Preparing the West Valley Fuel Reprocessing Facility for Demolition
West Valley Demonstration Project (WVDP), West Valley, NY, USA – 10423

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ABSTRACT

The West Valley Demonstration Project (WVDP) Act of 1980 authorized the Department of Energy (DOE) to conduct a high-level radioactive waste management demonstration project at the site of the former Spent Fuel Reprocessing Plant in West Valley, New York, for the purpose of demonstrating solidification techniques which can be used for preparing high-level liquid waste for disposal. The former reprocessing facility at this site, known as the Main Plant Process Building (MPPB, Main Plant), was the only commercial NRC-licensed spent fuel reprocessing plant to have operated in the United States. Spent fuel reprocessing operations ended in 1972 and DOE's cleanup operations have been underway since 1982. Liquid high-level waste solidification was completed at the site in 2002 and follow-on activities at the approximately 81-hectare (200-acre) WVDP have centered on waste processing and equipment dismantlement and decontamination of the MPPB. Only a few of the more than 50 original cells in the MPPB still contain process equipment from spent nuclear fuel reprocessing activities.

Site managers, the U.S. Department of Energy and the New York State Energy Research Development Authority, jointly prepared an Environmental Impact Statement to allow decision making on some aspects of the end state of the project. A Record of Decision on the Environmental Impact Statement (EIS) is expected in the spring of 2010. Meanwhile, State and Federal agencies with management and regulatory roles at the WVDP have agreed to proceed with a number of activities at the site, including mitigation of a contaminated groundwater plume at the site, demolition preparations for the Main Plant Process Building and preparations to move the 275 solidified high-level waste canisters currently stored inside the Process Building.

This paper focuses on the dismantlement activities associated with three recent cell cleanout projects – the Acid Recovery Cell, Extraction Cell-3, and the Hot Acid Cell in the MPPB and the rationale applied for vessel and piping removal in each of those cells. Combined, the cells contained 22 vessels individually weighing as much as 5.4 metric tons (6 tons) that ranged in characterization from low-level waste (LLW) to Transuranic (TRU) waste. Some were removed in pieces and others were removed intact. Thousands of meters of process piping were also removed during equipment dismantlement of the three cells. In the process, the WVDP gained invaluable experience with a variety of vessel removal techniques from confined and non-confined areas.

Each of these projects offers applicability for dismantling equipment in similar highly-contaminated facilities with confined or limited access cells. The WVDP employed a number of material-handling strategies, techniques for in-situ and post-removal size reduction, and innovative packaging options. The lessons learned at West Valley have applicability in terms of worker safety, radiation exposure savings, and cost-savings for other sites managing similar work.

INTRODUCTION

The vessel and piping removal from the Acid Recovery Cell, Extraction Cell-3, and the Hot Acid Cell represent three varied approaches to in-cell equipment dismantlement at the WVDP. The methods chosen and the duration of the work differed for each of the three cells. In each instance, radiological conditions, cell access, vessel size and configuration, and availability of material handling equipment determined how vessels and piping were removed from each cell.

VESSEL AND PIPING REMOVAL APPROACH

The Main Plant Process Building at the WVDP is comprised of approximately 55 individual cells and operating aisles. Since the U. S. Department of Energy began operation of the facility in 1982 to support the WVDP, it began removing radioactively-contaminated equipment and debris from the cells and aisles to reuse portions of the Main Plant to support liquid high-level waste vitrification, and later, to prepare the facility for demolition. By the end of 2009, only five of the cells in the facility still contained original nuclear fuel reprocessing equipment. The equipment from the remaining cells will be removed and the facility is scheduled to be fully prepared for demolition by June 2011.

Variations among in-cell conditions, contamination levels, cell access, and in-cell equipment have made each cell equipment dismantlement project at the WVDP unique. The various cell cleanout projects have required detailed evaluation of existing infrastructure, available equipment, cell access points, dose rates and contamination levels, and configuration of in-cell components to determine the best method for removing vessels and piping. In some situations, the only access to a three-story tall cell filled with contaminated materials might be through a ceiling hatch. In other instances, the only access to a cell could be through a man-door at the floor level. Contamination and dose rates in the cells varied dramatically, in some cases allowing in-cell dismantlement work with relatively long worker stay times; in other situations work was required to be preceded by extensive dose-reduction activities or entirely by remote means. In some situations, the in-cell conditions were determined to be an entirely different situation than first thought after a manned entry confirmed in-cell conditions. Some cells required the addition of grout to provide a level floor for safer working conditions for manned entries and/or to lower in-cell dose rates.

A typical single-shift, in-cell decontamination and dismantlement crew in a radioactive cell in the West Valley Main Plant Process Building consists of:

- Two operators in-cell,
- One rad technician in-cell,
- One fire watch,
- One job supervisor,
- One backup in the air lock,
- One backup outside the air lock, and
- One outside rad technician monitoring electronic dosimeters.

Typical manned entries use supplied air or Powered Air-Purifying Respirators (PaPRs) with a protection factor of 1,000.

A generalized checklist of the decontamination end-point criteria for cell decontamination appears in the Table I. The approach to satisfying that criteria varies for each individual cell, depending upon cell conditions, configuration, available equipment, etc.

Table I. Cell Decontamination End-Point Criteria.

Cell Decontamination End-Point Criteria	
Cell Component	General End-Point Criteria
Utilities	De-energized, isolated, locked-out, and verified. Systems needed to support demolition phase of facility and continued High Level Waste (HLW) canister storage remain functional.
Process Vessels	Emptied to the extent practical and remaining liquids and solids are immobilized.
Vessels and Associated Systems	Isolated.
Fluid system piping	Drained and dried or de-mobilized.
Contaminated penetration piping and systems	Drained, decontaminated to the extent practical, and dried or immobilized. Contaminated piping is removed to the extent practical; removal is within one foot of applicable penetration. Piping ends/stubs are isolated.
Cell penetrations	Air-gapped to prevent airborne contaminant transfer.
TRU and mixed waste	Removed to the extent practical.
Waste not suspected of being of TRU and hazardous waste	Remain in place for the commercial demolition of the Main Plant Process Building based on: ▪ Health, safety, and risk considerations to the workers performing labor-intensive activities; and ▪ Cost-effectiveness – Accessibility, less labor-intensive, greater control and flexibility in waste management/classification.
Readily-removable radioactive materials	Removed and dispositioned in accordance with waste management procedures.
Cell surfaces (remaining systems, floors, walls, ceilings)	Smearable contamination on cell surfaces that were initially in excess of 200 dpm beta-gamma and 20 dpm alpha per 100 cm^2 have been reduced/fixed to the extent practical to prevent future spread. Applying fixative, grouting, surface removal, or other decontamination methods may be applied for contamination and dose control.
Shielding	Approved for dose control in continuous occupancy areas.
Resource Conservation and Recovery Act or Toxic Substances Control Act-suspect related items	Removed to the extent practical, including asbestos-containing materials (ACM), mercury-containing parts, PCB-containing equipment and other fluids (oils).
Non-readily removable ACM embedded in concrete penetrations	Inventoried and marked for removal during facility demolition.
Pre-and post-fixative characterization surveys	Performed for inventory purposes.
Post-decontamination inventory	Performed for suspect hazardous waste.
Minimize dose	Dose rates are maintained at <10mR/hr at two meters or ALARA to the extent practical.

Cell Decontamination End-Point Criteria	
Cell Component	General End-Point Criteria
Engineering revisions	Conditions that warrant revisions to engineering controls are pre-established.
Continued storage of HLW canisters	Monitoring systems will remain operational to support facility demolition and to ensure necessary engineering controls for continued storage of the HLW canisters in the Main Plant Process Building remain operational.
Configuration verification	An independent verification of the Main Plant configuration is performed prior to facility demolition.

In situations calling for asbestos removal, an asbestos-trained removal crew was called in to work in the cell, removing the asbestos from the vessels and piping before the equipment could be prepared for removal. In those situations, the three-person asbestos removal team was supported by a supervisor and radiation and safety technician in the cell, as well as a backup team outside the cell. A typical cell entry lasted 3.5 hours in duration.

ACID RECOVERY CELL

The Acid Recovery Cell, located on the second floor of the Main Plant Process Building, contained six vessels and approximately 1,700 linear meters (5,500 linear feet) of process piping used to recover and store nitric acid from the nuclear fuel reprocessing cycle. The cell is unlined and is L-shaped with a partial two story tower in one corner. The vessels were placed as the facility was constructed and the two access points into the cell are considerably smaller than the vessels inside the cell.

Access into the Acid Recovery Cell can be made through a floor-level personnel door or a person-sized ceiling hatch. Although a third access point is shared with the neighboring Off-Gas Cell, the adjacent cell contained highly contaminated fuel reprocessing equipment and debris and therefore access through the Off-Gas Cell into the Acid Recovery Cell was not an option.

Because the points of access into the cell were considerably smaller than the vessels inside, in-cell size-reduction of the vessels or establishing an access opening large enough for their removal were required. Conservative preliminary dose-based calculations indicated the vessels may be TRU waste; in that event, size-reduction would be a requirement for offsite disposal. That preliminary waste determination, combined with the difficult in-cell configuration of the vessels led to the decision to size-reduce the vessels in place rather than attempting to create wall openings large enough to allow intact removal. Establishing a larger point of egress from the cell was still required to enable removal of waste boxes containing the size-reduced vessels.

During the first personnel entries into the Acid Recovery Cell since the 1970s, asbestos was discovered on the vessels in the cell. This insulation, which was not identified on the design drawings, resulted in the need to re-engineer the disassembly work and vessel removal plan to include an aggressive asbestos removal effort prior to piping and vessel removal. This process added approximately four months to the schedule for in-cell dismantlement work. Figure 1 depicts two operators removing asbestos from a vessel in the Acid Recovery Cell.

Fig. 1. In-cell asbestos removal activities in the Acid Recovery Cell.

Following asbestos removal, loose contamination inside the cell was removed by vacuuming or wiping, or was fixed in-place with a spray fixative using a low-pressure sprayer. The small amount of process piping that was to remain in the cell for continued use in other areas of the facility was clearly marked at frequent intervals to avoid unintentional removal during the dismantlement process. The piping to be removed during cell cleanout was marked for removal with a contrasting color. Removal of liquid and drain verification from all in-cell piping and vessels was conducted using tell-taling devices. Similar to a hot tap machine, the tell-taling device allows the user to drill into a pressurized line to create a branch connection without shutting down the system. The WVDP's version of this allows the user to drill into an existing line to drain and collect any internal liquid under controlled conditions. Contamination spread is reduced during this operation. The liquid was captured and pipe sections were cut into approximately four-foot lengths for packaging and removal from the cell.

Once the piping was physically removed from the immediate area, the vessel itself was prepared for size-reduction. Vessels were inspected for the presence of internal liquid using either visual inspection or a boroscope camera. If liquid was found, a lesson learned from a different cell decontamination project was applied using a radiation detection probe inserted in the vessel while the liquid was drained and captured to obtain real-time readings as the liquid was being evacuated. This method was applied to ensure that dose rates in the cell were not being raised as the liquid was drained because the liquid was acting as a radiation shield inside the vessel. If a rise in dose rates was observed, provisions to shield the operators during vessel draining, cutting, and removal were required. Once the liquid was removed, the vessel internals were then coated with direct to metal (DTM) acrylic paint or Oakite Clearcoat® fixative using a low-pressure spray applicator to affix any loose contamination.

A typical vessel in the Acid Recovery Cell was constructed of 304 stainless steel, varying in thickness from .635 cm to .9525 cm (.25 inch to .375 inch). Plasma torch cutting was selected for size-reduction of the vessels in the Acid Recovery Cell. Though preferred in terms of speed and efficiency, plasma cutting is considered high-hazard due to the potential for fire and hazards for workers. To mitigate the fire hazard, a fire watch was assigned to each cutting operation with assigned duties extending half an hour beyond in-cell cutting operations to ensure there was no fire event. The large amount of airborne matter created by particulate plasma cutting has a tendency to accumulate on ventilation filters. Therefore, each cutting operation was preceded with prior notification to plant systems operations to ensure that Main Plant ventilation was closely monitored for abnormalities during cutting operations. Enhanced Personnel

Protective Equipment, including flame resistant coveralls, hose protectors, weld shields, welding gloves, welding aprons and welding chaps were specified to ensure operators involved in plasma cutting were adequately protected during cutting operations.

Plasma cutting was conducted to size-reduce the vessels into manageable pieces of approximately .6 meters by .9 meters (2 feet by 3 feet) each. The cut pieces were packaged in-cell into waste boxes. An enclosure was built on the outside of the Main Plant to establish an access point into the Acid Recovery Cell. It was equipped with a roll-up door and a mechanical lift to hoist and lower waste boxes into and out of the cell. At the second floor level, the concrete wall was removed to create access to enable movement of waste boxes inside and out.

In-cell dismantlement activities in the Acid Recovery Cell were completed in November 2009.

HOT ACID CELL

Located on the fourth floor of the Main Plant, the Hot Acid Cell contained two large vessels formerly used for holding recycled acid during fuel reprocessing activities in the Main Plant. Equipment dismantlement activities in the Hot Acid Cell involved removal of two vessels, 7D-11 and 7D-12, associated valves and piping, and a pump.

The original concept for equipment removal from cells such as the Hot Acid Cell was for in-situ size-reduction of tanks, vessels, and piping using plasma torches and/or mechanical means. With the vessels determined to be low-level waste, this concept was revised for the Hot Acid Cell to remove and package the vessels whole, resulting in significant cost-avoidance over conventional in-place size reduction. Primary considerations that led to the decision to remove the vessels intact included:

- Only 18 inches of working space between the two, 2-ton vessels;
- Personnel safety concerns associated with the operation of a plasma torch in the confined space;
- Concern that using a plasma torch in the confined cell could cause a ventilation disturbance in the adjacent Ventilation Exhaust Cell;
- Lack of in-cell cranes or hoisting apparatus would make it difficult to move and package vessel pieces within the cell if vessels were cut into pieces;
- In-cell plasma cutting would require two supplemental, self-cleaning filter units;
- Plasma cutting would require one or more portable ventilation units; and
- Eleven B-25 boxes would be required for packaging of tank components.

In-cell dose evaluations of the vessels determined that after surface decontamination, the vessels would meet criteria for classification as LLW. This determination made them especially eligible for removal from the cell whole – providing an access point into the cell could be made and hoisting could be arranged for removing the vessels from their fourth floor location. For the vessels to be removed intact, significant planning and coordination was required to address a number of engineering and operational issues associated with vessel removal.

- Reinforced, multi-layered disposal bags with an IP-1 rating offered significant cost-savings over conventional hard container packaging. The bags were special-ordered for these vessels.
- Vessel internals were sprayed with fixative to capture and hold any loose contamination.

- Vessel externals were wiped down to remove external surface contamination and sprayed with fixative to capture any remaining loose contamination.

- A platform was fabricated and installed on the Analytical Aisle roof to support the vessels as they were removed from the cell.

- An access opening was cut in the concrete cell wall using a circular diamond bit saw.

- Significant coordination with other site projects was required to maximize use of a rented mobile crane. The crane completed a series of unrelated lifts while it was on site over a period of one week.

- Actual dose rates for the two vessels (0.6-0. 2 mR/hr and 0.2 mR/hr on contact) were higher than preliminary dose estimates. The WVDP worked with disposal facility EnergySolutions to ensure the vessels would meet acceptance criteria at that facility for LLW before vessel removal and packaging.

Equipment was staged prior to arrival of the 272-metric ton (300-ton) mobile crane, ensuring that all hoisting and rigging equipment was prepared for the vessel lifts. When the crane arrived on site, it was set up in front of the Main Plant and was used to hoist the roof platform into place. The access opening was then cut through the wall of the Hot Acid Cell while the crane was put to use elsewhere on the site performing other unrelated lifts. Once the opening was established in the wall of the cell, the crane was brought back in place and the tanks were winched out on to the roof and lowered onto a flatbed truck.

Fig. 2. The two vessels in the Hot Acid Cell are exposed through the opening cut in the wall of the cell as the vessels are prepared for removal through the cell wall.

Both tanks were removed from the Main Plant, surveyed, packaged, and prepared for off-site shipment in one day. The WVDP maintained close communication with EnergySolutions throughout the process to ensure acceptance of the vessels for disposal. Upon arrival at EnergySolutions, the tanks were grouted and disposed. The entire process – arrival and setup of the crane, wall breakthrough, vessel removal and packaging, vessel shipment, grouting and disposal – took less than two weeks to complete. The success of this project was a direct result of the engineering and preparations that preceded the onsite arrival of the mobile crane and the strict attention to detail and safety throughout the project.

EXTRACTION CELL-3

Extraction Cell-3 was one of the original process cells cleaned out for reuse in support of HLW vitrification. In 1984 and 1985, WVES predecessor West Valley Nuclear Services Company undertook manned dismantlement and decontamination activities inside the cell (4.6 meters by 6.4 meters by 17.4 meters or 15 feet by 21 feet by 57 feet high) to remove 27 metric tons (30 tons) of waste and debris. The cell was then sprayed with fixative and fitted with 12 new vessels, including one large vessel comprised of three large tanks that are welded together and approximately 1,768 meters (5,800 linear feet) of piping. The equipment is associated with the Liquid Waste Treatment System and was used for pretreatment of the supernatant layer of the liquid in the HLW tanks. The Liquid Waste Treatment System was in use from 1988 to 2005 and was subsequently flushed at the cease of operations. The computer-generated graphic in Figure 3 depicts the internal configuration of the vessels and piping in Extraction Cell-3 at the start of cell cleanout.

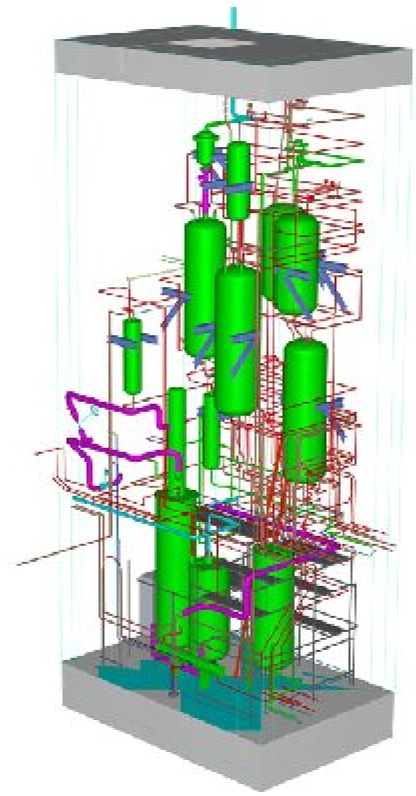

Fig. 3. Computer-generated graphic of the Liquid Waste Treatment System equipment located inside Extraction Cell-3.

In early 2008, WVES began preparing for in-cell dismantlement of Extraction Cell-3. Initial dose readings were taken inside the cell and preparations were made to begin top-down removal of piping and vessels. Vessels were drained of residual liquids to prepare for in-cell activities. Draining of the evaporator resulted in an elevation of in-cell dose rates due to the unexpected shielding from water inside the evaporator. As a result, liquid was temporarily re-introduced into the evaporator vessel to allow a number of in-cell activities to take place while engineering was initiated for acid flushes of the evaporator. The acid flushes proved to be very successful at reducing in-cell dose rates, allowing manned entries to take place for the remainder of the in-cell dismantlement activities. A summary of the three acid flushes appears in Table II.

Table II. Acid Flushes in Extraction Cell-3.

Starting general work area dose: 230 mr/hr	
1st nitric acid/water flush	Reduced dose by factor of 5
2nd nitric acid/water flush	Reduced dose by cumulative factor of 7
3rd nitric acid/water flush	Reduced dose by cumulative factor of 15
Final general work area dose: 15 mr/hr	

The nitric acid in 1.8 molar solution was held for a minimum soak time of 48 hours prior to each evaporator flush. Subsequent to the final flush, the radiological hot spot located inside the evaporator at the vessel's bottom heel was reduced to 1.1 R/hr.

The Product Purification Cell-North, adjacent to Extraction Cell-3, was cleared and prepared as a material handling chute for removing smaller waste streams from the Main Plant. This modification included cutting a large opening in the east wall of the PPC-N at floor elevation and installing material handling rollers and air locks to create a flow path from the Extraction Cell Crane Room at the 160-foot elevation to the Waste Reduction and Packaging Area dock (95-foot elevation). This flow path enabled materials to be brought into and out of the Main Plant without the need for a mobile crane. Dismantlement of Extraction Cell-3 provided the first opportunity to use Product Purification Cell - North for that purpose.

Due to the size limitation of the opening out of the Product Purification Cell, only two of the smaller vessels (71-V-010 and 71-E-005) were removed from Extraction Cell-3 using this path. This flow path was used for removing piping, scaffolding, suit up waste, and bringing supplies into the Main Plant.

Removal of liquid and drain verification from all in-cell piping and vessels was conducted using tell-taling devices.

A typical removal sequence through Product Purification Cell-North would be to lift the material out of Extraction Cell-3 up though the Extraction Cell-3 ceiling hatch using an overhead 4.5-metric ton (5-ton) gantry crane. Moving the item from over the Extraction Cell-3 ceiling hatch to the Product Purification Cell ceiling hatch, the item was then lowered to a waiting waste container located on the floor of Product Purification Cell. The waste box would then be sealed closed and moved using rollers from the Product Purification Cell to the Waste Reduction and Packaging Area dock, where it would then be transported into storage using a fork truck.

Fig. 4 depicts the first vessel (71-V-010) being removed from Extraction Cell-3 in May 2009. The vessel was wrapped in plastic to control contamination.

Figure 4. Removal of the first vessel from Extraction Cell-3 through the adjacent PPC-N.

Removal of the 12 larger vessels from Extraction Cell-3 involved repositioning the vessel beneath the Extraction Cell-3 ceiling hatch, lifting it up through the ceiling hatch and then supporting it using beams which spanned the hatch opening. At this point a mobile crane was used to lift the vessel out of the Main Plant and place it in a waste box. Specially-designed waste boxes were fabricated to enable the vessels to be loaded in the vertical position so that any hazards associated with placing the vessel into a waste container would be significantly reduced. Once the vessel was safely placed into the waste box and sealed closed, it was then rotated to the horizontal position using the same mobile crane and then transported into the waste storage system using a fork truck.

The larger 12 vessels varied in size and weight from a maximum of 4.9 meters (16 feet) long and to a maximum weight of 5.4 metric tons (6 tons). The advantages associated with removing the vessels whole included minimized contamination spread and the most expeditious method available for vessel removal.

Two of the vessels required extensive cutting to allow them to be removed independently of one another. These were the Reboiler and Separator, which combined formed the larger Evaporator. To cut these stainless steel units apart, plasma was used to cut a 2.5 cm (1-inch) thick plate and 9 cm (3-1/2- inch) diameter bar which married the two vessels together. Utilizing extensive mockups and a separate ventilation source, the cell remained “clean” after the cutting operation was completed without the need to replace filters on the main ventilation system of the cell.

Once all the piping, vessels, and scaffolding were removed from the cell, all four walls, ceiling and floor of the evacuated cell were painted to affix any remaining contamination. This work was completed in late December 2009.

CONCLUSION

The WVDP has gained a wealth of experience in remote and hands-on dismantlement and decontamination of the Main Plant Process Building at West Valley, New York. The facility has offered a complex set of factors that include a wide range of contamination and radiological dose hazards, cell access points that range from easily accessible to restricted, and often with limited material handling capabilities. As the remaining few cells are cleaned out and the facility is prepared for demolition, the lessons learned during vessel and piping removal have great applicability for planning the remaining work in this facility.

In 2010, work will begin in Extraction Cell - 1, which is one of the most contaminated cells of the 55-cell facility. Planning is underway for that remote cleanout, and the lessons learned in the many cells that have already been decontaminated in the Main Plant will provide a valuable basis for engineering that work.

There are currently five cells that still contain vessels and piping and a number of ancillary areas that contain hazardous materials. Those areas are the focus of work in the facility between now and June 2011.