Design, Fabrication, and Delivery of a Shielded Type a Container-11512

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ABSTRACT

The U.S. Department of Energy (DOE) U Plant Complex is the first canyon demolition to be performed at Hanford. This is a critical milestone for the demolition contractor and the DOE to demonstrate demolition planning and execution methods. Residing under the canyon deck was a irregularly-shaped tank containing radioactive materials with highly elevated radiation levels. The tank had to be removed using the existing canyon crane prior to the demolition of the canyon complex and then placed into a container for storage and eventual shipment. This milestone effort required strict weight, radiation shielding, and handling specifications. The combination of requirements was coupled with a no-fail delivery schedule of December 2010. Innovative design, real-time execution of planning, and schedule compression were critical elements in the successful delivery of this shielded Type A container.

INTRODUCTION

Cavanagh Services Group, Inc. (Cavanagh) was contracted by CH2M Hill Plateau Remediation Company (CHPRC) to design, build, and deliver a large shielded, single-use transport and storage container for a vessel under a canyon deck at the U Plant Canyon plutonium processing complex at Hanford. This vessel exhibited significant radiation levels that required shielding to protect workers during its removal and storage. The container was classified as a critical procurement in the demolition process of the U Plant Canyon complex.

The vessel under the U Plant Canyon deck presented many challenges to the design team. It was irregularly-shaped and had radiation levels exceeding 350 milli-Gray per hour. The vessel also had to be remotely loaded into the shielded container. Once the vessel was inside the container, the loaded container had to be under the weight limits of the U- Plant canyon's re-certified bridge crane and meet the requirements of the U.S. Department of Transportation (DOT) for a Type A container. The schedule for delivery of the container presented a challenge because the procurement authorization occurred less than five months before the required delivery date.

This paper discusses how the project was performed including how the team was assembled and led, the design approach, project management techniques, and assembly and delivery.

THE TEAM

Cavanagh had extensive experience in building and procuring DOT complaint Industrial Packages and delivering them ready to serve for the cleanup efforts at Hanford being performed by CHPRC. However, this was a special project since it had many design elements that were significantly different than a "typical" metal container design and fabrication. Cavanagh sought out firms with demonstrated experience with heavy component design and fabrication. The procurement required that the firms have an NQA-1 Quality Assurance program. Lastly, the teaming firms had to be able to comply with the cost and schedule components of the procurement.

Cavanagh chose the team of Greenberry Industrial, a metal fabricator in Corvallis, Oregon with extensive experience in structural steel, heavy tanks, and vessels for the fabrication. The design team selected was ARES Corporation, based in Richland, Washington, who demonstrated expertise in performing engineering and structural analysis for DOE clients at Hanford.

DESIGN APPROACH

The vessel under the U Plant deck was unusually shaped. It was approximately eight feet in diameter with asymmetrical support legs welded to its body. The vessel contained radioactive sludge and other materials that exhibited high radiation levels required shielding for transportation and storage. Since the container would be transported conventionally on public highways, adding width to maximize distance from the vessel to the outside of the container was not an option. The weight of the container was significantly constrained due to the bridge crane's weight limit at the U Plant Canyon.

The conflicting design requirements of relatively low weight and size while providing significant radiological shielding for a large and odd shaped vessel dictated an innovative approach. Lastly, the schedule for delivery was very aggressive lasting only four months from award to delivery.

Because the container was to be used one time, multiple-use operability was not a factor, nor was the need to optimize the design for mass production. Consequently, the Cavanagh team split the design approach into two parts. The first part was to develop a simple and robust container design that could be rapidly analyzed using conventional, but simplified, structural and mechanical engineering evaluations. Once those conventional structural and mechanical engineering calculations demonstrated that the design concept met the DOT Type A test standards and the customer's handling requirements, shop drawings were produced, and materials were ordered.

The second part of the design was to either perform the physical testing or alternatively develop the detailed engineering analysis that would prove that the container met the DOT Type A container certification. Because the container was too large and complex to economically perform the tests required by the DOT for certification as a Type A container, the Cavanagh team used Finite Element Analysis (FEA) an engineering computer modeling program which simulated the DOT required testing of the Type A container certification. Nonetheless, since an FEA for even a simple container can take months to perform, the Cavanagh team took the approach of over-designing the container to minimize the risk that the FEA would reveal that the container would not meet its design goals. Fabrication would begin after the materials had arrived and modified as necessary based on the results of the FEA. Starting fabrication prior to completing the FEA was a risk, but it resulted in compressing the schedule significantly.

PROJECT MANAGEMENT

Once the Cavanagh team decided on the design approach, it had to determine the optimum method of managing the project. None of the team members had worked together before. All of the teams had the advantage of being within a day's travel of each other which proved to be an important factor in the earlier design phase and then later during the construction phase when independent inspections had to be performed. All members were aggressively committed to meeting the design goals and schedule. To that end, the team decided to hold standard weekly progress meeting via conference calls. Cavanagh's in-house Package Design Authority (PDA), SME on DOT packages, was dispatched to the fabrication facility twice per month to oversee progress on the container. The PDA developed detailed progress reports which were reviewed each week. Any issues uncovered by the PDA were then immediately acted upon to avoid any impact to the customer's required delivery date.

SPECIFIC DESIGN AND FABRICATION ELEMENTS

The original design concept for the container contemplated a large, free-span steel box that contained lead for shielding the elevated radiation levels of the vessel. Although a simple rectangular shape initially seemed like the easiest design approach, evaluation using FEA quickly determined that a rectangular shape had significant disadvantages.

Using a symmetrical rectangular shaped box to contain the irregularly shaped vessel would have required an inordinate amount of material which would lead to a large amount of unused space within the container. Encompassing unused space would have required steel and lead, both of which are heavy, working against the requirement that the container and its contents be within the bridge crane's lifting capability. Cavanagh's team amended the original conceptual design and concluded that a smaller, somewhat form-fitting, odd shaped container would reduce the amount of material necessary and therefore the weight.

When the conceptual design was revised, the team noted that there was enough of a reduction in materials that it was now feasible to use steel as the shielding material instead of a composite of steel and lead. This dramatically streamlined the construction since a simple steel box is much easier to build than a container that is comprised of multiple materials. Eliminating the lead shielding also removed the final radiation shielding testing that would have been required to detect gaps in the lead had it been used. Lastly, the FEA was much easier to perform because the analysis did not have to consider multiple construction materials of vastly differing properties.

To facilitate the required remote loading of the vessel into the container, an internal guide system was designed and constructed of structural aluminum to ensure proper alignment of the vessel within container.

SUMMARY

The design of the shielded Type A container had to meet many unique characteristics that presented challenges during the design and fabrication phases.

The Cavanagh team approached the project with the premise that simplifying the design and construction of the container would result in significant cost savings to the client, reduce complexity and therefore reduce the fabrication timeline while still meeting the rigorous DOT and customer requirements. This approach proved to be successful with the container being delivered on time and ready to serve within the allowable budget.

References

1. 49 CFR 173, “Shippers—General Requirements for Shipments and Packagings,” *Code of Federal Regulations* as amended.

    49 CFR §173.410, “General Design Requirements.”
    49 CFR §173.411, “Industrial Packagings.”
    49 CFR §173.412, “Additional Design Requirements for Type A Packages.”
    49 CFR §173.461, “Demonstration of Compliance with Tests.”
    49 CFR §173.465, “Type A Packaging Tests.”
    49 CFR §173.410, “General Design Requirements.”
    49 CFR §178.350, “Specification 7A; General Packaging, Type A.”

2. ANSI/ASME, NQA-1, “Quality Assurance Requirements for Nuclear Facility Applications, American Society of Mechanical Engineers, 14 March 2008.

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