High-Level Waste Storage Project Utilizes Modified SNF Dry Storage Design – 14521

Heatherly Dukes**, Joe Ebert**, Dan Meess**, Lettie Chilson**, David Kurasch**, Cynthia Dayton**, Mark Bellis*

* US DOE-WVDP

** CH2MHILL B&W West Valley, LLC

ABSTRACT

The West Valley Demonstration Project (WVDP) is preparing to relocate 278 canisters of vitrified high-level waste (HLW) from their current location inside the Main Plant Process Building (MPPB) to an outdoor pad for long-term, on-site storage. The waste was produced at the WVDP between 1996 and 2002 and was originally placed in interim storage inside the MPPB in anticipation of off-site shipment for disposal. Relocation of the canisters is now part of WVDP Phase 1 Site Decommissioning work and will enable pre-demolition activities inside the MPPB to proceed. Preparations for the on-site transfer of the canisters include fabrication of a robust storage system that includes steel canister overpacks and reinforced concrete storage casks, facility and haul path upgrades to support canister movements, and construction of an outdoor engineered storage pad for the relocated canisters. The five-pack storage system design is based on spent nuclear fuel (SNF) dry cask storage systems in use in the U.S. and abroad with modifications for long-term storage of vitrified HLW. This project will mark the first time in U.S. history that vitrified HLW will be placed in long-term outdoor passive storage.

PROJECT BACKGROUND

The West Valley Demonstration Project (WVDP) is located on the Western New York Nuclear Service Center (WNYNSC) that comprises 3,300 acres of land used for the commercial reprocessing of spent nuclear fuel. Between 1966 and 1972, commercial nuclear fuel reprocessing was conducted within the Main Plant Process Building (MPPB). In 1972, commercial nuclear fuel reprocessing ceased and was never resumed.

On October 1, 1980, President Carter signed the West Valley Demonstration Project Act (WVDP Act) that provided the roadmap for cleaning up the site. The WVDP Act authorized the DOE to demonstrate solidification of approximately 600,000 gallons of High-Level Waste (HLW) left behind at the site by the reprocessing operations. The WNYNSC is owned by the New York State Energy Research and Development Authority (NYSERDA), with DOE given temporary possession of approximately 200 acres referred to as the “Project Premises” to complete their responsibilities under the 1980 Act. Upon completion of their responsibilities under the Act, DOE will return possession of the 200 acres to NYSERDA. The following table provides the WVDP Act requirements for DOE and their current status:

WVDP Act Activity Requirement	Status
1) Solidify the high level radioactive waste by vitrification.	Complete
2) Develop containers suitable for the permanent disposal of the high level waste solidified.	Complete
3) Transport the solidified waste to an appropriate Federal repository for permanent disposal.	Incomplete – no HLW repository available
4) Dispose of low level radioactive waste and transuranic waste produced by the solidification of the HLW under the project.	In progress for part of the waste inventory
5) Decontaminate and decommission, in accordance with Nuclear Regulatory Commission (NRC) requirements, the tanks and other facilities in which the HLW was stored, the facilities used in the solidification of the waste, and any material and hardware used in connection with the project.	In progress for most of the facilities (the HLW storage tanks, the Construction and Demolition Debris Landfill and NRC-Licensed Disposal Area (NDA) are deferred until a later decision making process is completed).

A multi-year effort is underway at the West Valley Demonstration Project in Western New York to partially complete #4 and #5 of the WVDP Act which is to deactivate and demolish the MPPB and the Vitrification Facility and their surrounding infrastructure. Since the HLW vitrified canisters are located in the MPPB and there is no current repository to ship it to, the canisters must be relocated to an interim storage location. The current plan is to load the HLW canisters from the racks into casks and move the casks to an on-site, outdoor storage pad. Canister relocation is part of the Phase 1 Site Decommissioning activities being undertaken by CH2M HILL Babcock & Wilcox West Valley, LLC (CHBWV), the prime contractor to the U.S. Department of Energy at the site.

Extensive planning, design and preparations were conducted in advance of the mid-2013 startup of physical construction activities. Considerations included determining the optimum on-site location for the storage pad and evaluating the current conditions of impacted indoor and outdoor areas. Surface and subsurface soil testing was conducted to determine reinforcement requirements for underground utilities and culverts along the haul path to support conveyance of the 87-ton loaded casks. Design specification considerations included existing conditions, canister characteristics, industry best practices, regulatory requirements, and long-term safe storage configuration.

Three major activities were initiated in 2013: fabrication of HLW overpacks capable of holding five canisters each, on-site fabrication of the concrete vertical storage casks, and construction of the storage pad. Additional activities underway include MPPB facility upgrades for loading the casks and evaluation of decontamination methods and systems.

The new storage configuration will provide secure, passive storage of the HLW canisters and is fully compliant with all state and federal regulations. The storage system has a minimum design life of 50 years.

The CHBWV team is on track to initiate canister relocations in 2015, with relocation completed in 2017.

Approach Benefits

The DOE sites that have High-Level Waste and Spent Nuclear Fuel are in various phases of their missions, and in some cases, are permanently closing and disposing of their facilities. There is no permanent repository to accept these wastes.

For the West Valley Demonstration Project (WVDP) which is in the process of decommissioning the majority of their facilities, the DOE moved forward with a novel idea to store High Level Waste (HLW) Canistered Waste Forms (CWFs)[1] in clustered groups using passive dry cask storage technology. This technology was to be adapted from existing successful systems used to store Spent Nuclear Fuel (SNF) from operating electric generating utilities. This approach offers DOE the potential to provide substantive long-term and permanent system benefits and savings. At the same time, it may diminish and in some cases negate the purpose and value of some previously planned actions that were established more than a decade earlier when it was envisioned that HLW CWFs would be stored and later shipped individually to the federal repository.

The HLW canister overpack approach offers a number of advantages, most contributing to reduced costs:

- A mature commercial industry provides multi-purpose canisters (spent fuel overpacks) and storage casks as purchased services to nuclear power generating stations worldwide with strong competition between multiple qualified vendors. There are accepted, reviewed, standard designs with known costs and schedules for implementation.
- Design, fabrication and licensing activities meet high nuclear quality assurance standards, such as those required by DOE for HLW related systems.
- NRC Type-B licensed shipping casks exist and interface with each vendor's multi-purpose canisters. As a result, overpacking multiple HLW canisters into vendor multi-purpose canisters creates a transportation ready configuration for the WVDP with enhanced confidence for future shipability and a shift of responsibility for the technical interface for transportation from DOE to an individual vendor. Existing Certificate of Compliance – only minor revision needed for HLW.
- Storage is dry, passive, safe and robust and requires little surveillance and maintenance. The need for buildings for storage or transportation packaging is eliminated while maintaining a robust, secure, low dose (<1 mrem/hr @1 m) configuration.

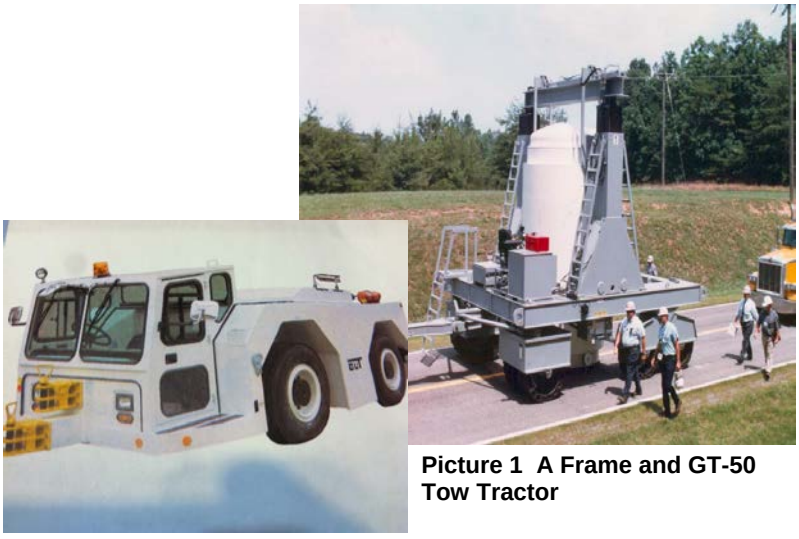
[1] In this document, the terms "HLW Canistered Waste Form" and "HLW Canister" are synonymous and used interchangeably.

- Multi-packaging substantially reduces handling and shipping costs since it handles five canisters at a time with a single package lift per cask at shipment and the receiver site.
- Material compatibility and sealed configuration maintain HLW Canister compliance condition.
- Multi-purpose canister overpacks eliminate risk of cross-contamination for the transport cask and the storage cask (cleaner system for future decommission).
- The individual WVDP HLW canisters will be fully retrievable from the multi-purpose canister overpacks via handling operations in an appropriately shielded facility.

Technical approach

The West Valley Demonstration Project (WVDP) is preparing to relocate 278 canisters of vitrified high-level waste (HLW) from their current location inside the Main Plant Process Building (MPPB) to an outdoor pad for long-term, on-site storage. Relocation of the canisters is now part of WVDP Phase 1 Site Decommissioning work and will enable pre-demolition activities inside the MPPB to proceed. The technical approach was designed to maximize available “off-the-shelf” technologies and methods to minimize design efforts, risk and overall cost and schedule impacts.

Preparations for the on-site transfer of the canisters include fabrication of a robust storage system that includes stainless steel canister overpacks and reinforced, steel-lined concrete storage casks, facility and haul path upgrades to support canister movements, and construction of an outdoor engineered storage pad for the relocated canisters. The five-pack storage system design is based on spent nuclear fuel (SNF) dry cask storage systems in use in the U.S. and abroad with modifications for long-term storage of vitrified HLW. This project will mark the first time in U.S. history that vitrified HLW will be placed in long-term outdoor passive storage. The following sections describe the main elements of the technical approach currently being implemented at the West Valley site.



Picture 1 A Frame and GT-50 Tow Tractor

Attachment A provides a flow diagram of the cask path through the Load In/Load Out (LILO) Building and the Main Plant Processing Building (MPPB), which includes the Equipment Decontamination Room (EDR), the Chemical Process Cell (CPC) and the tunnel that connects the EDR and CPC. The process for loading begins with a storage cask, loaded with an overpack, being provided at the LILO Facility via a Vertical Cask Transporter powered by a tow tractor. Picture 1 depicts a typical Vertical Cask Transporter (A Frame) and tow tractor (GT-50).

An In-Plant Cask Handling Unit is used to pick up the empty storage cask from outside the LILO Building and move it indoors and through the LILO Building, the EDR, and to the rail cart located in the tunnel. See Figure 1 for a depiction of the TL220 which is the selected In-Plant Cask Handling Unit. In the EDR tunnel, the TL220 places the storage cask onto a rail cart which takes the cask into the CPC where a crane loads five canisters into the overpack/cask. Prior to loading, the canisters will be decontaminated and surveyed.

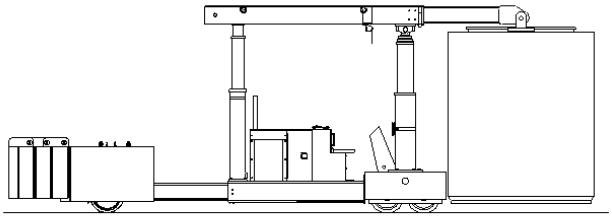
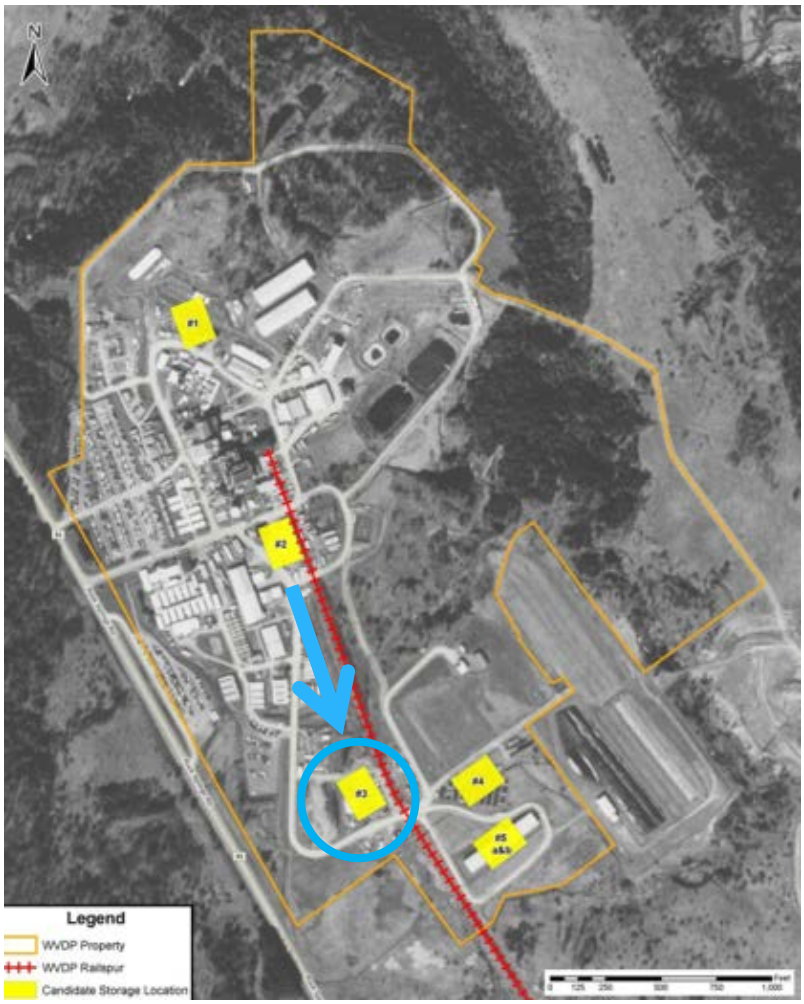


Figure 1 The TL220 is the West Valley In-Plant Cask Handling Unit

After loading, the rail cart brings the cask back out of the CPC to the EDR where the overpack lid is added and the TL220 lifts it and transports it to the LILO area to a welding station to hermetically weld the lid and seal the overpack. After the storage cask lid is installed and decontaminated (if necessary), the TL220 transports the cask outdoors where the Vertical Cask Transporter (picture 1) takes the cask to the new interim storage location which is an engineered pad located on the south plateau of the site. The status of implementing this approach is provided in the following subsections.



Picture 2 Overhead view of pathway from the MPPB to the storage pad site

Interim Storage Site Selection and Validation

The HLW canister relocation team developed and applied a site selection screening process to identify potential siting alternatives on the WVDP premises for storage of the vitrified HLW canisters (candidate sites denoted in yellow in Picture 2). Five candidate sites were identified for further evaluation after eliminating (excluding) certain areas on the WVDP premises based on the defined screening

criteria. Areas excluded from consideration included active on-site work areas, wetlands and wetland buffer areas, locations within the 100-year floodplain, and an exclusion zone area encompassing land located within a 100-meter “setback” from the closest public access road (a controlled area boundary).

A set of 21 different siting evaluation criteria were developed and weighting factors were assigned to each. These evaluation criteria and the weighting factors were used to develop a siting alternatives ranking matrix that the team used as a tool for “scoring” each candidate site with respect to each evaluation criterion. After scores were assigned and weighted for each of the 21 criteria, values for each site were summed to produce a single overall value.

The candidate site having the highest total ranked value was found to be in Waste Management Area (WMA) #6, which is located along the west side of the existing rail spur and on the north side of the access road to the RTS Drum Cell area. Besides providing easy access to the rail spur, it also was located away from the major decommissioning activities and contamination areas.

HLW System Description

The HLW system represents the means to transport and store the HLW canisters at their new Interim Storage location. The HLW System includes the cask storage pad, the HLW canister overpacks, the storage casks, and the means to transport the casks. Both vertical and horizontal storage systems were considered for use. A “best value” major procurement process was conducted which culminated in the NAC International vertical storage system being selected. By contract, NAC International was responsible for providing the transport systems, the MPC overpacks, the overpack lid welding system, the vertical storage casks, and the design for the cask storage pad. The construction of the cask storage pad was competitively bid and subsequently awarded to Butler Construction Company. The following sub-sections describe the cask storage pad, the MPC overpacks, and the vertical storage casks in more detail.

Picture 3 A typical ISFSI for spent fuel dry storage.

HLW Cask Storage Pad

The West Valley cask storage pad design is based on the commercial nuclear design for Independent Spent Fuel Storage Installation (ISFSI). Picture 3 shows a typical ISFSI pad and cask configuration for spent fuel dry storage. NAC International utilized Enercon to design the West Valley HLW cask storage pad.

The West Valley pad features an at-grade design capable of supporting the weight of 57 loaded storage casks (each weighing 87 tons). The pad itself is 144' long and 110' wide. An adjoining pad structure includes an approach ramp that allows the transporter to take the cask onto the pad and place it (eliminates critical lifts). The apron is 170' long and 98' wide. In addition to the apron, the pad has two engineered crane pads that are approximately 26' wide by 144' long. The pad and related structures were designed to support canister storage casks for a minimum of 50 years. Figure 2 is a schematic of the West Valley storage pad.

Picture 4 Completed excavation of the storage pad (up to 15' deep)

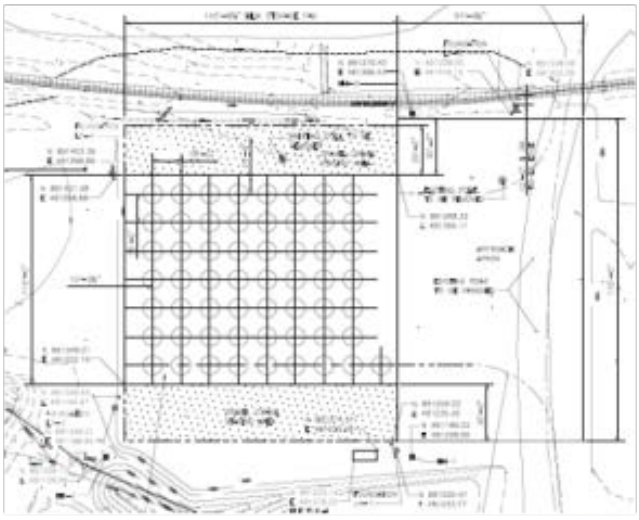


Figure 2 Drawing layout of the HLW cask storage pad

Prior to construction, temporary storm water barriers were installed to minimize environmental impacts resulting from area runoff which remained throughout the duration of the construction activities. Permanent drainage features located north and west of the pad and finished grading are designed to accommodate the rainwater discharge from a 100-year storm event.

For the construction of the pad, up to 15 feet of material was excavated to reach soils that met the required parameters determined via geotechnical analysis. The excavated pad area was backfilled first with 2,660 tons of granular fill and then with 8,250 tons of permeable fill. Once the compaction was completed the three foot thick pad itself was constructed with 133 tons of rebar for the bottom and top mats and the placement of 1,800 cubic yards of concrete. See pictures 4, 5 and 6 for the pad construction.

Once the pad was constructed, the apron area was excavated and 4,585 tons of fill was placed, 110 tons of rebar installed, and ~900 cubic yards of concrete placed. A grounding system was also installed for grounding the pad and associated electrical components needed for lighting and security features. See picture 7 for the completed storage pad.

The storage pad is located approximately 0.5 mile from the Main Plant. The haul road to the plant was evaluated using geotechnical and structural analyses with road modifications scheduled in early FY15.

Picture 5 A total of 243 tons of rebar was installed for the storage pad and apron.

Picture 6 Construction of the main storage pad required approximately 1,800 cubic yards of concrete.

HLW Canister Overpacks

The WVDP-HLW overpack includes a 5 cell basket, which can hold up to 5 WVDP High-Level Waste canisters. The overpack is conceptually the same as what is commonly known as a Multi-Purpose Canister (MPC) or Transportable Storage Canister (TSC) for spent nuclear fuel (SNF) storage. Once loaded, the overpack lid will be welded and placed in storage in the Vertical Storage Casks. The design of the WVDP HLW overpack will allow WVDP to load it directly into a NAC-STC shipping cask. Design characteristics of the canisters include:

- Stainless steel 304/304L
- 3/8” walls
- 2” bottom plate
- 4” thick welded lid
- 70.5” diameter, 126” tall
- Unloaded weight: 14,500 pounds

Picture 7 The constructed storage pad.

Vertical Storage Casks

The WVDP High-Level Waste Vertical Storage Casks (VSC) are modified from an existing NAC SNF storage design. The WVDP HLW VSC is based on the NAC-MPC Vertical Concrete Cask Storage component design currently approved by the NRC for use under the General License provisions of 10CFR72, Subpart K, CoC 72-1025. The only noticeable difference is the VSC has no air inlet or outlet openings as none are required to maintain the required thermal performance. This totally enclosed design also eliminates the potential dose rate "hot-spots" typical of a vented system and provides greater protection for the overpack, and its contents, across a wide range of external threats. Additional advantages of the WVDP VSC design are that it requires no grounding cables, connections or mats and requires no temperature monitoring or daily walk around inspections to ensure air vents are unobstructed. The VSCs are virtually maintenance-free and are designed for a minimum 50-year lifetime.

Picture 8 The first group of 8 VSCs was fabricated in 2013.

VSC components (liner, lid, rebar) will be shipped to WVDP where the casks will be constructed on-site. To date, eight VSC's have been completed. See picture 8 for the first group of completed VSCs.

VSC Specific Physical Characteristics

- 4.01 meters (161") tall with lifting lugs
- 3.05 meters (120") diameter, 0.5 meter (20") concrete with 10.16 cm (4") thick steel liner
- Unloaded weight: 59.6 ton (133,500 pounds)

Canister Decontamination

The first WVDP production HLW Canistered Waste Form was made in 1996 and the last in 2002. During this time, completed canisters were placed into open rack storage positions in the High Level Waste Interim Storage Facility (HLWISF). The HLWISF is the former Chemical Processing Cell of the Main Plant Process Building at the West Valley site. WVDP HLW Canisters are stored in a double tier with one positioned on top of another. In this configuration, the upper canisters extend just over 3 feet above the uppermost part of the open rack assembly. Canisters are separated laterally from adjacent canisters by about 2 inches. Attachment B illustrates this arrangement.

Prior to placement into an open rack position in the HLWISF, the exterior surfaces of each Canistered Waste Form were decontaminated in the Vitrification Cell using cerium nitrate in a

nitric acid solution. At that time, the levels of non-fixed contamination on the exterior of each HLW CWF were confirmed to have been at or below specified levels. The non-fixed contamination on a wiping sample did not exceed 22,000 disintegrations-per-minute (dpm) per 100 cm^2 for both beta- and gamma-emitting radionuclides and 2,200 dpm per 100 cm^2 for alpha-emitting radionuclides. Multiple wiping samples per HLW canister were taken, in areas just over 500 cm^2 each, using moderate pressure.

During more than 10 years of such storage, airborne contamination has deposited on the exterior surfaces of the canisters as a result of various activities.

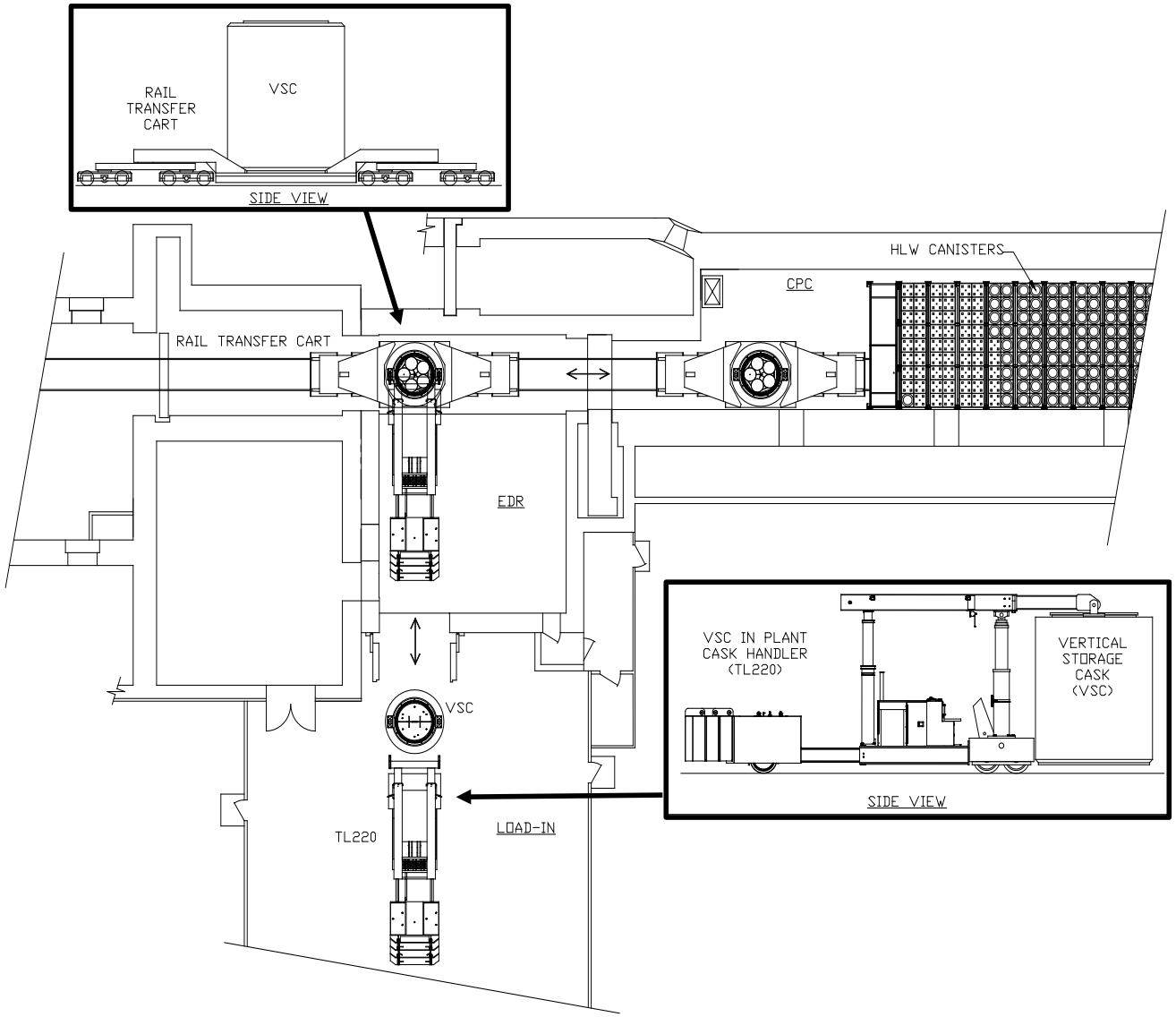
A series of HLW canister survey data indicates that contamination levels on the tops of the exposed HLW Canisters exceeded 22,000 disintegrations per minute (dpm) per 100 cm2 for both beta- and gamma-emitting radionuclides and 2,200 dpm per 100 cm2 for alpha-emitting radionuclides. In total, six different decontamination test evolutions were conducted over the course of about 3 months.[2] These tests involved actual production WVDP HLW canisters and involved decontaminating areas of their flat lids and sides. A smear sample was taken before each decontamination action to establish a reference starting point and thus gauge the relative effectiveness of each applied method. The testing included dry brush vacuuming, wet and dry wiping, and use of decontamination agent Simple Green®. In addition to decontamination testing for canisters, a similar series of tests was initially performed for the grapples. The technologies tested provided favorable decontamination capabilities and additional decontamination testing is being pursued. The additional testing is designed to improve decontamination factor effectiveness for technologies already tested.

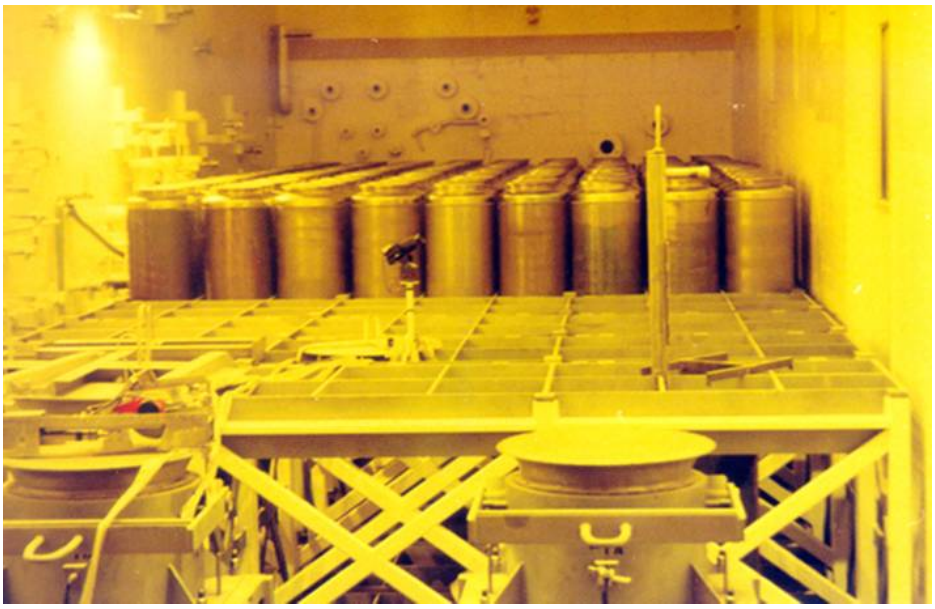
Schedule

The current schedule is to complete the long-lead procurements for the transporters and welding system by the end of FY14. Final facility modifications and training will complete in early FY15 to allow startup. The overpacks and storage casks will continue to be fabricated as annual budgets are approved. West Valley currently anticipates having all HLW canisters packaged and relocated in 2017.

[2] Cerium nitrate is not being tested since the spent solution can no longer be fed back into the vitrification process and now produces a hazardous waste that would need to be dispositioned.

Attachment A- Flowchart of Cask Movement Into the Chemical Process Cell





WVDP HLW Canisters in Racks in former CPC, looking South