie along the horizontal centerline of the box. The central closure location in this design allows for strengthening of box corners that tend to be points of weakness or failure in 49CFR173.465 drop tests. By combining the split cavity design with large diameter tubing and diagonal cross bracing, drop test requirements of 49CFR173.465(1) and (2) were met and demonstrated through finite element analysis modeling. The development and use of this new container dramatically reduced the need for downsizing the equipment and allowed the project to meet objectives within cost and schedule targets.

INTRODUCTION

Waste Management personnel at Y-12 are concluding a multi-year effort to dispose of a large backlog of low-level waste. Six containers presented a particularly difficult technical challenge in that they each contained large robust equipment (mostly salt baths) with elevated levels of highly enriched uranium (exceeding DOT fissile-excepted quantities) that had been removed from service for approximately 20 years. Photographs of a salt bath and its original legacy container are shown in Figs. 1 and 2.

The fissile content of the six boxes was preliminarily estimated using multiple rounds of field non-destructive assay (NDA) measurements, with the results ranging from 20 to 500 g of highly enriched uranium. The challenge to the project was to complete the characterization of the equipment and determine a way to compliantly ship the waste equipment to disposal at the Nevada National Security Site (NNSS).

Fig. 1. Top view of salt bath equipment.

Fig. 2. Equipment packaged in legacy box.

METHOD

Packaging Planning

Early in project planning, it was determined the equipment would not meet a fissile exception under 49CFR 173.453 [1] and that a fissile package would be required. All of the equipment items were larger than the standard 1.2 m × 1.2 m × 1.8 m (4 ft × 4 ft × 6 ft) DOT 7A Type A boxes commonly used to ship fissile materials from Y-12. Furthermore, due to the robust fabrication of the equipment items (thick plate steel and insulating block and concrete), size reduction would require a costly and labor intensive effort. It was also recognized that DOT Special Permit 14267 [2] could be used to ship whole equipment items in a DOT 7A Type A package with up to 252 grams of U-235.

To meet project deadlines for disposal, the project team decided to pursue a two-pronged approach: (1) continue to evaluate any feasible size-reduction of the equipment or pieces during the detailed characterization phase and (2) explore the potential for acquiring an oversize 7A Type A (fissile-rated) container to overpack and ship the salt bath equipment in the original legacy box.

Solicitation and Design Considerations

Beginning in early 2012 (including at the WM2012 Conference), the project team solicited interest from container manufacturers regarding their experience in making oversize 7A Type A containers that would also pass the 49CFR173.465 drop tests for fissile material. Several vendors indicated that they had experience in making custom containers that met these requirements. A competitive procurement was issued and after proposals were received and evaluated, an award was made to Container Technologies Industries, LLC (CTI) for the design and fabrication of two oversize containers. The original design request was for two different sizes (one for large equipment and one for smaller equipment), but this request was later changed to two boxes of the same (larger) size so that there would be a backup container available for all planned shipments.

Key design preferences for the oversize containers included the following:

- Reusable container – could be used as overpack for boxed waste or as the primary sole container for other future oversize wastes.
- Easy loading and unloading – a design with easy opening access (possibly side loading), with large forklift pockets on bottom for loading on/off the trailer.
- Easy internal securement mechanisms for blocking and bracing.
- Easy trailer tie-down features.
- Preferably 8 ft wide to fit on a standard trailer without being over width.

Final Radiological Characterization

Meanwhile, final radiological characterization of the equipment began at an onsite facility using a combination of process knowledge, radiological survey data, sampling and analysis of the surface contamination residues, and field NDA. As areas of elevated enriched uranium activity were identified, these areas were evaluated for disassembly and removal and packaging separately in order to reduce the overall uranium content of the salt bath. The radiological content of the remaining equipment carcass was then calculated by applying the uranium concentrations observed in the residue analytical data to the contaminated surface areas of the equipment in observed (or estimated) thicknesses. These calculations resulted in final values for the equipment ranging from 42 g U-235 to 135 g U-235 for the first 3 pieces of equipment.

Design and Testing of the new DOT 7A Type A Container

CTI proposed a split cavity design that allowed the gasketed and bolted closure to lie along the horizontal centerline of the box. The central closure location in this design allows for strengthening of box corners that tend to be points of weakness or failure in 49CFR173.465 drop tests. The design also included approximately 10 cm × 10 cm × 1 cm (4 in × 4 in × 3/8 in) square hollow structural section (HSS) steel tubing as the primary support framing, with approximately 10 cm × 5 cm × 0.6 cm (4 in × 2 in × ¼ in) A500 steel tubing as diagonal cross bracing (stiffeners) angled into each corner. Panels are constructed of 10 gauge A1011 hot rolled steel sheet.

External dimensions are approximately 3.5 m long × 2.7 m wide × 2.8 m high (11.7 ft × 8.9 ft × 9.2 ft) with a maximum gross weight of 10,660 kg (23,500 lb) and a payload capacity of 6,804 kg (15,000 lbs). Internal dimensions clear of any bracing are 3.2 m long × 2.4 m wide × 2.6 m high (10.6 ft × 7.8 ft × 8.4 ft). The box was designed with 19 mm thick (3/4 in) D-rings on each lower exterior side (for securement to the trailer), on each internal side (for payload securement), and on the lid exterior (for lid lifting only).

The drop tests to meet 49CFR173.465(c)(1) and (2) requirements were demonstrated through finite element analysis modeling, using Autodesk Simulation Mechanical 2013 software. The container was rotated 45° about each horizontal axis with the lowest corner positioned 1 foot above the rigid target for the 8 corner drops and 2 feet above the rigid target for the final drop on the most damaged corner. In general, each drop event lasts approximately 1 second with the initial corner impact occurring at time step 0.3 sec for the 1 ft drop and at 0.4 sec for the 2 ft drop. A series of images were used to document the drop test results for both the 1 ft and 2 ft drops. The images illustrate the general stress field in the container structure during the event as well as areas of plastic deformation. Enlarged images of the deformed geometry were examined at the impact locations. Graphs were also provided to illustrate predicted deflections at the gasket sealing surface to demonstrate adequate gasket compression throughout the duration of the event. For each side of the closure, the change in distance between the gasket sealing surface as well as the gasket compression were plotted vs. time. Selected examples of these graphics are shown in Figs. 3 through 5.

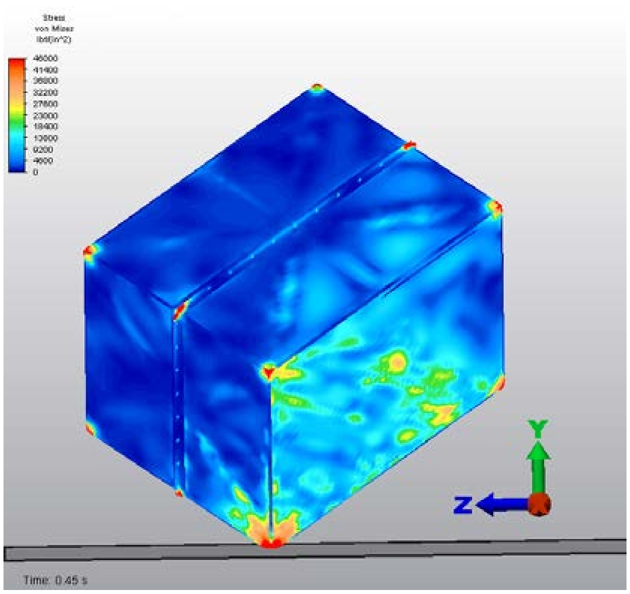

Fig. 3. 2-ft drop at time 0.45s.

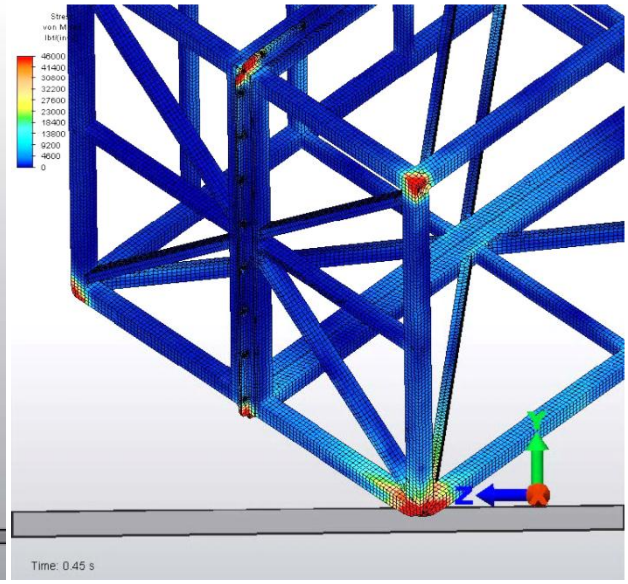

Fig. 4. Frame deformation and stress field at impact.

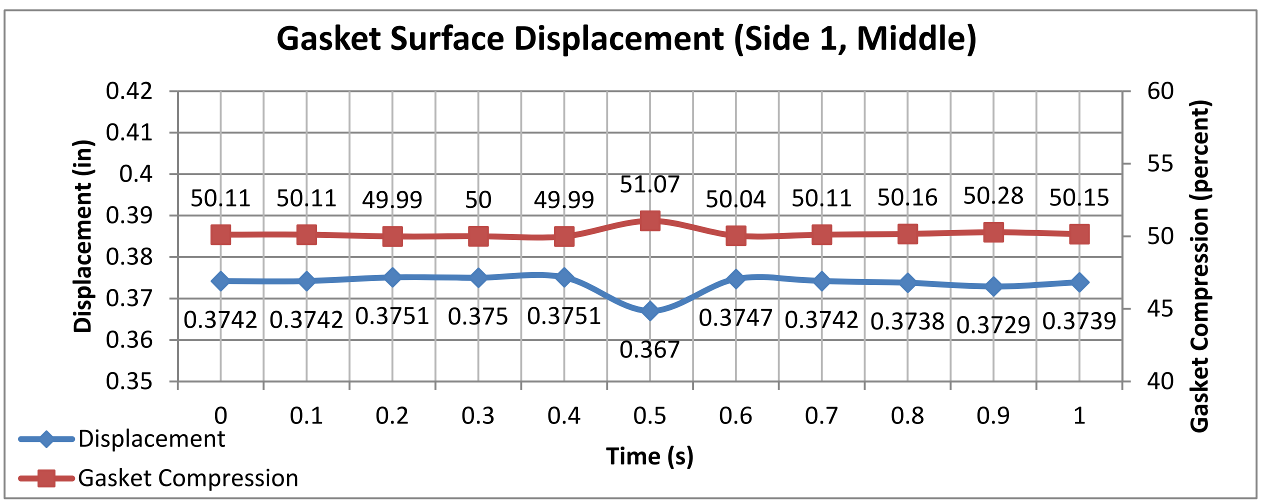

Fig. 5. Gasket surface displacement and gasket compression

Results of the finite element analysis indicate the container would experience some local damage and plastic deformation in the area of initial impact and to a lesser degree at the secondary impact ("slap down"). However, the integrity of the container was maintained throughout the simulation preventing loss of any contents, and the container was deemed compliant with the 49CFR173.465(c)(1) and (2) requirements.

Delivery and Preparations for Shipment

After quality assurance inspections were completed, the boxes were delivered, inspected, and prepared for use (Fig. 6). A lift plan was developed to describe the requirements to hoist the legacy boxes (containing the equipment items) into the new 7A Type A overpacks. A set of dedicated slings and edge protectors were identified to remain in each overpack box in order to make offload at NNSS easier. Transportation specialists developed the securement plan for the internal box inside the overpack, using chains and ratchet binders. Extra gasket material and bolts were provided inside each overpack in case the gasket was torn or bolts were stripped or damaged during offload. After hoisting the boxes and equipment into the 7A Type A overpacks (Fig. 7), the lift plan, rigging certifications, and box loading photos were provided to NNSS personnel a few weeks before the planned shipment in order to allow the NNSS crew to plan the offload.

Fig. 6. View of the open 7A Type A overpack container ready for loading.

RESULTS

The initial shipments to NNSS using the new 7A Type A overpacks occurred in September 2012 with great success and without incident. DOT Special Permit 14267 was used to ship the equipment with enriched uranium content up to 252 g in the 7A Type A overpacks.

The transfer and offload at NNSS went smoothly (Fig. 8). NNSS personnel chose to remove the overpack lid and offload the internal box while leaving the lower half of the overpack attached to the trailer. The empty overpack boxes were then shipped back to Y-12 for reuse. A follow-up phone call to discuss lessons learned with NNSS personnel indicated the only suggested improvement was to secure the edge protectors to the inner box so they did not slide down into the lower parts of the overpack.

Fig. 7. Lowering the lid during overpacking the salt bath and legacy box.

DISCUSSION

The development and use of this new container dramatically reduced the need for downsizing the equipment and allowed the project to meet objectives within cost and schedule targets. As the site continues to remove similar large equipment and objects from enriched uranium facilities, the reusable overpack containers will continue to be a valuable resource for Y-12 for several years to come.

Fig. 8. Unloading the inner container for disposal at NNSS.

REFERENCES

1. Code of Federal Regulations, Title 49, Part 173, Shippers - General Requirements for Shipments and Packagings.

2. U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Special Permit Authorization DOT-SP 14267, issued June 30, 2006, expiration October 31, 2015.

DISCLAIMER

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