Dismantling the Vitrification Facility at the West Valley Demonstration Project

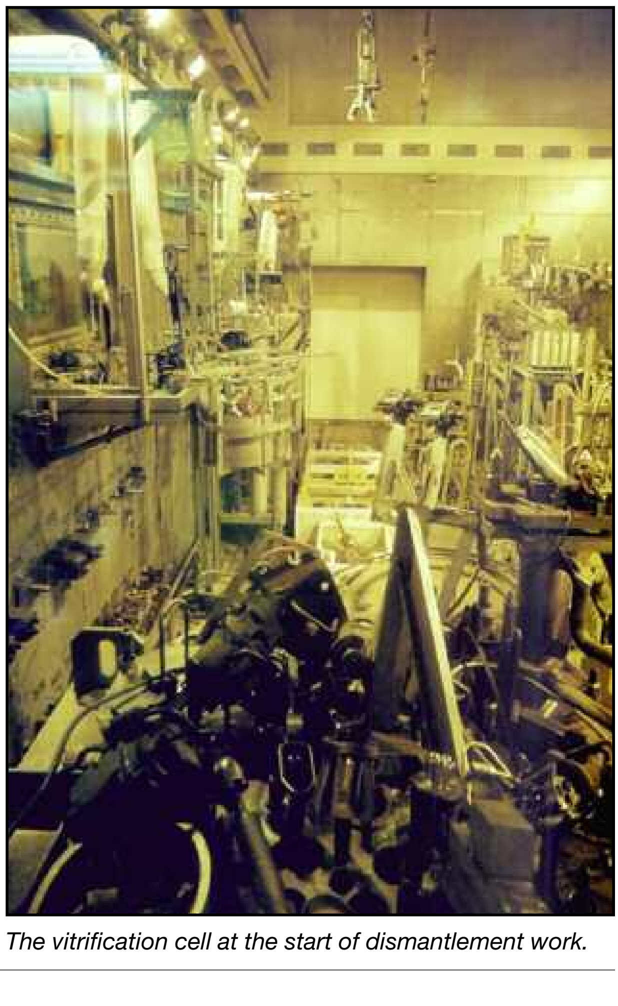
High contamination, high radiation levels, a compressed work schedule, and limited in-cell infrastructure made the Vitrification Dismantlement Project difficult. Thorough planning, a dedicated team, and strict attention to safety and contamination control made the project a success.

By Michael J. Cain, Cynthia Dayton, and Ahmad M. Al-Daouk

There were no "easy" tasks associated with the dismantlement of the Vitrification Facility at the West Valley Demonstration Project (WVDP). When Washington Group International's West Valley Nuclear Services Co. (WVNSCO) completes the 18-month-long project this winter, it closes the book on the legacy of the U.S. Department of Energy's two-decade-long effort to solidify high-level radioactive liquid waste that was stored at the site of the nation's only operational commercial nuclear fuel reprocessing facility at West Valley, N.Y.

The success of this project was paramount to the continuation of the forward momentum of dismantlement of the obsolete reprocessing facility. With contaminated equipment readings as high as several hundred rem per hour and general area dose rates ranging from 5 to 50 rem/h, the Vitrification Facility contained some of the highest dose rates encountered during radioactive dismantlement at the WVDP thus far. Packaging and removing the materials in the cell utilized the expertise of the skilled radiological engineers and operators in WVNSCO's workforce to place the cell in a safe configuration while long-term issues surrounding site closure are being sorted out.

Virtually all in-cell dismantlement required the use of remote tooling. High contamination, high radiation levels, a compressed work schedule, and limited in-cell infrastructure made the project difficult. Thorough planning, a dedicated team, and strict attention to safety and contamination control made the project a success.



The vitrification cell at the start of dismantlement work.

Starting at the Top

Most large projects are formidable when considered as a whole, but breaking them into small, logical pieces and assigning key people to take responsibility for a part of the endeavor makes even the most difficult projects manageable. Sorting out a logical order, identifying the key people responsible for various tasks, and recognizing possible impediments to success were the first tasks accomplished in the Vitrification Dismantlement Project.

At a brainstorming session held shortly after WVNSCO received DOE authorization to begin dismantling the facility, several engineers and operators had input into the plan that would determine the removal sequence of components from the cell. Early on in that session, they identified key issues, including keeping critical ventilation systems operable while other less critical systems and equipment were removed, selecting lower dose rate packages first to facilitate the development of operator proficiency before higher dose rate packaging began, and planning large-component removal.

Vitrification Facility Extremes

Highest Dose Rate Component Removed

1st Prefilter Housing: approximately 715 rem/h (prepackaged).

Heaviest Component Removed

Vitrification Melter: 54-tons (prepackaged weight).

Smallest Clearance

MFHT: approximately 0.75-in. clearance through the transfer tunnel.

Heaviest Packaged Waste Container

Packaged Melter: approximately 200 tons.

Overcoming Obstacles

A tight work schedule placed the Vitrification Dismantlement Project in a high-priority position from its onset. With an 18-month start-to-finish plan, the project would have to quickly ramp up its number of qualified decontamination and dismantlement operators and radiation protection personnel if the completion date was to be met.

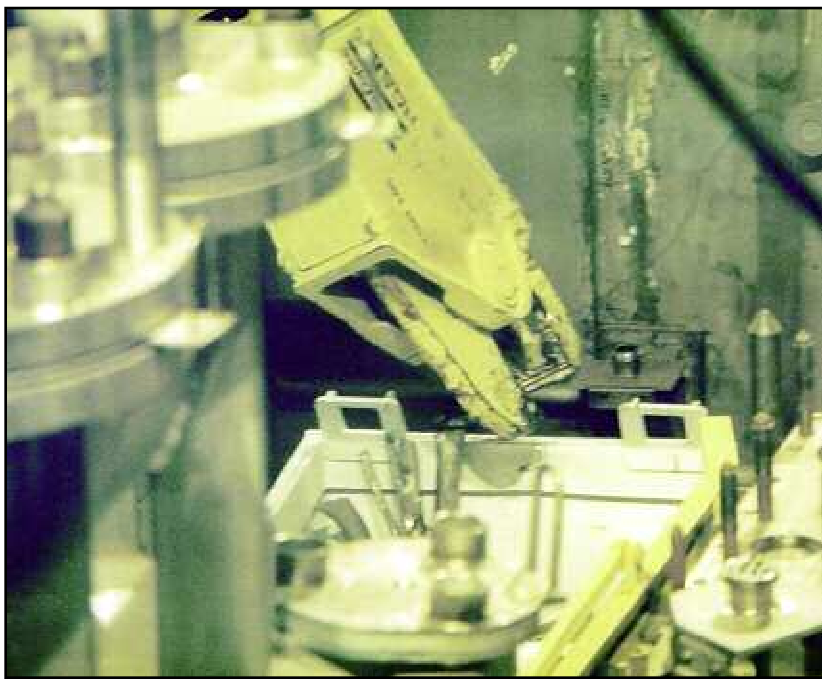
The vitrification cell had been designed for remote waste solidification. However, while much of the in-cell equipment had lifting bales and disconnect points, the task of wide-scale dismantlement was beyond the capabilities of much of the previously installed tooling for remote operations. Process manipulators could be used for small, intricate tasks, but the rigors of constant impact from dismantlement would quickly take its toll on the operations tooling.

Construction of the Vitrification Facility and placement of its large components had taken place before the cell roof was installed. Due to the extremely high radiation levels, the equipment could not come out the same way it went in. There was only one way out of the facility for contaminated equipment—through the transfer tunnel that connects the vitrification cell to the rest of the Process Building and the outside. Contamination and radiation concerns were diminished, but fitting the largest waste boxes through the tight door openings would present another obstacle to large-component removal.

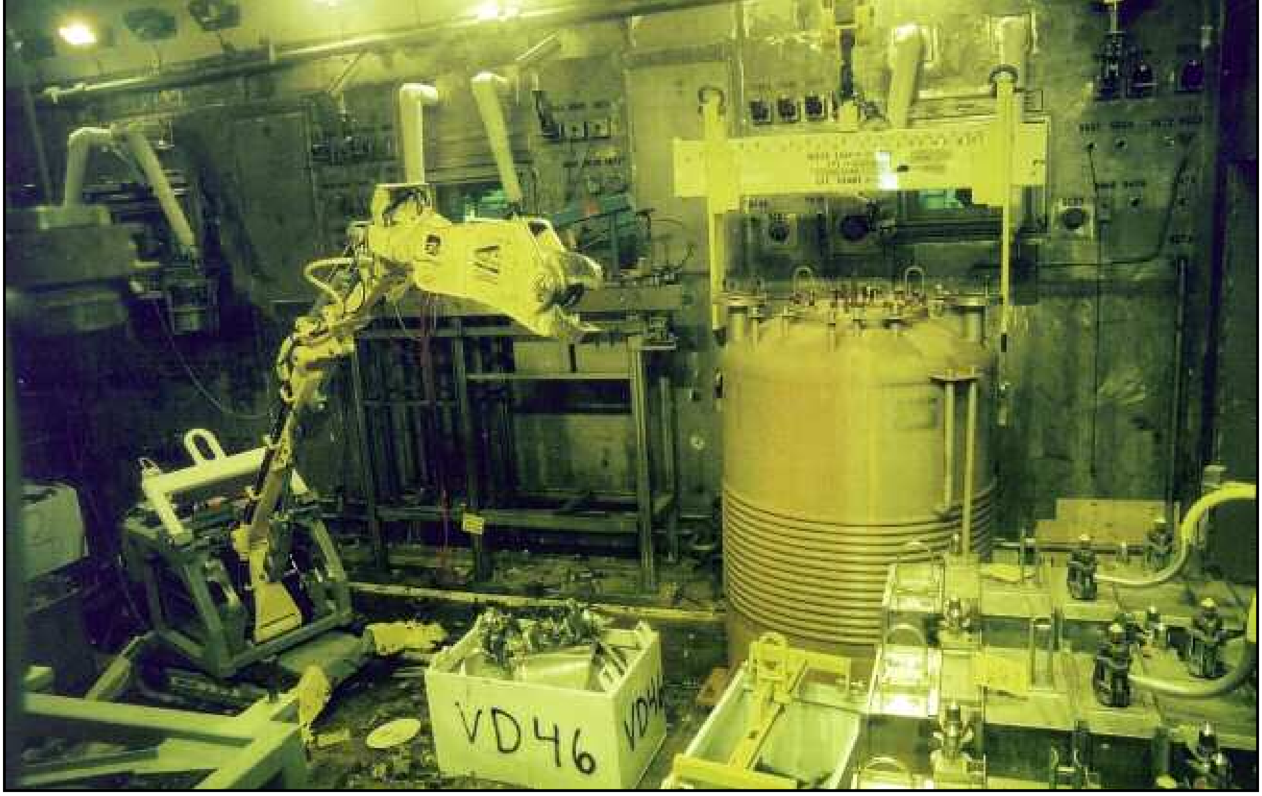
The packed cell contained a myriad of approximately 200 pipes and jumpers that connected the vessels to the external waste and chemical feed systems. Their removal from the cell provided the space needed to maneuver and remove the larger pieces of equipment in the cell.

Determining the dose rates associated with the packaged waste in advance optimized planning and the application of as-low-as-reasonably-achievable principles from the onset of the dismantlement project. Knowing component dose rates inside the Vitrification Facility where only remote dismantlement operations took place, personnel could be better prepared to handle packaged waste and limit their exposure while working on equipment and packages in the Equipment Decontamination Room (EDR). Radiation protection personnel working outside the cell utilized remote telemetry badges that provided real-time readouts for determining dose rates of components.

Engineering the removal of the five largest components in the Vitrification Facility would require considerable project resources. The 54-ton melter, the third largest component in line to be removed from the cell, was the heaviest single item to be packaged. With in-cell overhead cranes topping out at a 25-ton capacity, lifting the melter across the cell was not an option. It had to be pulled out



The Brokk, equipped with various end-effectors, proved useful during dismantlement of the vitrification cell.



The Brokk, left, is being used for in-cell waste processing during dismantlement of the Vitrification Facility.

along a set of tracks embedded in the cell floor. Even moving it to the center of the cell would present challenges.

The only removal pathway for the equipment and waste boxes from the vitrification cell, through a set of shield doors into the transfer tunnel, also provided a transport path for the migration of contamination during dismantlement and package removal. The EDR, located at the opposite end of the tunnel, serves as the first point of personnel contact for maintenance work on equipment and waste packages. From the EDR, waste packages could be directed into a mixed waste storage cell in the Process Building or to the exterior of the building through the Vitrification Load In/Load Out Facility. Control of contamination on packages and equipment exiting the Vitrification Facility was a paramount consideration for limiting worker exposure and the spread of contamination.

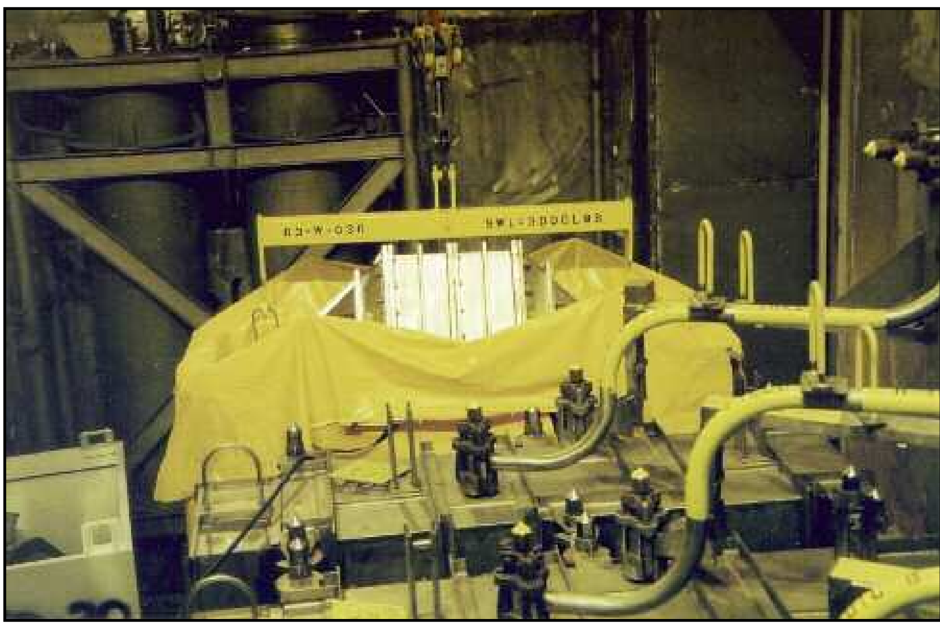
working platform for remote radiological demolition operations. The Brokk, capable of deploying a variety of end-effector tools from a quick-connect hub, proved to be an invaluable tool in the dismantlement project. Modifications such as the installation of access doors for the electrical cabinet and hydraulic valve bank and the installation of a frame-mounted bail made prior to its deployment reduced the amount of hands-on maintenance that would be required.

End-effectors were designed for the various tasks the Brokk would perform, including a shear that proved efficient at snapping off jumpers up to 4 inches in diameter, two 800–1000-millimeter-diameter cutoff saws proficient at cutting the electrodes off the melter, and a combination cutter-gripper-spreader that is effective at picking up small debris from the floor of the cell.

Assembling the Tools

Key to the success of the Vitrification Dismantlement Project was assembling the right tools for the job. Human resource needs included experienced radiation workers and radiation protection personnel who would enable the steady progression of removal of packaged waste from the facility. With a dedicated workforce, trained on specialized equipment, and creative work scheduling, the project could be scheduled for seven-days-per-week operations. For the last five months of the project, operations were conducted around the clock.

Through sharing of resources with the Miamisburg, Ohio, Closure Project, WVNSCO was able to obtain the Brokk™ 330, a Swedish-made mobile



A prefilter housing being lowered into a Herculite-lined waste box.

Planning for Component Removal

Waste box liners for smaller debris were lined with Herculite™ to provide in-cell contamination control. Initial packaging of the heavily contaminated pieces of equipment in waste box liners took place within the Vitrification Facility. Loaded liners could then be removed from the cell through the transfer tunnel and placed in the waste box staged inside the EDR. This packaging method reduced the possibility for contamination to creep outside the vitrification cell and EDR.

While initial jumper and process piping removal was ongoing, preparations for the removal of the large vessels were under way. Waste packages were designed and constructed to fit the dimensions of the large components, maximize shielding and strength, minimize packaged weight, and allow for movement through the tight shield door openings. Wrapping the large components in the cell in Herculite wasn't feasible, so a method of controlling the migration of loose contamination needed to be employed.

The four large components—the Concentrator Feed Makeup Tank (CFMT), the Melter Feed Holding Tank (MFHT), the melter, and the canister turntable—would prove to be among the most challenging equipment removal evolutions undertaken at the WVDP. Significant planning went into the design of the component waste containers, the methods of removing them (the configurations of the vessels required modifications to the exit plan for each vessel to accommodate shield door clearances and provide adequate load distribution), and movement of them once they were out of the facility.

Removing the CFMT and MFHT

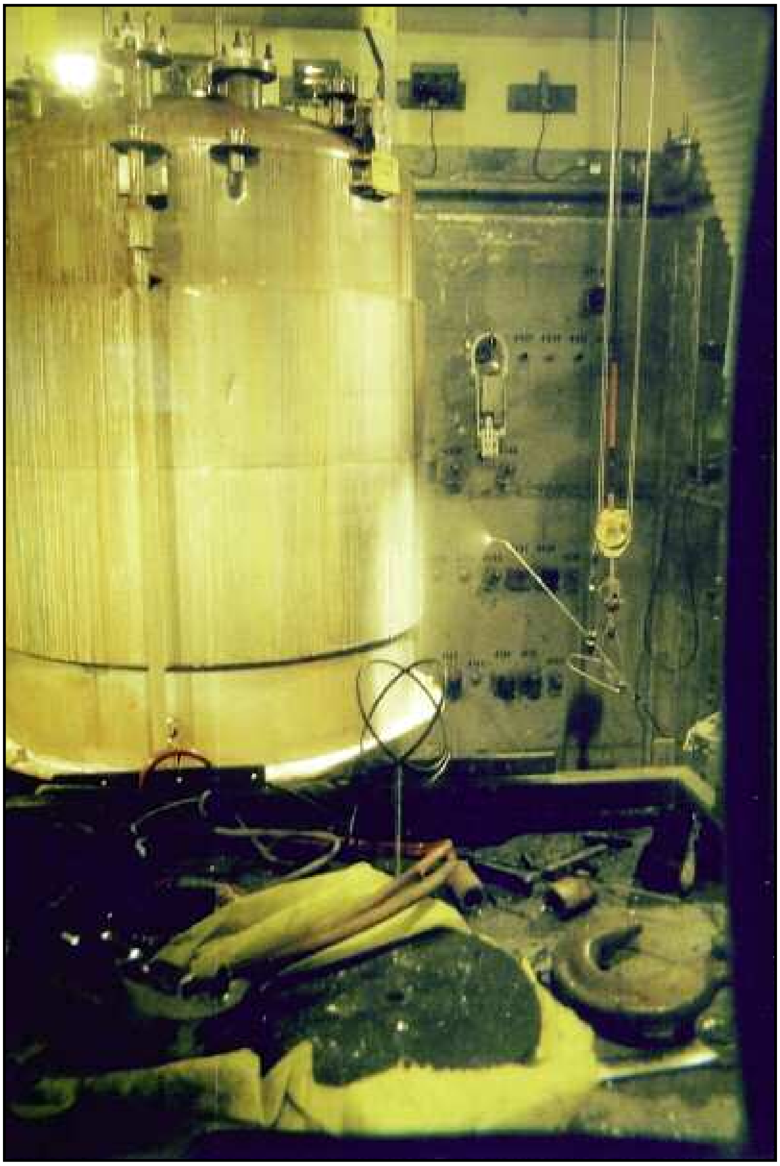
The similar configuration of the largest tanks enabled use of a single design for both waste packages to contain them. Conceptualized at the WVDP with final design and fabrication by an offsite vendor, the massive containers were shipped from the fabrication shop in Ohio to West Valley by superload trucks ranging in length from 130 to 210 ft.

The first container arrived in late August 2004. With special U.S. Department of Transportation permitting requirements, route limitations, and nighttime travel restrictions, transport of the 90-ton load from the fabrication shop to the site required a lead escort car, two rear escorts, and three police escorts. The second container, which was shipped three weeks later, was held up in transport for more than two weeks because of the aftereffects of hurricanes, which precluded the use of portions of the shipping route for several days.

Once at the site, the containers were offloaded using a set of gantry cranes that offered a smaller footprint and more stability than mobile cranes. As each container was off-loaded from the truck, it was lifted, turned, and positioned on a jack-and-slide system that transferred it across the floor of the Load In/Load Out Facility to the shield door of the EDR. Mated to the shield door with a custom containment tent structure, the container was then prepared to accept the removed vessel.

Meanwhile, inside the cell, preparations for the removal of the vessels were under way. The CFMT, which contained residual wastewater from flushing activities, had to be drained. External contamination present on the vessels was fixed in place using polymeric barrier system spray coating inside the vitrification cell.

Removal of CFMT and the subsequent MFHT progressed according to plan, with the vessels being equipped with belly bands for lifting inside the vitrification cell, lowered to a horizontal position near the transfer tunnel entrance, and moved into the EDR. Despite extremely confined clearances that brought the MFHT to within 0.75 in. of the transfer tunnel sides, removal of the two vessels progressed according to plan. In the EDR, the vessels were



The CFMT being sprayed with fixative for contamination control.

Top: The steel container constructed to hold the CFMT is unloaded from a truck upon arrival at the WVDP. It is elevated on a set of gantry cranes erected in front of the Load In/Load Out Facility to support the lifting and lowering of heavy containers removed during the dismantlement project.

Left: The CFMT container is mated to the Equipment Decontamination Room shield door and surrounded by a containment tent to prevent the spread of contamination during vessel packaging.

Bottom: The packaged melter feed hold tank is being removed from the Load In/Load Out Facility.

hoisted onto a waiting cradle, drawn through the shield door containment tent, and brought to rest inside their respective containers.

Low-density grout pumped into the containers was allowed to flow into the vessels through open ports as the waste containers themselves were filled to provide additional shielding and meet the criteria necessary to withstand a postulated accident scenario during transport. The daylong grouting procedure resulted in the stabilization of the containers with grout that hardened to a compressive strength of 1000 pounds per square inch after 28 days.

The jack-and-slide system, capable of moving the containers at approximately 3-foot increments, delivered the loaded vessels to the exterior door of the Load In/Load Out Facility. From there, the containers were hoisted in the air on the gantry cranes and positioned on a trailer for movement to an onsite storage area.

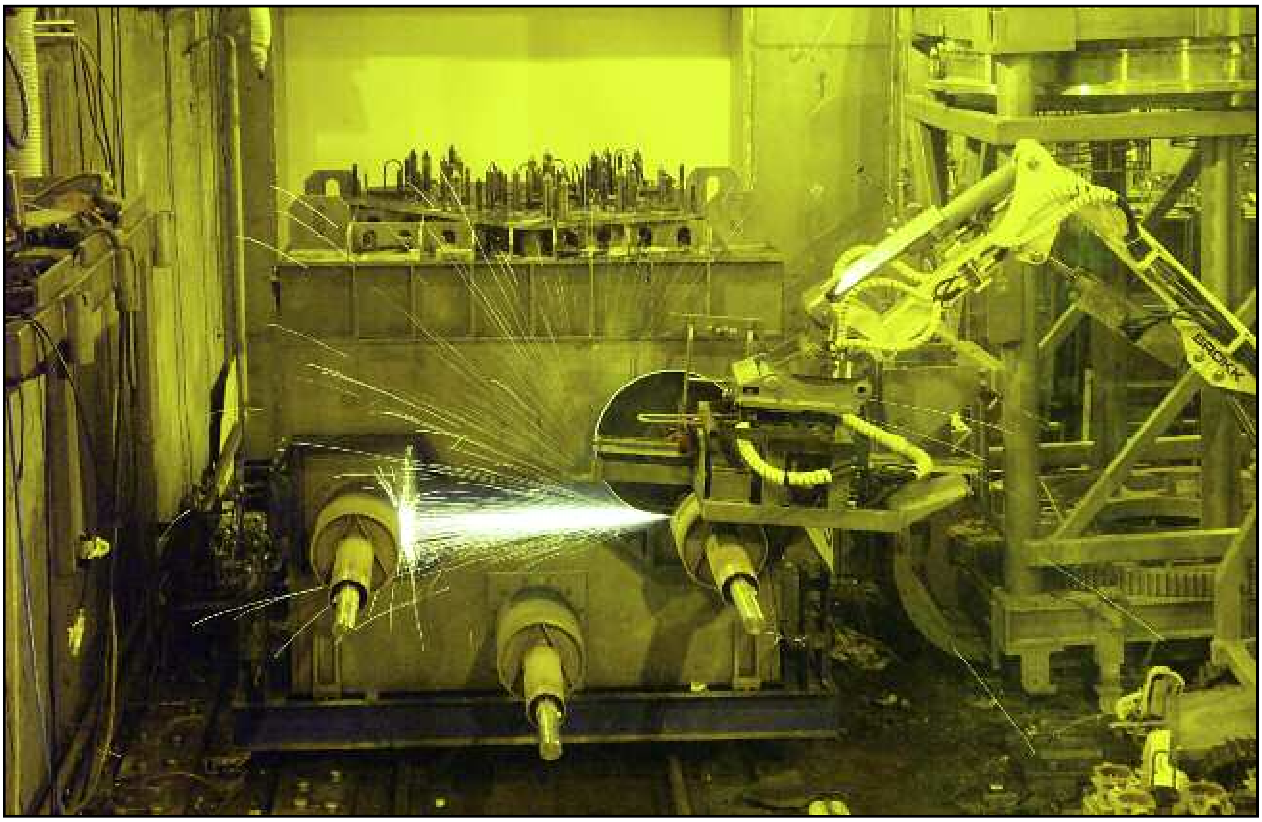
Necessity Is the Mother of Invention

The CFMT is being drawn through the EDR shield door into the staged waste container.

Removal and packaging of the melter was expected to be the most difficult aspect of the Vitrification Dismantlement Project. Its 54-ton mass, the fact that it rested upon a set of rail tracks embedded in the floor and extending over a pit, tight shield and tunnel clearances, and high radiation levels would all combine to make movement and packaging a difficult task. For that reason, extensive planning went into the melter removal strategy, including the design, fabrication, and mockup loading of a full-scale test melter. The actual melter had been equipped with a set of rollers at the point of construction to facilitate its eventual removal from the Vitrification Facility. Moving the melter across the floor of the vitrification cell was largely dependent upon the performance of those rollers along the tracks embedded in the floor and the rail incline that was installed in the EDR to facilitate its loading into a radiation transfer shield.

The Brokk was used to coax the unhooked melter out of its position in the far corner of the cell. A Brokk-mounted 800-mm cutoff saw was then used to separate the melter electrodes from the melter, and spray fixative was applied to the vessel's exterior.

Mockup loading using a test melter was conducted at the vendor's fabrication facility to demonstrate that the vessel could successfully be moved up the inclined ramp and into the shield transfer box in the EDR. During loading of the actual melter, however, the vessel failed to travel along the inclined tracks as expected. Rail sweeps mounted in front of the rollers contacted the incline, causing the melter to lose contact with the tracks on the trailing set of rollers.



The Brokk, equipped with a circular cutoff saw, was used to cut the electrodes off the melter.

The melter encountered an interference on the tracks inside the transfer tunnel as it was being removed from the vitrification cell. The Brokk was used to position a jacking bar under the melter and return it to the tracks.

The limitations of the in-cell equipment were clearly evident at this point. With the forward progress of the melter halted a few feet inside the transfer tunnel and the back set of rollers off the track, there were few options but to devise a method to lift the vessel, slide it sideways, and reposition it on the tracks.

A number of circumstances contributed to the complexity of the melter recovery effort. The melter's location—partially inside the EDR and partially inside the transfer tunnel—made access to it limited, at best. There are no overhead cranes in the Vitrification Facility, transfer tunnel, or the EDR capable of making the melter lift. The portion of the melter requiring lifting was still inside the tunnel, where access was further impeded by a lack of clear space and limited visibility. The best available option for lifting the melter involved using a jacking bar and a 50-ton jack.

The tools needed to lift the melter were loaded into the EDR, hooked to the grapple of the overhead crane, and moved to the entrance of the tunnel. Communicating by radio, the EDR crane operator "passed off" the tools to the Brokk operator, who was working at a viewing window and display monitor nearly 60 ft from the tunnel entrance. Grasping each tool firmly in the mouth of the Brokk's shear extended over the top of the melter, a jacking bar, cribbing, a 50-ton jack, and the jack stand were all remotely moved into place on the back side of the melter.

The design efforts of vitrification dismantlement engineers, coupled with the outstanding coordination of operators outside the Vitrification Facility and within and outside the EDR, resulted in using a combination of tools and a series of incremental jacking operations to lift the melter back up to a level position. With the tools exchanged over the top of the melter inside the transfer tunnel and the melter repositioned on the tracks, the melter continued on its path out of the building. Thirteen days after it first encountered the rail interference, it was safely and successfully loaded into the staged container.

Waste Packaging and Disposition

There were 163 waste containers filled with equipment, debris, and large vessels generated during the dismantlement of the Vitrification Facility. In-cell segregation of wastes helped to minimize the generation of greater-than-Class-A radioactive waste. Higher activity Class B, C, and transuranic wastes were packaged for disposal in 3-in.-thick B-25 steel boxes. The special containers for all the oversized pieces of equipment were custom designed and fabricated.

With a disposal path available for Class A waste, immediate preparation for offsite shipment was made at the point of generation. More than 80 waste boxes were immediately shipped offsite for disposal. Greater-than-Class-A wastes, including the special containers holding the CFMT, MFHT, and the melter, remain in storage at the WVDP. Additional large-scale and highly radioactive pieces of equipment removed from the cell were placed in temporary storage in concrete vaults on the site, pending size reduction in the facility's Remote-Handled Waste Facility. ■

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