A COMPLETE HISTORY OF THE HIGH-LEVEL WASTE PLANT AT THE WEST VALLEY DEMONSTRATION PROJECT

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ABSTRACT

The West Valley Demonstration Project (WVDP) vitrification melter was shut down in September 2002 after being used to vitrify High Level Waste (HLW) and process system residuals for six years. Processing of the HLW occurred from June 1996 through November 2001, followed by a program to flush the remaining HLW through to the melter. Glass removal and shutdown followed. The facility and process equipment is currently in a standby mode awaiting deactivation.

During HLW processing operations, nearly 24 million curies of radioactive material were vitrified into 275 canisters of HLW glass. At least 99.7% of the curies in the HLW tanks at the WVDP were vitrified using the melter. Each canister of HLW holds approximately 2000 kilograms of glass with an average contact dose rate of over 2600 rem per hour. After vitrification processing ended, two more cans were filled using the Evacuated Canister Process to empty the melter at shutdown.

This history briefly summarizes the initial stages of process development and earlier WVDP experience in the design and operation of the vitrification systems, followed by a more detailed discussion of equipment availability and failure rates during six years of operation. Lessons learned operating a system that continued to function beyond design expectations also are highlighted.

INTRODUCTION AND BACKGROUND

The West Valley Demonstration Project (WVDP or the Project) is a High-Level Waste (HLW) solidification and radiological cleanup project being conducted by the United States Department of Energy (DOE) at the site of the only commercial nuclear fuel reprocessing facility to have operated in the United States. As mandated by a Federal Law enacted in 1980, Public Law 96-386 (or the Act), one of the DOE's primary responsibilities at the 220-acre WVDP site in West Valley, New York is to safely solidify liquid HLW into a durable solid suitable for transport and disposal at an approved Federal repository.

The HLW requiring solidification was generated from 1966, when the site was operated as a commercial reprocessing facility by Nuclear Fuel Services (NFS), until 1972 when NFS suspended reprocessing operations at the site. Most of the HLW requiring solidification resulted from neutralization of waste produced by using the plutonium uranium extraction (PUREX) process to extract useable product (plutonium and uranium) from spent nuclear fuel. A lesser amount of the HLW requiring solidification was produced by using the thorium extraction (THOREX) process to extract useable product from one core of mixed uranium-thorium fuel that was reprocessed at the site.

During the time period when spent fuel reprocessing operations were being conducted, nitric-acid-based waste generated by PUREX processing neutralized with sodium hydroxide was transferred to a large underground carbon steel storage tank (8-D2). Acidic waste generated by THOREX processing was transferred to a smaller underground stainless steel storage tank (8D-4) without neutralization. Over time, neutralization and concentration of the PUREX waste in 8D-2 caused insoluble hydroxides and other salts (notably sodium sulfate) to precipitate out of the liquid and form sludge layers at the bottom of the tank. The acidic THOREX waste remained liquid. By the time the DOE was given responsibility for conducting the WVDP, about 2,200 cubic meters (600,000 gallons) of liquid and sludge HLW in 8D-2 and 30 cubic meters (8,000 gallons) of liquid HLW in 8D-4 required solidification.

After receiving its mandate to conduct the WVDP, the DOE prepared an Environmental Impact Statement (DOE/EIS-0081) to assess the impacts of the proposed High-Level Waste solidification as required by the National Environmental Policy Act of 1974 (NEPA). Subsequently, a Record of Decision (ROD) was published in 1982 that made it possible for the DOE to process the HLW into terminal waste form by vitrification. Initial process development began shortly thereafter, beginning with sampling and analyses done to determine the radiochemical and chemical composition of the HLW to be processed.

Based on analyses of the first HLW samples taken, the decision made was to use a chemical method to separate HLW from the liquid, combine it with sludge, and vitrify the resulting HLW mixture into a glass waste form. The proposed approach to chemically separate (pre-treat) the HLW also involved developing a method to process the resulting decontaminated liquid into an approved low-level waste (LLW) form. By taking this approach, it was possible to significantly reduce the amount of glass that needed to be produced while also ensuring the integrity of the final glass product. Once this processing decision was made, efforts got underway to select the best methods to achieve decontamination, process LLW, and produce a final HLW glass form. The general progression of events following this early process development decision is shown on the timeline in Fig. 1.

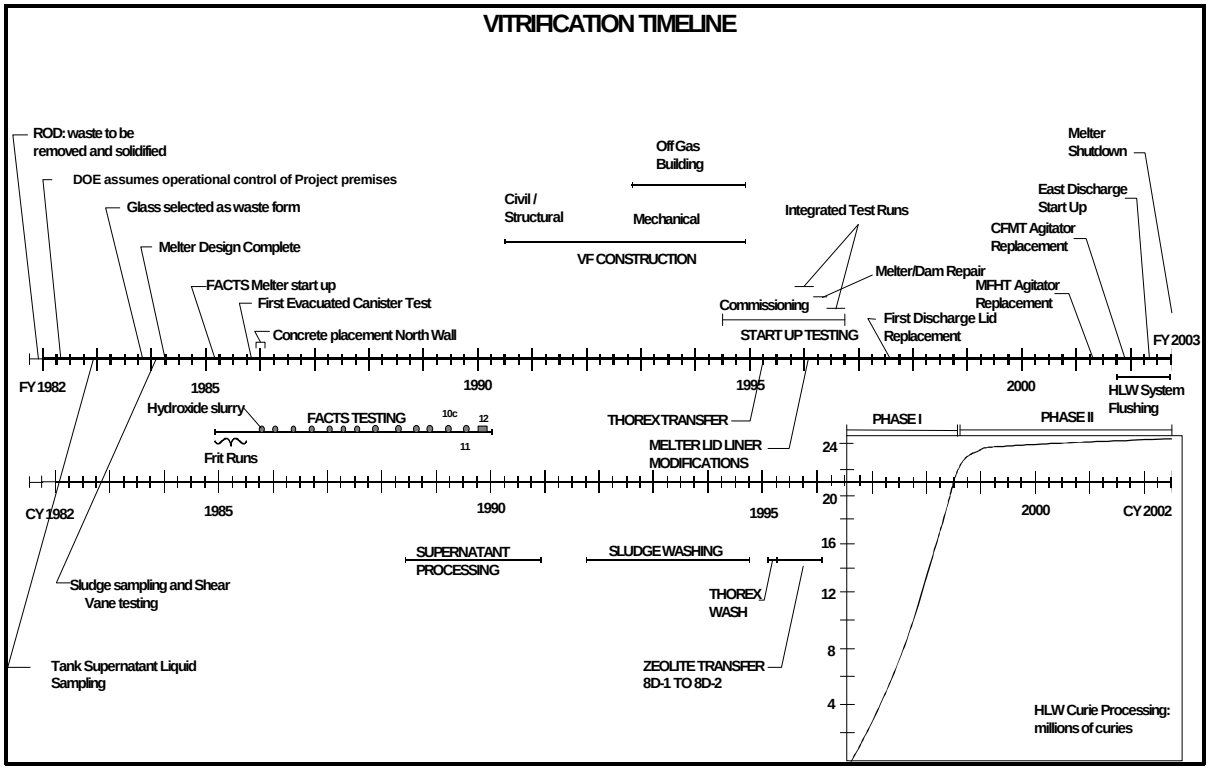

Fig. 1 Timeline

VITRIFICATION PROCESS DEVELOPMENT

As methods for accomplishing liquid decontamination were being developed, parallel efforts were made to select a final HLW glass form and advance vitrification process development. Melter design began shortly after borosilicate glass was selected as the final HLW glass form. In early 1983, a design for a slurry-fed ceramic-lined melter had been approved and was ready for fabrication. By the end of 1984 a unit built according to approved design specifications was ready for use in the Functional and Checkout Testing of Systems (FACTS) program, a full-scale testing program developed to checkout vitrification system processing operations and demonstrate the WVDP waste glass qualification approach.

The overall method developed for processing HLW involved preparing the HLW for processing by separating (removing) the majority of the radioactive species (Cs-137 and Sr-90) from the waste liquid, combining the resulting HLW with the waste sludge, and processing the HLW mixture into the approved glass waste form. After removing HLW from the waste liquid, the resulting low-level waste (LLW) liquid also was processed into an approved waste form, cement encapsulated LLW. The basic overall method and systems used to process liquid HLW into approved HLW and LLW forms are illustrated in Fig. 2.

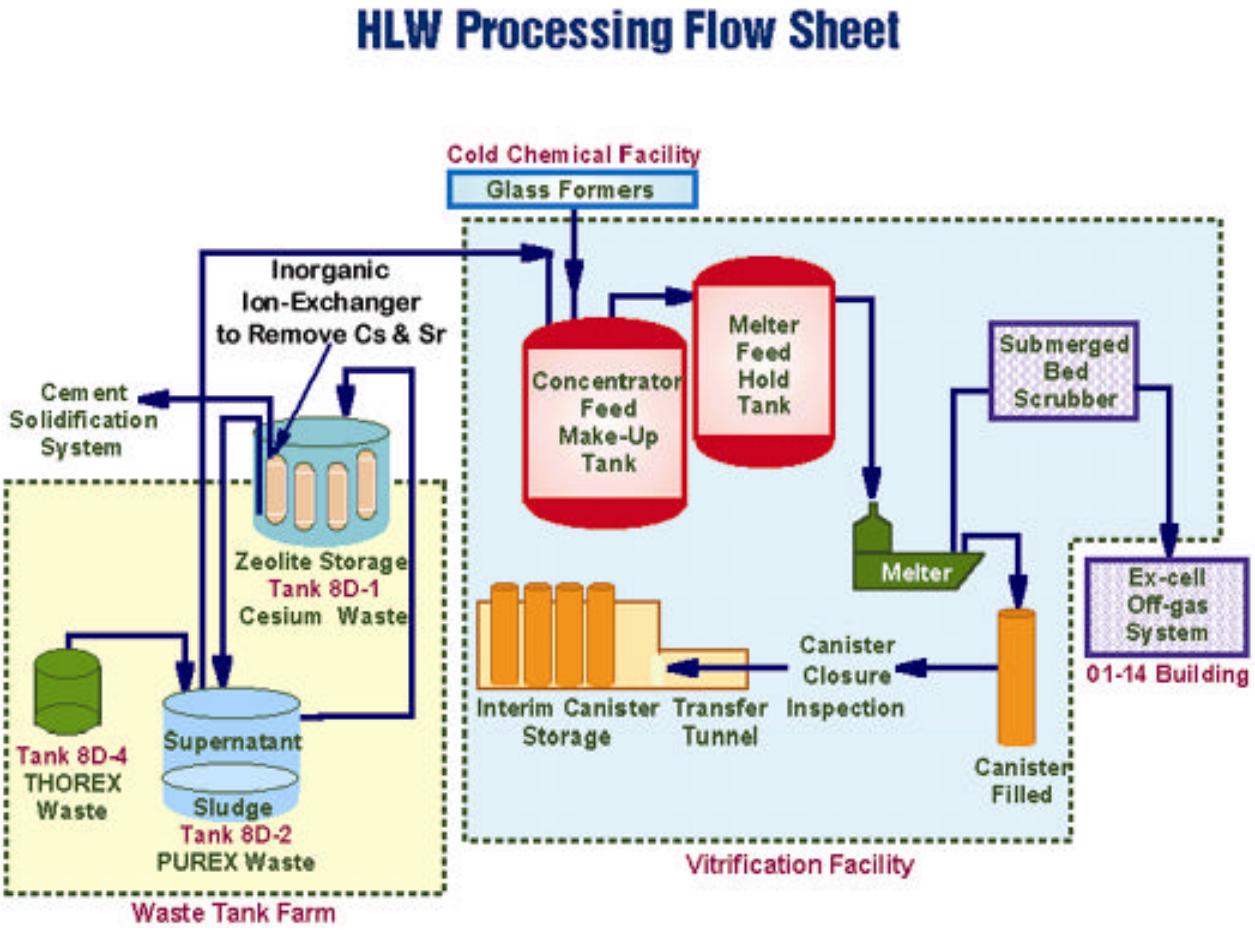

Fig. 2 HLW Process

The methods used to remove HLW from waste liquid and prepare the HLW mixture for vitrification are briefly summarized here, followed by a more detailed description of the vitrification process, including a brief summary of the FACTS program and a description of the Vitrification System.

HLW Pre-treatment: HLW was separated (removed) from waste liquid from 1988 to 1991 by processing HLW liquids through zeolite-filled ion-exchange columns installed for this purpose in the duplicate (spare) HLW tank at the WVDP site, tank 8D-1. More than 99% of the major radioactive species in the waste liquid (Cs-137 and Sr-90) were selectively removed from the liquid using this process. Effluent solution resulting from HLW removal was concentrated and processed into drums of cement encapsulated LLW that meet U.S. Nuclear Regulatory Commission (NRC) criteria for LLW disposal. Liquid pre-treatment also served to remove sodium and interstitial sulfate salts from the HLW mixture before vitrification. Sodium was removed through liquid (supernatant) processing. Sulfate salts were removed by washing the sludge using a three step process: filling the primary HLW tank (8D-2) with demineralized water; adding sodium hydroxide to keep uranium and plutonium in the precipitate; and processing the resulting liquid through the ion-exchange columns in 8D-1. Sludge washing was carried out from 1991 until 1994. After the supernatant and sludge washing was completed, the ion-exchange media in tank 8D-1 and remaining liquid (THOREX) waste in tank 8D-4 were transferred to 8D-2 and combined with the existing sludge to form the waste slurry to be processed into HLW glass in the Vitrification Facility. Pre-treating the liquid HLW before vitrification resulted in a 90% overall reduction in the total amount of HLW glass that needed to be produced in the Vitrification Facility.

Functional and Checkout Testing of Systems Program: Full-scale testing of the vitrification system design was accomplished through the Functional and Checkout Testing of Systems (FACTS) Program. Conducted from 1984 until 1989, this program provided the opportunity to evaluate process system, subsystem and component performance, confirm the HLW glass qualification approach and use the Vitrification (Vit) System to produce high quality glass on a production schedule. Systems and subsystems tested as part of the FACTS program included the melter, canister turntable, off-gas system, (excluding components used for oxides of nitrogen [NOx] abatement), and the slurry feed preparation system. Thirty seven different system tests were performed and approximately 150,000 kilograms of glass were made during the FACTS program using non-radioactive isotopes in lieu of radioactive species to produce a waste glass as close as practical to the projected HLW. Following the final FACTS run, the Vit System was disassembled for examination of test components and conversion for radioactive service, including the melter. A number of components that performed well during FACTS were reassembled for reuse, including the tanks used to prepare and feed slurry the melter, the Concentrator Feed Makeup Tank (CFMT) and Melter Feed Hold Tank (MFHT), as well as the facility used to prepare the glass former recipe to be blended with the HLW slurry, the Cold Chemical System (CCS).

After the FACTS program and the remote facility construction were completed, a phased program of remote-handling demonstrations, integrated testing and operations was carried out. Remote-handling demonstrations involved performing each activity to be carried out during Vit System operations using remote techniques as far as was practicable to further develop operating proficiency. Jumpers and high maintenance items in particular were tested to show successful remote replacement. Performance testing progressed from component and subsystem demonstration using water first, then testing (non-radioactive) slurry to fully integrated system test runs known as integrated operations (IO). The IO runs culminated with an Operational Readiness Review and approval to begin radioactive operation in June 1996.

Vitrification System Operation

HLW solidification using the Vit System was carried out in two phases. Phase I involved transferring the HLW slurry mixture from HLW tank 8D-2 to the CFMT where it was blended with batches of cold chemicals (including glass formers), concentrated, transferred to MFHT, continuously fed to the melter, and poured into stainless steel canisters to produce the final HLW glass form. During Phase I, which was conducted from July 1996 until June 1998, 211 canisters were made, for a production total of 436,546 kilograms of HLW glass. Following the same basic processing sequence, Phase II was conducted from July 1998 until August 2002, resulting in the production of 64 canisters, for a production total of an additional 132,756 kilograms of HLW glass. The processing sequence used to accomplish HLW glass production during both Phase I and Phase II is described briefly as follows.

HLW Glass Production: The basic process used to produce canisters of HLW glass began by combining the radioactive species captured in the zeolite media during HLW pre-treatment with the HLW sludge, blending in recycled waste liquids resulting from off-gas treatment, and transferring the homogenous HLW slurry from 8D-2 to the CFMT, where the first step of HLW processing was initiated. This processing step involved taking slurry samples and sending them to the Analytical and Process Chemistry (A&PC) Lab for chemical and radiochemical analysis to determine the exact glass-making recipe needed to process the slurry into HLW glass. While slurry samples were analyzed, the batch of slurry in the CFMT was concentrated to remove excess water. After the batch recipe was determined and a pre-mix of chemicals prepared, the pre-mix was transferred into the CFMT, mixed with the concentrated slurry and sampled again to ensure target glass composition. This feed preparation cycle was the most critical stage in HLW glass production because the time it took to prepare a feed batch had to be less than the time it took to transfer a full tank of feed from the MFHT to the melter, about 180 hours. The greatest portion of feed preparation time involved slurry analysis. Modifications made to improve batch preparation cycle time during both testing and early radioactive operations proved to be critical to the success of Phase I operations. (1)

The next step in HLW processing involved transferring feed to the melter, allowing water to evaporate, salts to decompose, and remaining solids to calcine. Inside the melter, calcined wastes and glass-formers melted and fused into a glass pool where they homogenized. During melter operation, homogenized molten glass was periodically airlifted into a stainless steel canister held in position under the melter by the canister turntable -- a four-position, four-canister device that provides one position for filling, one position for canister removal and replacement, and two positions for filled canisters to cool. After being allowed to cool, the filled canister was moved from the canister turntable to the weld station, where a stainless steel lid was welded onto the canister. From the weld station, the welded canister was moved to the canister decontamination station, where the surface of the canister was decontaminated by chemical etching. Decontamination solution used was recirculated back into the melter feed. The final step in canister production involved moving decontaminated canisters from the Vit Cell to the High-Level Waste Interim Storage Facility (HLWISF) which is equipped with racks to hold the HLW canisters. Canisters used in HLW glass production were brought into the Vit Cell through a pathway that began in the canister load-in facility. From this location, canisters were inserted horizontally through a cylindrical shield door into the Equipment Decontamination Room (EDR). In the EDR, the canisters were upended, placed onto the transfer cart, moved into the Vit Cell, and placed into a canister storage rack for eventual loading into the canister turntable.

During the glass-melting process, steam, volatile elements evaporating from the glass pool, and feed particles entrained in the process off-gas were vented to the off-gas treatment system. The first component of this system, the Submerged Bed Scrubber (SBS), was used to quench the off-gas and

remove particulate from it by scrubbing it through a submerged bed of ceramic spheres. Quenched off-gases were then drawn through a mist eliminator and high-efficiency mist eliminator (HEME) to remove mist and fine particulate. Scrubbed and treated off-gas was then heated and passed through a high-efficiency particulate air (HEPA) filter to remove particulate. Essentially free of radiological pollution at this point, the treated off-gas stream was directed through an underground trench to another building where final stages of HEPA filtering and oxides of nitrogen (NOx) abatement were completed before venting the treated off-gas through the Main Plant stack.

The vessel vent system was used to maintain all primary process vessels under slightly negative vacuums during radioactive operations. This system operated by passing vessel vent gas from a header through a condenser to the off-gas stream directed toward the HEME. The vessel vent system also served as a means to bypass the Submerged Bed Scrubber (SBS) if the melter off-gas line became plugged. In-cell pressure and contamination control was provided by the Heating, Ventilation, and Air Conditioning (HVAC) system. This system was designed such that any air leakage associated with the cell shield walls flows back into the Vit Cell where it is exhausted through the Vit System's HEPA filters.

VITRIFICATION OPERATING EXPERIENCE

Systems and system hardware used in HLW processing and glass-filled canister production at the WVDP functioned beyond design expectations. Several aspects of system operation required close attention as canisters of HLW glass were produced. Melter operation and related functions affecting glass production played a major role. Specific factors that influenced system performance and experienced gained from managing events related to these factors during radioactive operations are described in the following discussions of melter operation and HLW processing that took place at the WVDP during HLW glass production.

Melter Discharge: The melter is designed to discharge molten glass by pulling homogenized bulk glass from the main melter cavity through an under flow drain (as illustrated in the cut-away view of the melter and turntable shown in Fig. 3). Glass is directed from the under flow drain up a sloped channel that rises to a trough. The high point of the channel is the melter overflow. Normally the melter is operated at a glass level of one to two inches below overflow, using the airlift to raise glass up to the trough where it then flows by gravity to the canister. The cavity holding the trough is independently heated to maintain glass temperature during pouring. Glass discharge from the melter is a recognized point of potential failure.

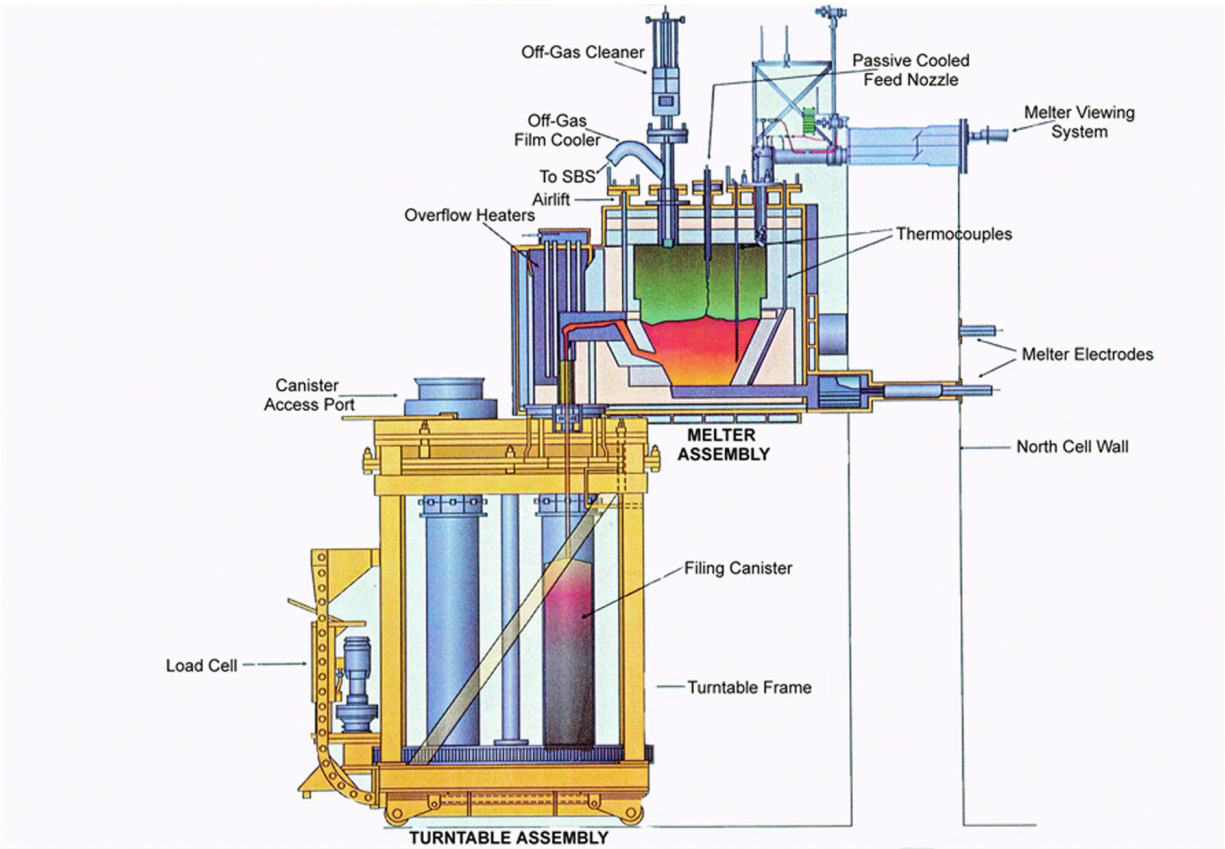

Fig.3 HLW Melter and Turntable

Trough wear, erosion, and corrosion caused by glass flow has often been observed in both commercial and waste melters. Beyond these factors, glass pouring itself can produce dripping and thin pour streams that solidify into glass structures. Formation of such structures can functionally disable the discharge chamber. For these reasons, the final design of the HLW melter included two separated glass discharge chambers, each one equipped with removable silicon carbide heaters. These heaters were used to keep the trough and pour spout hot enough to maintain glass viscosity. The heaters that were installed are remotely replaceable units that can be used in either discharge chamber. During melter operation, only one pour spout was heated while the second chamber was maintained unheated, preventing unwanted glass pours from the "cold" discharge chamber.

Experience with silicon carbide heater assemblies during FACTS operation indicated a service lifetime from six to 18 months, with an expected average service life of nine months. The first assembly failed after about 16 months of service. As a failed heater assembly represents a large, heavy block of highly contaminated waste, efforts were made to formulate an approach to increase their service life. The approach developed by WVNSCO engineers to extend service life was focused on reducing stress placed on the heaters by temperature transients. This was accomplished by providing back up power to the heater supplies and changing threshold limits on the control system to limit temperature swings. Effective reduction of stress on the heaters extended the service of the second set of heaters to 4 ½ years, after which the internal resistance in the silicon carbide heater bars used in heater assemblies increased until power supplies could not provide enough energy to heat the assembly to required temperatures.

A failure associated with operation of the discharge chamber occurred when the glass exit port plugged with glass. As previously described, problems with pouring such as the formation of drips can cause fibers to build up as glass is being poured. The drips form when melter pressure fluctuates. Damage to the pour tip also can cause pour problems by dividing the glass streams, each one acting like a drip. Although a direct cause of the exit port plug has not been identified, it may have been caused by the formation of drips. An examination of the discharge chamber is needed to determine the exact cause of the plug. As a result, the secondary discharge chamber had to be brought on-line with a fresh heater assembly near the end of radioactive operations. As part of the process of bringing the discharge chamber into service, an airlift tube was installed in the riser after heating the discharge chamber. Platinum was selected for the air lift tube (pipe) because it is impervious to the glass. The expectation was that it would last for the remaining life of the melter, as well as being thin-walled and flexible enough to bend as it slid down the sloped riser channel. However, flexibility proved to be detrimental in getting the tube down the riser as it bent and folded on itself (accordion style), instead of extending down the riser. Although the airlift was made operational, the design insertion depth was never obtained.

Heat up of the east discharge chamber was performed within a prescribed schedule. A slow ramp to temperature was used to limit stresses from different rates of thermal expansion within the refractory and the metal dam. Even with the slow ramp (heat up), cracking in the refractory caused air to leak between the discharge chamber and the main melter cavity. Air flow in the west discharge chamber was controlled by an orifice in the connecting jumper on top of the melter. This orifice was effectively bypassed in the east discharge chamber. Air apparently traveled past the airlift and through the seal between the lid and main cavity. This event indicates that additional work on discharge chamber seal design to reduce air flow is warranted.

Melter Lid and Penetrations: Instrumentation and process lines enter the melter through openings (penetrations) in the melter lid. Mechanical design of lid penetrations is somewhat complex because linings used in the penetrations have to be durable enough to withstand remote installation of various services and the corrosive effects of melter off-gas. Original designs used heavy Inconel 690 tubes (pipes) welded into the lid with fragile, low density, castable refractory placed behind the liners to provide lid insulation. Corrosion of these liners during FACTS testing caused them to fail within three years and damage the lid refractory. As a result, alumina liners were incorporated into the final design of the melter. Thermal stress on these liners during melter start-up caused them to crack, making it necessary to remove them and replace them with Inconel liners. The replacement liners included channels to draw air through the liners for cooling and flushing of corrosive vapors from the penetration region. As no damage was reported when periodic liner inspections were performed during the first two years of melter operation, subsequent inspections were limited to examination of liners that had to be removed to perform other maintenance tasks. Liner inspections performed after six years of melter operation showed only minor visible damage.

Melter Off-Gas: There is considerable variation in off-gas flow rates and the amount of particulate produced by an operating slurry-fed ceramic melter. During the early phases of vitrification program development, peak variability was measured at six times normal off-gas flow. This value was used as a design input for subsequent designs and behaved adequately as melter testing progressed. The final design for the WVDP melter used externally supplied air injection to make up the difference between nominal and peak off-gas flow rates. Steady melter pressure was maintained during radioactive operations by controlling it with an air injection control loop that served to dampen (filter) pressure signals. This made it possible to slow down responses to rapid fluctuations in melter pressure. Slower responses limited the possibility for over reaction to short term pressure spikes, providing for better control of melter pressure.

Excess particulate exiting the melter off-gas system was managed by using a film cooler mounted near the off-gas penetration in the melter lid. Acting like a curtain of air, this device works by intercepting particulate in the off gas stream. Set in the melter off gas penetration, the cooler includes a series of louvers that cool and distribute air as it leaves the melter plenum and moves up the off-gas line. The final design for the film cooler is based on a series of designs developed at the WVDP and the Savannah River site to address plugging experienced during vitrification process development. This design uses a cleaner (brush) to periodically remove particulate by moving the brush from its resting position from above the film cooler down into the melter cavity and back up again. Used during early melter operation, brush operation diminished and was then discontinued because particulate build-up in the off-gas line was no longer observed. A plug did form in the off-gas jumper during radioactive operations, but not near the film cooler. The plug occurred at the bend in the jumper where flow is diverted downward. Plug formation was indicated soon after radioactive operations began by an observable rise in jumper differential pressure. Additional plug formation was mitigated by adding a water purge to the injection/control air run through the jumper. Although periodic water purges cleared away most of the particulate build-up, build-ups continued to occur such that water purges were far less effective at melter-shutdown than they were when first used.

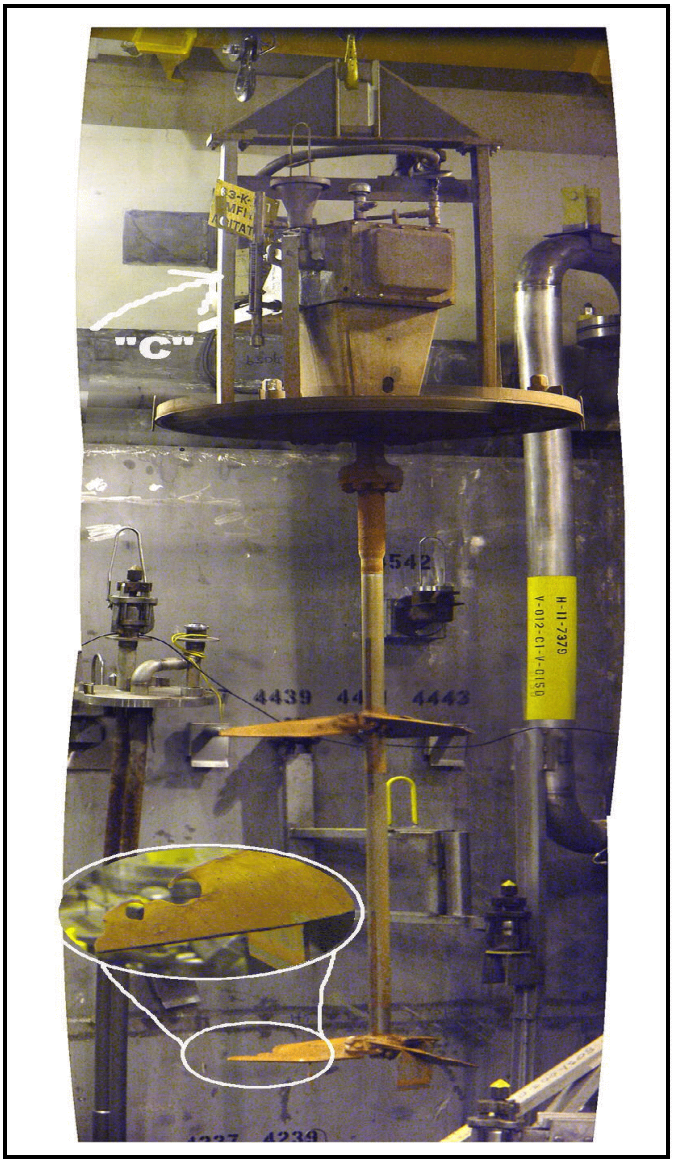

Fig.4 MFHT Agitator

Agitators: The homogeneous slurry mixture needed to make HLW glass was prepared and fed to melter using two slurry tanks, the Concentrator Feed Make-up Tank (CFMT) and the Melter Feed Hold Tank (MFHT). Homogeneity of slurry mixtures held in each tank was maintained by using commercial agitators that had been modified for remote service. Although the Vit Cell was not equipped to perform preventive maintenance on these agitators, it was possible to add oil to the agitator gear box using in-cell equipment. Radiation resistant lubricants were specified for periodic additions of oil. Generally one frame size larger than standard motors, the agitator motors were specified with a 1.15 service factor but were not radiation resistant. Both agjtators failed after five years of radioactive service. Failure mode was identical

for both agitators. Failure occurred within the flexible coupling, located between the motor and the gearbox, the metal grid holding the two mating hubs together (see Fig.4,"C"). The agitator manufacturer did indicate that grid failure occurs if the coupling is not greased periodically. When the motor housing was remotely removed from the coupling, a broken grid and hardened grease was found. As no method was available to replace the grid or the coupling, the entire agitator assembly had to be replaced. Blade wear was noticed on all blades after the agitators were removed from each tank. MFHT agitator failure occurred first because it was used on a full 24 hour cycle to keep feed slurry suspended during melter feed operations. Its blades showed the greatest amount of wear (see Fig.4 inset). Although the CFMT was used steadily, it was shut off when new batches of glass forming chemicals were being prepared.

A number of preparations had to be made so that the replacement agitators could be moved into the Vit Cell, including construction of a tipping frame used to fit the agitator assemblies through the shield door during transfer cart operation. Replacement was accomplished by bolting the agitator onto the tipping frame, placing the tipping frame onto transfer cart, and moving the transfer cart into the Vit Cell. Once inside the Vit Cell, the frame was tipped upright, allowing lubricating oil to be pumped into the agitator gear box before installation.

Electrical connections for each agitator were run through a rigid jumper with PUREX connectors. During agitator replacement, flexible jumpers were substituted for the original rigid jumpers because they are difficult to fit. Flexible jumpers also proved to be problematic because it was difficult to orient the jumper connection with the agitator. Flexible jumpers had to be made more rigid before completing assembly.

Canister Level Detection: At the beginning of radioactive operations, four different techniques were developed to ensure that each canister produced was no less than 85% full. Weight measurement and level detection were the main techniques used to confirm canister filling. Mass balance calculations based on feed depletion and glass production, and glass pour viewing also were used to verify canister filling. Of all techniques used, level detection proved to be the most effective. Canister weight measurement proved to be the least effective. Canister level detection was accomplished using the Infrared Level Detection System (ILDS). Design and radiation testing of the ILDS has been described in detail elsewhere. (1) Operating experience using the ILDS and other techniques is described here.

Canister weight measurement was derived from data generated by one of four load cells under each pour position on the canister turntable. Electronic summing of each load cells produced final canister weight. As canisters were rolled into position, movement on to and off of the weighing platform damaged the load cell assemblies, resulting in the need to make significant adjustments to achieve credible output. When it became apparent that the ILDS produced highly reliable results, canister weight measurement as a fill detection technique was abandoned.

The ILDS uses an infrared sensitive imaging radiometer (camera) mounted inside a shielded enclosure to detect areas of high temperature representing freshly poured, hot glass. Layering of glass from separate glass pours makes it possible to determine fill levels by detecting temperature differences. Level detection using the ILDS was so precise that it was possible to consistently produce canister that were 90% full. The shielded enclosure that houses the ILDS radiometer is designed to extend the life of the unit, which is about one year in continuous service. An internal (Sterling) cooler was used to maintain the detection unit at cryogenic temperatures. The ILDS units used during radioactive operations lasted up to two years with intermittent service until the cooler failed. Shielding of other radiation sensitive components was sufficient to prevent radiation alone from causing ILDS failure.

Glass Production: Several efforts were made during pre-operational testing to enhance rates of glass production. One such effort made use of a technique known as "power skewing." This involves adjusting the amount of heat generated by each of the melter's three power circuits to change internal glass (natural) circulation rates, thus increasing heat transfer and glass production. Use of the technique was abandoned after various combinations of settings tested yielded insignificant results. However, measurable increases in glass production were noted near the end of the six-year period of melter operation, independent of any active effort. This was most apparent during the last year of melter operation when glass convection patterns and temperature profiles from the two control thermocouple sets were found to be substantially different from earlier operations. Normally, temperatures toward the bottom of glass pool are the lowest, increasing steadily until the cold cap is reached. In the last year of melter operation, temperature readings from the middle of the glass pool were lowest, with higher temperatures being recorded both above and below the middle of the glass pool. This new temperature gradient suggests a circulation pattern with heating from below. Changes in glass pool temperatures and circulation patterns resulted in glass production rates increasing from 35 to 40 kg of glass per hour to 45 to 50 kg of glass per hour.

Changes in heat distribution also were noted toward the end of melter operation. Such changes in heat distribution in the glass pool are believed to be attributable, in part, to formation of a conductive sludge layer that built up over time near the bottom of the melter cavity. Modeling during formation of the sludge layer showed that localized hot spots moved and were more intense as the depth of the sludge layer increased. The first noticeable change in melter operation was temperature instability. All of the glass thermocouples in one of the thermowells changed rapidly from 50 to 75 EC, either as an increase or decrease in temperature. Rapid fluctuations (temperature excursions) caused interruptions in melter power control. They also affected all parts of melter operation, making the entire process more difficult to control.

In-cell Maintenance and Housekeeping: One of the core requirements for designing the Vit Facility was to incorporate it as a new system into existing structures and facilities. From a practical standpoint, this limited the amount of space available for constructing the Vit Cell. Although the final system design proved to be highly successful in supporting six years of radioactive operation, it restricted the ability to maintain and manage expended equipment and material inside the Vit Cell. As a result, several provisions had to be made to address the amount of expended equipment that was accumulating. These provisions included adding a maintenance station to perform simple maintenance tasks and developing a sorting and size reduction program to manage the amount of expended material resulting from routine in-cell operations more effectively. Considerable resources were dedicated to maintenance and housekeeping during radioactive operations.

SUMMARY

The WVDP is the first HLW immobilization project brought to completion in the U.S. Radioactive operations conducted in two phases over six years resulted in the immobilization of about 24 million curies of radioactive material into 275 cans of HLW glass. Continuous melter operation and 71% plant availability (86% in the first year) resulted in the production of 211 canisters made from 54 feed batches that were filled to 90%. The second phase of radioactive operations resulted in the production of 64 canisters from 15 batches of HLW feed material prepared from cleaning and flushing of the HLW tanks, cell walls, sumps, and slurry transfer lines. After the last canister of HLW was produced using the Vit System, the melter was shutdown and emptied using two evacuated canisters. These operations were completed in September 2002, marking the end of six years of successful Vit System operation and solidification of HLW at the WVDP.

REFERENCES:

1. “Vitrification: A success Story in 1997 Across the DOE Complex,” Schneider, Rowland, Rudy and Wagoner, Waste Management ‘98.

2. “Completion of the first Phase of HLW Vitrification at the West Valley Demonstration Project,” Hamel, Elliott and Valenti, Waste Management ‘99 Symposium, March 3, 1999.