Waste Management Lessons Learned from the Paducah C-340 Metals Reduction Complex D&D—14300

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ABSTRACT

Multiple decontamination and decommissioning (D&D) projects either are ongoing or being planned throughout the U.S. Department of Energy (DOE) Complex. These projects could benefit from lessons learned as a result of changed conditions or better waste management implementation strategies used at Paducah during D&D of the C-340 Complex. Lessons learned include (1) sampling to verify operational process knowledge assumptions; (2) demolition waste volumes variation depending on the type of building being demolished and the building structure; and (3) downsizing and railcar loading techniques.

INTRODUCTION

The C-340 Metals Reduction Plant Complex was located on the east side of the Paducah Gaseous Diffusion Plant (PGDP). The buildings that comprised the C-340 Complex had a combined footprint of approximately 65,000 ft^2 (6,000 m^2). It was made up of the C-340-A Powder Building (42,000 ft^2 or 3,902 $m^{2)}$; C-340-B Metals Building (17,920 ft^2 or 1,665 m^2); and the C-340-C Slag Building (4,400 ft^2 or 409 m^2). These buildings were physically adjoining structures. They were metal frame structures with transite exterior walls and built-up roofs. C-340-A consisted of seven floors. C-340-B was a single-level structure with operating platforms. C-340-C had four floors. A photograph of C-340 is shown in Figure 1. The C-340 Metals Reduction Plant Complex was operated from 1956 into the 1980s, although the building remained in use for other purposes until 1991 [e.g., to convert depleted uranium hexafluoride to uranium tetrafluoride (UF_4) using a hydrogenation process and to convert UF_4 to uranium metal by reaction with magnesium]. The early operations are the source of contamination in the C-340 Complex structures.

The C-340 Complex demolition began in August 2012. Demolition ended in February 2013, with the last waste shipment in September 2013. Several activities had to occur prior to beginning demolition. Deactivation of the C-340 Complex was initiated under the American Reinvestment and Recovery Act. A key part of the activities undertaken during the deactivation included removal of chemicals and radioactive material left in process lines and equipment when the building was shut down. Review of C-340 Complex documentation (design drawings and analytical data) for development of the waste forecast and potential disposal scenarios had to be completed prior to the development of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal action documents (i.e., removal notification, action memorandum, engineering evaluation/cost analysis, and remedial action work plan). These documents had to be written and approved by regulatory agencies prior to initiating demolition of the C-340 Complex.

Figure 1. C-340 Complex, View from Northeast

DISCUSSION

During the latter stages of the deactivation process and during the demolition of the C-340 Complex, the project team encountered and addressed several challenges and changed conditions. In addition, the project team implemented lessons learned from other sites or projects to minimize risk and improve performance where applicable. Following are some of the challenges, changed conditions, and identified lessons learned.

Waste Disposition Estimates in CERCLA Removal Action Documents

CERCLA removal action documents estimated that most of the resulting waste from building demolition was expected to be low-level radioactive waste, with some polychlorinated biphenyl (PCB) bulk product waste. Project baseline assumed that 30% of the debris from C-340 would require off-site disposal, and 70% would be disposed of on-site.

Building takeoffs from original design drawings were used to estimate the total waste volume for the waste requiring off-site disposal by weight, including the equipment inside the building. Approximately 1,625 tons (1,474 metric tons) of debris for off-site shipment was estimated using this process.

More specifically, it was expected that demolition of the structure could generate up to 253,000 ft^3 (7,164 m^3) of asbestos-contaminated material, radiologically contaminated waste, PCB bulk product waste, PCB remediation waste, nonhazardous solid waste, or any combination of these.

Sampling to Verify Operational Process Knowledge Assumptions

Sampling and analysis in 2011 determined that there was a significantly larger amount of PCB waste in the building than projected. The equipment and structural debris from the bottom two floors of the Powder Building (C-340-A) and the Slag Building (C-340-C), as well as the entire Metals Plant Building (C-340-B), were determined to be PCB remediation waste at concentrations greater than 50 parts per million (ppm) PCB. This waste required off-site disposal, with transfer via railcars to the disposal facility. The upper two floors of the four-story Slag Building (C-340-C) and the top five floors of the seven-story Powder Building (C-340-A) were characterized as PCB remediation waste, at concentrations less than 50 ppm, which could be disposed of in the on-site landfill. Due to these results, the demolition of the Metals Plant involved an unusual waste segregation circumstance.

Demolition Sequencing—Waste Volumes Variation Depending on the Type of Building being Demolished and the Building Structure

The demolition of the C-340 Complex was sequenced to allow segregation of the waste streams. The sequence was to demolish the Metals Plant Structure (C-340-B) first, packaging that in railcars for off-site shipment. This sequence also allowed access to the higher portions of the Slag Unit (C-340-C) and Powder Building (C-340-A). The top floors of these two structures were demolished and transported to the on-site C-746-U Landfill, leaving the lower two floors of each; then these were demolished and packaged for off-site disposal in the railcars.

During the demolition of the Powder Building (C-340-A), which had a substantially larger footprint than the other facilities, projections were made about the number of railcars expected to require loading. The projection, approximately 24 railcars, was based on the square footage of Metals Plant demolished to date, versus the number of railcars loaded at the time, then extrapolating the number of cars required to containerize the square footage remaining to be demolished.

As demolition progressed to the lower floors of the Powder and Slag structures, the rate of waste generation increased per square foot of building demolished. Effectively, more waste was produced per square foot demolished in the bottom two floors of the Powder and Slag Buildings, than was demolished per square foot of the building footprint of the Slag Building. The final tally required 28 railcars, exceeding the mid-project projection by approximately 4 railcars.

Downsizing and Railcar Loading Techniques

Waste materials were sorted and segregated on-site, size reduced, packaged, and/or staged for disposal in accordance with applicable or relevant and appropriate requirements (ARARs). Most waste was loaded directly into shipping containers in areas adjacent to the C-340 Complex (Figure 2). Staging areas were used for storage of loaded containers prior to loading containers onto conveyances (e.g., railcars or trucks) for shipment. Figure 3 depicts staging of transite after removal from the C-340 Complex in preparation for disposal in the on-site C-746-U Landfill.

Existing waste storage facilities were used, as appropriate, for staging and storage of waste (e.g., hazardous or PCB waste) prior to shipment for disposal. Wastewater was transferred to temporary storage pending characterization and treatment. All waste storage locations were located inside the DOE-controlled area.

Figure 2. Waste is Loaded Directly into Shipping Containers in Areas Adjacent to C-340

Figure 3. Staging of Transite after Removal from the C-340 Complex

The waste packaging methods were dictated by the waste sizes and configurations and selected transportation and disposal options (Figure 4). Waste volumes were minimized by utilizing methods for component disassembly and size reduction. Heavy equipment was used to cut large steel sections into smaller pieces so that rail cars could accommodate more waste (Figure 5).

Figure 4. Debris Is Being Sorted into Waste, Part of Which Will Be Shipped to an Approved Disposal Facility and the Rest Taken to the On-site C-746-U Landfill

Large, heavy-duty liners were installed in the rail cars, which also were equipped with removable, sealable lids to keep rain out of the waste. The railcars and lids will be decontaminated at Energy*Solutions* and returned to the Paducah site for reuse.

Waste Actuals

Based on actual weights, approximately 1,920 tons (1,741 metric tons) of debris was loaded into 28 railcars for off-site shipment (Figure 6), or a variance of approximately 20% greater mass than expected. Using downsizing and careful loading of the railcars, an average density of nearly 50 pounds per cubic foot (1765 pounds per cubic meter) was achieved. Prior demolition activities and a scrap yard cleanup on-site using railcar shipment achieved significantly lower densities (average of 20 pounds per cubic foot or 706 pounds per cubic meter), indicating the downsizing and railcar loading techniques were effective in reducing costs for the PCB remediation waste disposition.

Figure 5. Heavy equipment was used to cut large steel sections into smaller pieces so that rail cars could accommodate more waste

The higher rate of waste generation can be attributed to three considerations.

(1) A majority of the Metals Plant Building was open and did not have a second floor. As a result, structural framing and steel floor plate waste was generated from the Powder and Slag Buildings that was not generated throughout the whole Metals Plant Building.

(2) The third floor structural framing and floor plate of both the Powder and Slag Buildings were considered the "top" of the second floor and characterized as waste requiring off-site disposal.

(3) Finally, the columns on floors 1 and 2 of the Powder Building and Slag Building were designed to support the higher floors and building roof, while the columns in the Metals Plant Building were required to support only the Building roof. As a result, the Powder Building and Slag Building columns were substantially larger than the columns in the Metals Plant building, generating more demolition waste per square foot of building footprint. The structural framing of the Powder Building and Slag Buildings was robust in construction and generated more waste than a comparable area of the roof trusses and roofing material that created the top of the Metals Plant Building.

Figure 6. A P&L locomotive travels near Woodville Road, south of the Paducah site, with the waste shipment in tow.

CONCLUSIONS

Consideration of these lessons learned during a demolition project should result in better planning, better estimating, and the potential for waste volume reduction that will result in cost savings/avoidance.