DECONTAMINATION AND DISMANTLEMENT
OF PLANT 7 AT FERNALD

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ABSTRACT

Decontamination and dismantlement (D&D) tasks have been successfully completed on Plant 7 at the Fernald Environmental Management Project. The seven story facility was radiologically, chemically, and biologically contaminated. The work involved the D&D work beginning with safe shutdown and gross decontamination, and ended with removal of the structural steel.

A series of lessons learned were gained which include use of explosives, bidding tactics, safe shutdown, building decontamination and lockdown, use of seam climbers, etc.

I. INTRODUCTION

The Fernald Environmental Management Project (FEMP) is a Department of Energy (DOE) Facility near Cincinnati, Ohio, which provided high purity uranium metal products to support United States defense programs. Production operations were halted in 1989 to focus available resources on environmental restoration activities at the facility.

Plant 7 was used as a pilot plant for reduction of uranium hexafluoride (UF₆) to uranium tetrafluoride (UF₄), and more recently served as a storage warehouse for drums of UF₄.

Plant 7 was the tallest, most visible structure at Fernald, measuring 80 feet x 60 feet x 110 feet high (seven stories). Plant 7 consisted of a structural steel frame enclosed by transite siding and roofing.

At the time D&D activities were initiated in 1993, the building was contaminated with radioactive, friable asbestos, and biological materials. The highest alpha and beta readings were 33,000 and 73,000 dpm/cm², respectively.

The project goal is to safely remove the building and contents as part of the restoration of the site by Fernald Environmental Restoration Management Corporation (FERMCO).

II. DECONTAMINATION AND DISMANTLEMENT (D&D) TASKS

D&D work began in June 1993 on the following key tasks:

A. Preparatory Work
   1. removal of drums and loose materials
   2. building safe shutdown
   3. gross decontamination

B. Interior Work
   1. pipe and equipment asbestos removal
   2. interior building washdown
   3. contamination lockdown
   4. removal of HVAC ductwork, non-process piping, electrical, and equipment

C. Exterior Work
   1. exterior transite roofing and siding removal
D. Structural Work

1. structural steel removal

III. TASK DESCRIPTION

A. Preparatory Work

Preparatory work involved the formation of a Design, Engineering, and Construction (DEC) Team to plan the work, prepare the generic specifications and scope drawing for the D&D package, and the Invitation for Bid (IFB).

An IFB document was prepared including instructions to bidders, award criteria, general provisions, special conditions, a project labor agreement document, the work statement including performance criteria, the design documents including scope drawings and specifications, Health and Safety requirements including a Project Specific Task Health and Safety Matrix, and an outline of the Quality Assurance Plan that the subcontractor must submit.

A significant supplement to the bid package material was videos of the exterior and interior features of Plant 7 and a still photobook giving panoramic views of key aspects of Plant 7.

Prior to the issuance of the IFB package, prequalification of bidders was conducted. The prequalifications required experience that was specifically related to this project. This included experience in government work, demolition work, asbestos abatement work, radiological work, heavy rigging, and a good safety record. The experience criteria was published in the Commerce Business Daily approximately two months prior to the issuance of the IFB. Responses were evaluated and successful subcontractors were notified prior to issuance of the IFB package.

Infrastructure work included the installation of four control area access trailers (two men's and one women's shower and one break trailer), water supply, and temporary power.

The safe shutdown operation consisted of: removal of pigeon droppings that had created a severe Histoplasmosis problem in the upper portions of the building; removal of about 5,000 barrels of greensalt and empty cans; removal of remaining loose debris in the plant; and a gross decontamination of the floors using HEPA vacuums.

Finally, the building utilities were isolated from the rest of the plant site. This was accomplished by cutting all of the ground floor and exterior wall penetrations. It was determined that a line such as water, air, or temporary construction power lines would remain energized, if we marked with yellow tape and "Caution - Live Line" tags every 5-10 feet. Once safe shutdown and construction lines were isolated, locked out and tagged, a walkdown with the D&D Subcontractor was completed to insure that a safe working environment was accomplished.

As part of the subcontractor's mobilization process, the following programmatic items were completed and approved: the safety plan; quality plan; a detailed construction schedule to measure the subcontractors performance; detailed task work plans for the removal of conduit, piping, HVAC ductwork, and interior transite; and a waste management plan. In addition, the subcontractor prepared a survey (per OSHA requirements) of the building to insure that no detrimental structural deterioration was present. After these tasks were completed and approved, authorization to start the interior demolition work was given. The subcontractor then mobilized the construction craftpersons on site and prepared the building for D&D activities.

B. Interior Work

Interior work in Plant 7 included pipe and equipment asbestos removal, removal of ducting, non-process piping, electrical components, equipment, and interior transite siding removal.

Prior to the D&D Subcontractor coming on-site, the on-site Construction Support Contractor performed interior pipe and equipment asbestos removal, temporary utility installation, redistribution of electrical power, washdown of the interior, and an interior lockdown using a 1/2 mil. coat of latex paint. Asbestos removal was accomplished using glovebags and localized negative pressure enclosures. The washdown was accomplished by converting the first floor into a "bath tub" by coating it around the first foot of exterior walls with a strippable material. The building was then washed down from top to bottom with high pressure water spray equipment. Radiation levels were reduced from 2700 dpm to 180 dpm beta.
The D&D Subcontractor started the interior D&D work on the seventh floor and worked down through the building, removing duct work, non-process piping, electrical components, and equipment. Components were removed by manual means, such as disconnecting, cutting with saws, and torch cutting when necessary. Interior components were dismantled, cut to disposal box size, ends sealed, segregated into key waste stream bundles, and stored on each floor for removal during the structural steel removal phase.

Once interior bulk removal was completed on a floor, the interior transite panel and batting insulation were removed. Interior panels were removed, stacked, and stored on each floor for removal during structural steel removal. Batting installation was treated as asbestos and removed and bagged.

After all interior removals, the interior of the exterior transite siding was locked down by coating the surface with latex paint. Acceptance testing was performed for radiation and asbestos before exterior transite paneling was removed.

C. Exterior Work

Exterior work consisted of two categories:

1. Exterior yard D&D work. Exterior yard work removal included an outside gantry crane and structural supports, concrete piers, structural pipe supports, and steel tanks. This removal started before the exterior building removal and was worked concurrent with the interior work. Concrete was razed using a hoe ram and containerized using a loader. Structural members were disassembled using a mechanical shear and loaded into containers using a grappler.

2. Removal of the building exterior. Exterior work of the building included exterior transite panels, gutter, down spouts, roof stacks, windows, frames, and exterior doors.

After the clearance test, the building exterior removal started with exterior transite panel removal on the lower sections of the sides and roof. Main side panels were removed starting from the bottom and working up. Two scan climbers were used to remove panels for the upper wall elevations and the building roofs. A scan climber is a motorized working platform supported by one or more towers that are secured to the building steel. This enables men to work safely while materials can be temporarily stored, taken off, and lowered to the ground for containerization.

Exterior windows and frames were removed from the outside and lowered to the ground where they were disassembled and containerized. Roof stacks and gutters were cut and rigged to the ground and containerized. The exterior transite roof had a double layer of transite paneling. The first layer was removed, then the second. All panels were removed by drilling out fastener screws, placing them on the scan climber, and then lowering them to the ground.

D. Superstructure Removal

Three alternatives were considered for "taking down" the superstructure of Plant 7.

1. Mechanical tripping. Mechanical tripping of the building consists of selective removal of key members, i.e., certain bays, X-bracing floor plates, cutting of columns and floor plates, and then pulling the building over with heavy equipment.

2. Modular dismantlement. Modular dismantlement consists of removal of entire floors on several bays as a unit with a heavy lift crane. This involves cutting steel connections with adjacent steel and lifting the module to the ground level.

3. Implosion. Implosion uses shaped charges to remove columns and splice plates on various floors so the building will fall in on itself. The shaped charges act as a cutting tool by placing approximately three million pounds of cutting force on the structural member.

The mechanical tripping method was not used primarily due to space limitations between Plant 7 and adjacent facilities. There was not adequate distance to position heavy equipment to perform the pulling operation. While the modular dismantlement method was the original preferred approach, this was replaced by the implosion alternative. The reason implosion was selected is that it eliminated worker exposure to heights (the height of the building was 110 feet), it reduced exposure to burning of lead paint from 640 manhours to 25 manhours, reduced worker time in a radiation area by four weeks, and reduced torch cutting of steel coated with lead paint from 3,420 feet to 90 feet. Implosion was not originally chosen because of concerns with the public perception of use of explosives on a contaminated structure. FERMCO explained the safety advantages and reviewed the mechanics of implosion in several public forums, public confidence supported implosion.

The superstructure take-down required two
implosions before it was completely successful. The first implosion was designed to take steel columns out on the first and third floor with an explosive sequence that would drop the structure in a northwest (NW) direction. Column splice plates and bolts, as well as web plates and bolts were cut on the fifth and sixth floors. The intent was that the first three floors would collapse on top of each other and tilt the building to the NW. This tilt was to move the center of gravity for the upper floor to a point where splice plates on the fifth and sixth floor would open up and allow the upper floors to slide off and drop to the ground level. The initial implosion, while completely successful from an explosive standpoint, did not tilt the building over far enough to allow the upper floors to slide off the splice plates. The result was that the building only dropped 35 feet.

A second implosion was performed seven days later. This implosion used shaped charges on the splices, web plates, columns, and selective X-bracing on the fifth and sixth floors. This implosion was successful and dropped the upper floors of the structure the remaining distance to the ground level.

Once on ground level, the building steel was cut into disposable pieces by two back-hoes fitted with heavy shears.

The purpose of this approach was to use the fastest and least cost method that reduced the risks to craft personnel. This method achieved this goal.

IV. LESSONS LEARNED

A. Use of Explosives for Superstructural Dismantling

1. Building the job on paper, brainstorming construction methods, bringing in experts, and exploring capabilities of construction equipment significantly reduces the cost and schedule.

2. Using generic specifications, identifying common scopes of work in similar buildings/structures, and creating specifications for those types of work significantly reduces design construction.

3. Bidders and owners can lower D&D costs on projects by supplementing the scope of work with a photobook, video, and multi-day prebid walkthroughs.

4. Waste handling criteria must be clearly defined in the bid specification.

5. Construction equipment (i.e., HEPA filters) used to perform D&D work should be procured from off the shelf stock, not fabricated. Procurement is simplified.

6. Use a single point contact between subcontractors and construction managers to improve communication and avoid disputes.

7. Isolate all energy sources by physically cutting all pipe and conduit in all exterior walls and the ground floor of the building, and provide temporary services that are in a known location.

8. If at all possible, use a sealed building shell as a containment.

9. Interior washdown was done before interior work started. Although it greatly reduced the contamination levels, it did not reduce PPE requirements. Therefore, interior washdown should be initiated after the completion of interior work.

10. Collection of contaminated water within buildings can be improved by using strippable coatings during a washdown process to prevent contaminated water from penetrating foundations or ground floor slabs.

11. Lockdown of the facility with paint prior to demolition lowers the radiation levels. However, it has a minimum life (i.e., 3 to 4 months) after which significant pealing starts. Lockdown with paint should only be used as a short term measure.

12. The utilization of the scan climber on major exterior transite removal proved invaluable. It improved production, reduced worker exposure to heights, and material handling.

13. Building implosion significantly reduced the risk exposure to the worker. It eliminated working at heights, dramatically reduced exposure to lead fumes from torch cutting (640 MH to 90 MH), reduced working in a contaminated/radiological area by four weeks, and allowed the complete handling of the steel with equipment rather than by hand.

14. Covering the ground and grade slab with a geotech fabric which was wetted down just prior to the implosion virtually eliminated any dust emissions.

15. Airborne contamination from the implosion was virtually non-existent, with the following recordings
from six monitoring stations:

  o Lead - only one station recorded any reading which was .12 mg/m³ or .5% of the permissible exposure level.

  o Asbestos - the average readings of .002 to .003 f/cc were 20-30% of the Ohio rate limit. The maximum reading is only 40% of the Department of Health limit.

  o Radiation - all stations read .01 pi cu/m³ except one with a reading of .03 pi cu/m³. The average uranium airborne concentration is 10% of the DOE applicable limit, while the maximum reading was 30% of the limit.

16. Concrete slabs in a structure connected to heavy girders and intermediate steel will remain virtually intact during an implosion. We had concrete slabs on the second and fifth floor that were covered with various encapsulants. These slabs showed no visible evidence of cracks after two implosions.

17. Shaped charges are a very effective method of cutting steel members. A shaped charge makes a clean cut (i.e., it looks like a knife cut through a block of butter).

18. Heavy steel structures with large steel columns, girders, intermediate steel, and steel decking are very rigid and retain their configuration through an implosion unless specifically cut with shaped charges.

19. Do not rely on gravity to open up heavy member connections in a structure during the implosion. Use shaped charges to take apart heavy member connections.

20. Determine what the end configuration of the building is to be after the implosion. Use shaped charges to cut columns and the structural members that will place the structure in the desired configuration.

21. Shaped charges are a quick and cost effective way of dismantling large structures. We were able to reduce the schedule by four to six weeks and dismantle an additional structure with a budget of $500,000 at no additional cost to the project.