THE DESIGN AND CONSTRUCTION OF THE WEST VALLEY DEMONSTRATION PROJECT VITRIFICATION FACILITY

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Abstract

The Vitrification Facility (VF) at the West Valley Demonstration Project (WVDP) has been designed to solidify high-level nuclear waste (HLW) stored at West Valley into a borosilicate glass. The final HLW form to be solidified will consist of a sludge settled at the bottom of the HLW Tank 8D-2, a cesium-loaded zeolite dumped onto the bottom of HLW storage Tank 8D-1, and THOREX acid waste stored in Tank 8D-4.

These three waste streams will be blended together as a single HLW slurry at the tank farm and fed to the VF via the Sludge Mobilization System (SMS). In the VF they will be mixed with glass formers (chemicals necessary for the formation of the borosilicate glass), fed into the melter, and poured as a glass stream into stainless steel canisters. Approximately 300 canisters of high-level waste will be produced during the solidification campaign.

The VF is a concrete structure with a Butler-type building shell. The facility's concrete structure has been designed as a canyon-remote cell and will house all of the main process equipment. Surrounding the cell will be a network of utility-piping and electrical-supply lines to operate the facility. Adjacent to the VF will be a chemical-mixing building known as the Cold Chemical Facility where the solid- and liquid-feed chemicals will be blended together and fed to the vitrification cell to ensure a consistent waste form.

In addition to the main-process line, the vitrification cell will also contain the feed-stream vessels and off-gas system servicing the melter, the primary filtration system for the cell, an equipment decontamination system, and various handling equipment. The cell is a seismic-containment boundary and as such has been dynamically analyzed for a design-basis earthquake.

This paper discusses the design basis and the procurement/construction status for the VF.

INTRODUCTION

The VF at the WVDP is being designed to solidify HLW stored at West Valley into borosilicate glass. Three high-level waste streams stored at West Valley will be used to make up the glass. These are: 1) approximately 2.3 million litres (600 thousand gallons) of aqueous-based liquid containing about 39 weight percent sodium nitrate and about 16 million curies of cesium-137 (this material is referred to as supernatant and is stored in Tank 8D-2); 2) sludge at the bottom of Tank 8D-2 (the sludge layer is about 508 mm (20 inches) deep and contains approximately 16 million curies of Strontium-90); and 3) thorium nitrate acidic waste stored in a stainless steel tank in the same general vicinity as Tank 8D-2. This tank (8D-4) contains approximately 14 curies of thorium.

HIGH-LEVEL WASTE PROCESSING

The Supernatant Treatment System

The supernatant is currently being passed through a series of ion exchange beds in a new facility known as the Supernatant Treatment System (STS). This system is made up of four ion exchange columns which have been installed inside spare Tank 8D-1. In this facility, the cesium is stripped from the sodium-nitrate liquid and remains on the zeolite ion exchange media. The decontaminated supernatant is further processed and solidified into a cement form. The spent zeolite (cesium-loaded) ion exchange media is being dumped onto the bottom of Tank 8D-1 where it will accumulate until all of the supernatant has been processed.

Sludge Washing

After all the supernatant is processed, the sludge in the bottom of the high-level waste tank will be washed by the following procedure: 1) A total of 757 m^3 (200 thousand gallons) of water will be added to the tank; 2) The sludge will then be mobilized using five large pumps; and 3) The sludge will be allowed to settle for approximately 40 days and then this liquid will be decanted through the STS to remove the interstitial supernatant and soluble solids precipitated in the sludge. It is currently anticipated that three washes of this type will sufficiently dilute the nitrates in the supernatant and the sulfates in the sludge to acceptable levels for vitrification.

Once the nitrates and sulfates have been removed to sufficiently low levels, the three waste streams will be pumped to a single tank and blended together. It should be noted that the supernatant waste stream will have been replaced by a cesium-loaded zeolite waste stream. The tank used for this blending will be the original 21.3 m (70-foot) diameter, high-level waste tank (8D-2). After blending and grinding, the high-level waste will be slurry pumped using a water carrier to the VF.

The Design and Construction of the Vitrification Facility

The VF is being designed to include a shielded, canyon-remote, process cell and to house the melter and its support equipment. The artists rendition of the facility shown in Fig.1 includes the salient portions of this building.

__Component Test Stand (CTS)__

Between 1981 and 1984, a building known as the CTS was designed and constructed. This facility included the melter, canister turntable, concentrator feed makeup tank (CFMT), and several other key components of the vitrification process line. The purpose of the facility was to test these major components and verify their capability to perform to the criteria levels necessary for waste qualification. The floor of the CTS was designed such that it could be converted to a remote-canyon floor (including a pit for the primary process equipment) in the event a future decision were made to locate the final facility at the same location. The decision to convert the CTS to a permanent facility was made in 1985. Since 1986, work has progressed to make this conversion. At the same time, testing has been progressing in the same facility. The final test prior to completion of the facility conversion is scheduled for late in 1989. At that time, it is estimated that the construction work will be too extensive for the next 2 years to permit any testing. At the end of the construction period, a 1-year test will be performed to qualify the overall facility. Hot operation of the facility is scheduled for October 1992.

Architect-engineering services for this facility are being provided by Ebasco Services, Inc. Their scope includes design of the confinement/shield boundary; all services, utilities, and enclosures outside of the confinement/shield boundary; and total design of the cold chemical feed building and its associated equipment. The confinement/shield boundary design is complete. This boundary is basically a concrete structure. The walls are 609.60 mm (24 inches) thick in those areas required to withstand a design-basis earthquake and range up to 1219 mm (4-foot) thick where necessary for shielding purposes. The primary cell dimensions are 17.07 m (56-foot) long by 10.67 m (35-foot) wide by 13.40 m (44-foot) high. About 4 percent of the cell floor is further recessed an additional 4 267.20 mm (14 feet) for the process pit. The confinement boundary also houses the cell ventilation system, transfer tunnel for transferring the vitrified waste to an interim storage facility, and the maintenance room for the cell cranes. These facilities add 10.97 m (36 feet) more to the length of the confinement boundary. A dynamic analysis for the site design-basis earthquake was performed for this boundary.

The construction of the confinement/shield boundary is scheduled to begin in March of 1989.

__The Cold Chemical Facility__

The Cold Chemical Facility is a subsystem of the VF. It will be housed in a 18.14 m (59.5 feet) long, by 10.36 m (34 feet) wide, by 10.97 m (36 feet) high building directly adjacent to the main VF. The primary function of the facility is to blend and feed the nonradioactive glass formers to the melter process line to permit the manufacture of a qualified

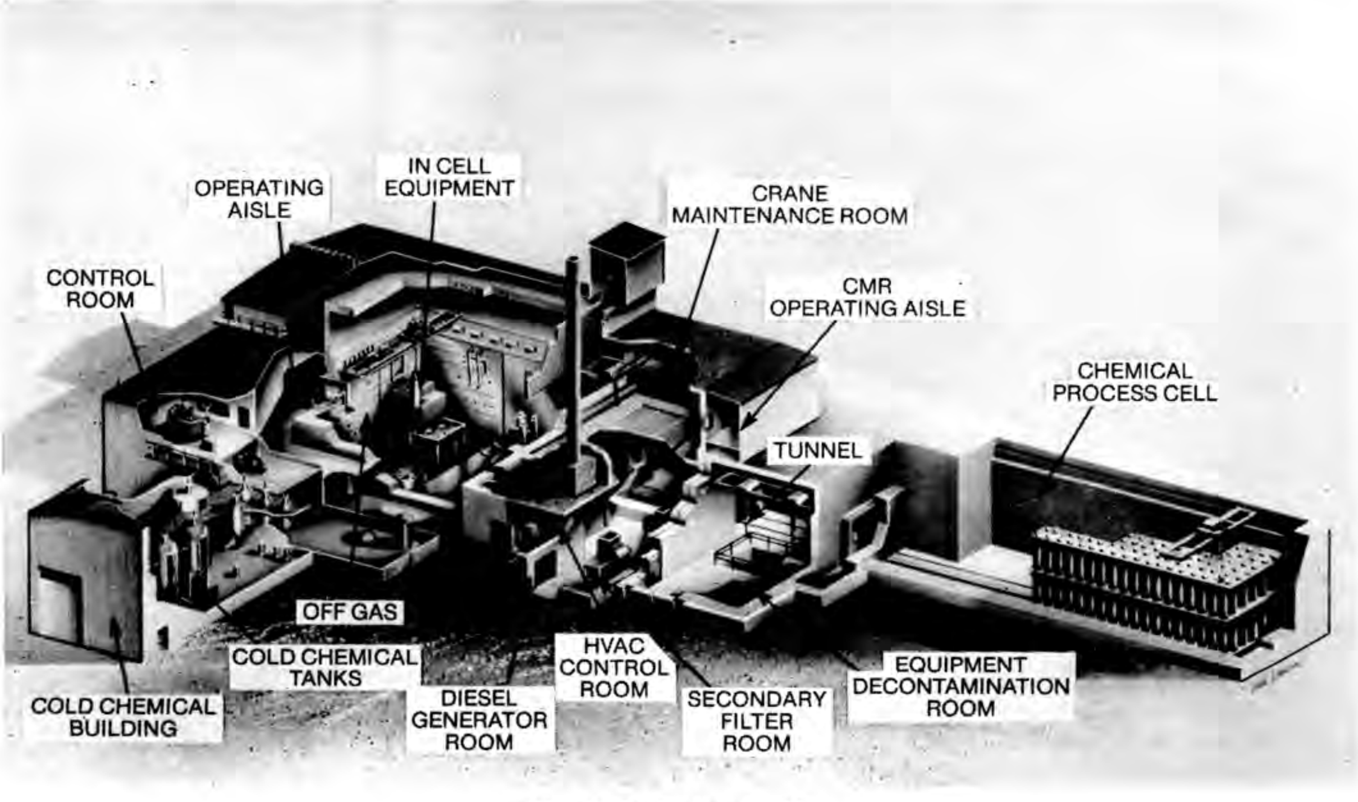

Fig. 1. Vitrification Facility.

waste form glass. In order to perform this function, the facility will contain two large main tanks where a batch of chemicals can be blended. If a batch is off-specification, another batch can be blended in the second tank without emptying the original tank. A smaller shim tank is also in the facility in order to make smaller changes to the batch-chemical composition if that is found to be necessary. Numerous pieces of chemical handling, weighing, and measuring equipment are necessary for this chemical makeup and are also housed in the building. Because of the limited space in the vicinity of the VF, only small amounts of bulk chemical storage can be accommodated in the Cold Chemical Facility.

The Cold Chemical Decontamination System

The Cold Chemical Facility will also house another small subsystem for the VF -- the chemical decontamination system. It is anticipated that the equipment coming from the main cell will require decontamination prior to contact maintenance. Tankage will be provided in the Cold Chemical Facility to make up acid or caustic wash solutions and to pump those solutions to the most probable locations for equipment decontamination including the crane maintenance room. The design of the Cold Chemical Facility is complete. The construction of the cold chemical building will be completed as a portion of the same contract which will build the seismic boundary of the vitrification cell. Even though the Cold Chemical Facility does not require a seismic design, proximity of the seismic facilities makes this single construction contract method beneficial to the project. In a like manner, the mechanical and piping portion of this facility is planned to be combined with similar work on the main facility in a future contract. The tankage for the Cold Chemical Facility has been purchased. As fabrication is completed, the tanks are being delivered to the site.

Vitrification Facility Modifications

The ex-cell portion of this work involves the modification of the CTS structure to provide the necessary room sizes and to isolate the three working elevations in the building from each other. It also provides all piping, electrical power, and instrumentation services necessary to operate the VF. Since this portion of the facility is outside the confinement boundary, no seismic-design requirement was imposed. Standard inflow ventilation philosophy developed for nuclear facilities was used. To the extent practical, utility instrumentation and control has been modularized into "instrument racks" so that these modules can be prefabricated to minimize on-site work. The original CTS operation used this type of instrument racks and many of these original racks will be modified and used in the final facility. The design of the ex-cell is currently being finalized. Construction work on this portion of the facility is scheduled to begin in March of 1990.

Vitrification Facility Hot Cell

There are seven large block-outs in the wall of the main cell which are called "wall modules". The majority of penetrations through the cell boundary occur in these wall modules. The design of the modules was done by

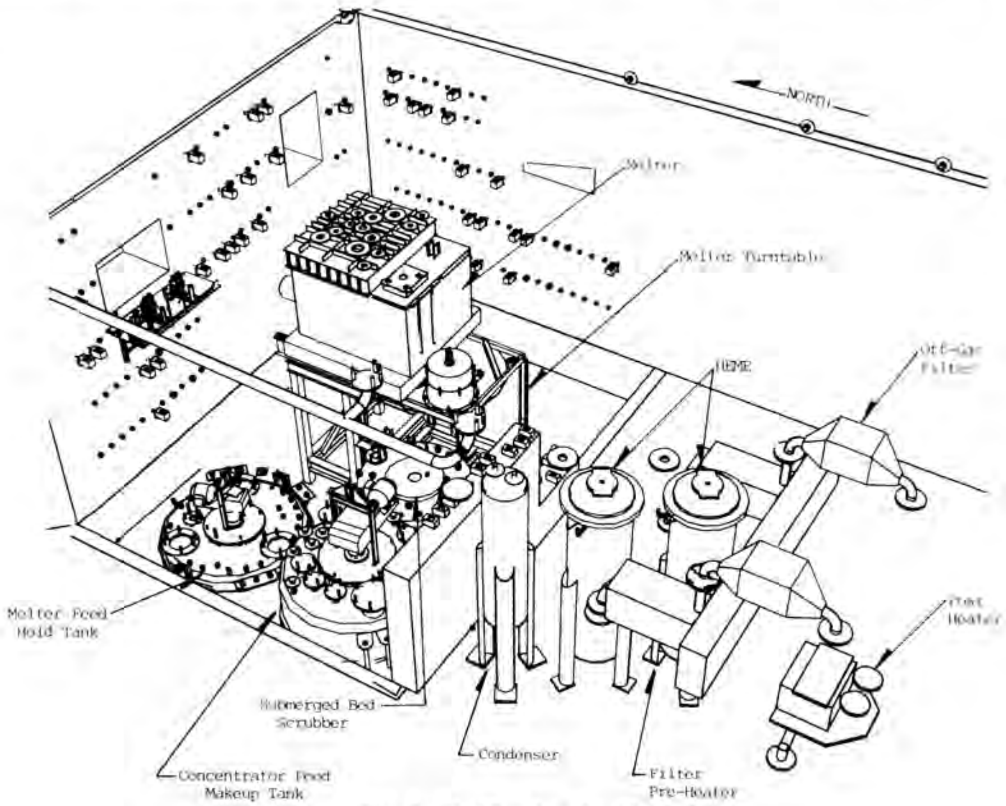

Fig. 2. Vitrification Facility.

Westinghouse Hanford Company (WHC) and the seismic conformance of the module design was confirmed by Ebasco Services. This methodology of using wall modules permitted design of the main building to progress while the details of the process system were still being finalized. It also permits a large amount of prefabrication at an off-site location so as to minimize the site congestion during construction. Over 300 penetrations including piping, electrical conduit, utility plugs, windows, and manipulator ports are incorporated into these seven wall modules. The design of the wall modules has been completed, a contract has been placed for their manufacture, and the modules are currently being built.

The in-cell portion of this facility is intimately associated with the vitrification process and consequently the design of the in-cell was done by Battelle -- Pacific Northwest Laboratories (PNL). As was mentioned previously, many of the major pieces of the in-cell equipment were installed as part of the CTS facility prior to the end of 1984. Fig.2 shows the main process system schematic. Since 1984, the most significant piece of process equipment to be added to the system is a CFMT which was installed in early 1988. The in-cell, off-gas system is the largest support subsystem housed within the cell. This subsystem has been defined and a design/build purchase is planned for placement in March of 1989. The two in-cell cranes have recently been completed and one of them has been installed. The other crane is being stored for placement later in the construction sequence. The shield doors for the entire facility are also nearing the end of the fabrication cycle. The sampling equipment necessary to take samples from the feed tank and the CFMT is scheduled to have fabrication complete by March of 1989. The primary High Efficiency Particulate Absolute (HEPA) cell filters have been fully specified and procurement of these filter housings has been started. The design of the maintenance station and canister decontamination stations is near the stage where a final design and build procurement package can be produced. By far, the largest design effort of the in-cell work during the past year has been the design of the in-cell jumpers. The cell is rather wide for a chemical processing cell and is very short for a cell housing this much equipment. Consequently, the process piping and electrical jumpers are rather complicated. Fig.3 shows the plan view of the cell when the jumpers are installed. A large amount of effort was expended to ensure that the jumpers were designed so that they could be installed without jumper-to-jumper interferences and were nested in such a way that they could be removed and reinstalled in the event of a failure. That effort is now being completed.

CONCLUSION

The VF at the WVDP is the largest and primary facility designed for the successful vitrification of the high-level wastes stored at the site. The design of the facility is scheduled for completion in June 1989. The construction of the final phases of the facility are scheduled to start January 1989. The procurement of the long-lead components is under way and several of those components have begun arriving at the site.

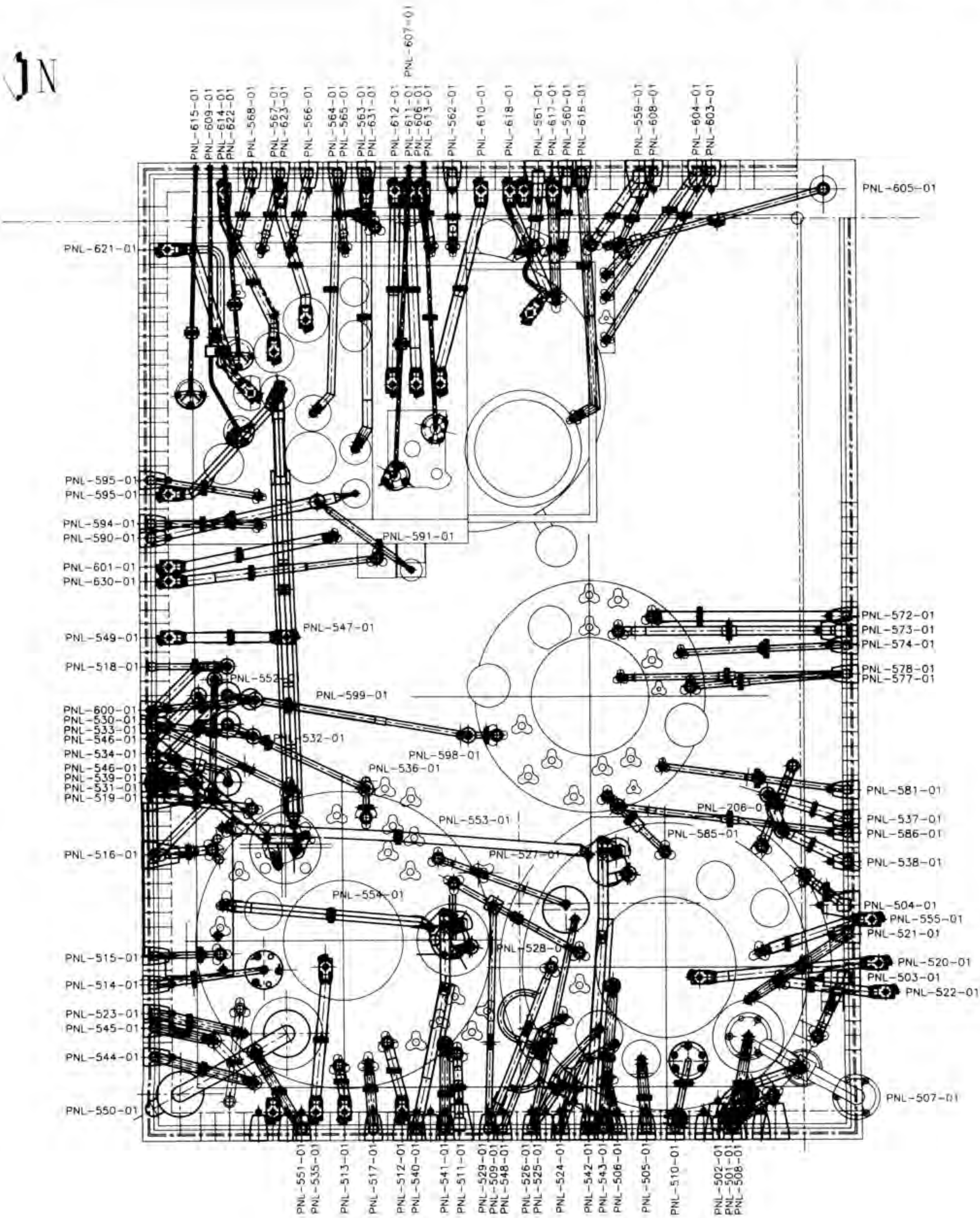

Fig. 3. Jumpers Feed System.