DESIGN OF A HIGH-LEVEL WASTE PRETREATMENT PROCESS
FOR THE PURPOSE OF VITRIFICATION

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ABSTRACT

The initial steps in solidifying the high-level nuclear waste presently stored at the West Valley Demonstration Project (WVDP) is to pretreat the waste to facilitate its removal from a complex underground storage tank, reduce the ultimate volume of its terminal form, and to optimize waste properties and composition for further processing. The two phase PUREX neutralized waste will be pretreated prior to its solidification in borosilicate glass. The liquid PUREX waste referred to as the supernatant, will be pretreated by a system to separate nonradioactive salts from radiocesium dissolved in the supernatant, reducing the ultimate waste volume by a factor of six. The radiocesium is ion exchanged using a chabazite type zeolite for implementation. This cesium loaded zeolite will be mixed with the PUREX sludge waste and a THOREX waste fed to the Slurry-Fed Ceramic Melter (SFCM) for vitrification. The nonradioactive salts will be solidified in cement and disposed of as Low-Level Waste (LLW). Prior to adding the loaded zeolite, the remaining sludge phase of the PUREX waste will be washed with process recycle water to both remove interstitial salts within the sludge layer and redissolve salt crystals on the tank floor. These wash solutions will also be treated through the Supernatant Treatment System (STS). The acidic THOREX waste stored in a separate smaller underground tank must be pretreated for both its removal and optimum blending with the sludge and zeolite wastes. This paper discusses the waste pretreatment process and the design approach of making use of existing technology and on-site facilities. Emphasis is placed on STS process design and the construction approach adopted to install the process in the existing Tank Farm. The equipment and method to create new tank openings in Tank 8D-2 is also presented.

BACKGROUND

West Valley Nuclear Services Co., Inc. (WVNS), a wholly owned subsidiary of Westinghouse Electric Corp., is implementing the WVDP for the US Department of Energy (DOE) to remove the high-level nuclear waste from underground storage tanks and solidify it in a form suitable for transportation to a federal repository for final disposal. One of the major tasks of the WVDP is to remove the wastes from the storage tanks, pretreat the wastes for solidification, deliver the waste to the process cell for vitrification, and ultimately decontaminate the storage tanks to a level that will allow in-place entombment.

The history of the West Valley site and the approach taken by WVNS to carry out the Project authorized by the "West Valley Demonstration Project Act" has been described in various papers.[1,2,3] The principal High-Level Waste (HLW) stored in a storage tank, referred to as Tank 8D-2, resulted from the commercial reprocessing of reactor fuels from 1966 to 1972 using the PUREX separation process.[4,5] The West Valley storage Tanks 8D-2 and 8D-1 have a complex internal structure at the bottom of the tank which extends to the outer tank roof. This is a major constraint to both tank modifications and waste removal. The tank is fully contained within a two foot thick reinforced concrete vault. The 8D-2 PUREX waste consists of a nonsoluble precipitate (sludge) and an alkaline liquid (supernatant). A Supernatant Treatment System (STS) is used to reduce the volume of high-level radioactive waste that will be solidified into borosilicate glass by removing certain radionuclides, primarily cesium, from the large amount of dissolved salts from the supernatant phase significantly reduces the amount of West Valley glass generated for repository disposal. The 8D-1 tank is presently being modified and will be used to house the STS process equipment.

After the supernatant is removed and treated, the sludge is washed with water to remove interstitial salts within the sludge and redissolve a sodium sulfate salt layer at the bottom of the tank. Washing the sludge minimizes the salt concentration of the waste feed to the SFCM to help assure that the glass produced from waste vitrification will be of the highest quality.

The sludge layer will be hydraulically resuspended in-tank using long shafted centrifugal pumps of the type used at the Savannah River Plant (SRP) for HLW processing and removal. As the sludge is resuspended in water, a separate long shafted centrifugal pump is used to transport the slurry to the Vitrification Process Cell. The cesium loaded zeolite produced from the STS will be stored in Tank 8D-1. For its removal, the zeolite will be slurried from this tank in the same manner as the sludge. The THOREX acid waste resulting from the reprocessing of a thorium-enriched uranium fuel is stored in a separate smaller underground storage tank called 8D-4. Although originally an acid solution, evaporation has resulted in crystalization of some of the thorium as a hydrated thorium nitrate. These solids will be redissolved for removal and mixed with the sludge and zeolite providing a consistent melter feed and relative uniform waste form.

Supernatant Pretreatment Process

The volume of borosilicate glass formed can be reduced by a factor of approximately six if the nonradioactive salt species contained in the supernatant can be separated from the radioactive species, namely cesium-137, dissolved in the supernatant. The separation process will decontaminate the supernatant to a level which will permit the decontaminated supernatant to be solidified in a specially formulated cement as LLW by the Cement Solidification System (CSS).

In-depth evaluation of many supernatant separation process efficiencies and their compatibility with the WVDP objectives were made before the ion exchange process using a chabazite zeolite was adopted. Part of the process evaluation consisted of in-cell verification tests performed at West Valley with actual supernatant from Tank 8D-2 to insure the process was valid.

Based on existing technology from other DOE sites, Hanford, SRP and experiments conducted at Battelle Pacific Northwest Laboratories (PNL) with simulated supernatant, several potential processes were examined. The process had to provide a cesium decontamination factor of at least 1,000, have acceptable safety and environmental effects, and have no detrimental impact on the Vitrification System and/or the Liquid Waste Treatment System (LWTS). After evaluating ion exchange media materials currently available in the market, and using experimental data with process constraints taken into account (e.g., pH level, temperature, pressure, flow rate, etc.), the inorganic ion exchanger IE-96 (Linde Ionsiv IE-96 zeolite) was chosen for cesium recovery due to its high exchange capacity, and decontamination factor (DF) values, and because it can easily be incorporated with glass formers into borosilicate glass. The zeolite (IE-96) is an alkali metal sodium alumina silicate of the chabazite structure ($Na_2O \cdot Al_2O_3 \cdot SiO_2$) in the mixed ionic form of Na^+, Mg^{++}, Ca^{++}. On the laboratory scale IE-96 has given DFs in excess of 10,000.

Table 1 lists the supernatant processes examined for treating the West Valley supernatant. A brief description of each of the processes examined and their limitations can be found in Reference 6. In addition to verifying the decontamination results obtained with simulated supernatant, the actual supernatant testing has been used to generate data required for full scale design. A description of the West Valley in-cell tests and their results can be found in Reference 7.

Supernatant Treatment System

Figure 1 illustrates the process flow for treating the supernatant. 2.0×10^6 litres of supernatant in Tank 8D-2 will be decanted from the sludge layer by a submersible pump suspended in Tank 8D-2 and transferred some 30 metres to the STS process through a buried double contained stainless steel pipe. The pump suction is kept above the sludge layer to minimize the potential for sludge pickup during operation. The raw supernatant at approximately 7 curies/litre is fed to a below-grade concrete and steel shield structure erected on top of the existing 8D-1 vault. A below-grade Valve Aisle located between STS support building and Tank 8D-1, which is part of the shield structure, is used to remotely operate valves and related instrumentation for controlling the STS process. The STS is remotely operated via valves and block connectors in the Valve Aisle. Monitoring and process control is maintained from the STS control room. The control panel provides for automatic control through a Programmable Logic Controller (PLC). The PLC will step the operators through the sequencing and checking conditions and will alarm on valve failure or operator error. All electric motors and solenoid operated valves in the system can be operated in the automatic or manual mode. Various electrical interlocks ensure safe operation during STS processing. Figure 2 gives a schematic representation of the STS building and structures and how they interconnect.

The raw supernatant is first filtered through a sintered metal cross flow filter to remove the approximate 80 ppm suspended sludge particles contained in the supernatant. Some insoluble solids containing strontium and plutonium are present in the suspended solids. Filtration is provided to prevent process contamination by these radionuclides. Although the solids concentration is not a problem at present, an unknown amount of particulate matter will be contained in the sludge wash solutions. Having a prefilter will protect the process at higher solids concentrations. Prior to feeding the filtered supernatant to the ion exchange columns, the supernatant is directed at 690 litres/hr to a feed tank which also serves as an intermediate process collection tank. The supernatant feed tank provides about eight hours of hold up. In addition, caustic soda and nitric acid

TABLE I

Supernatant Processes Examined for Treating West Valley Supernatant

Reagent	Process
Devoe-Holbein	Inorganic Ion Exchange
Durasil	Inorganic Ion Exchange
Linde IE-95/IE-96	Inorganic Ion Exchange
Duolite® Cs-100/Amberlite IRC-718	Organic Ion Exchange
Sodium Tetraphenyl Boron (NaTPB)	Precipitation
Nickel Ferrocyanide [$NiFe(CN)_6$]	Precipitation
Phosphotungstic Acid (PTA)	Precipitation

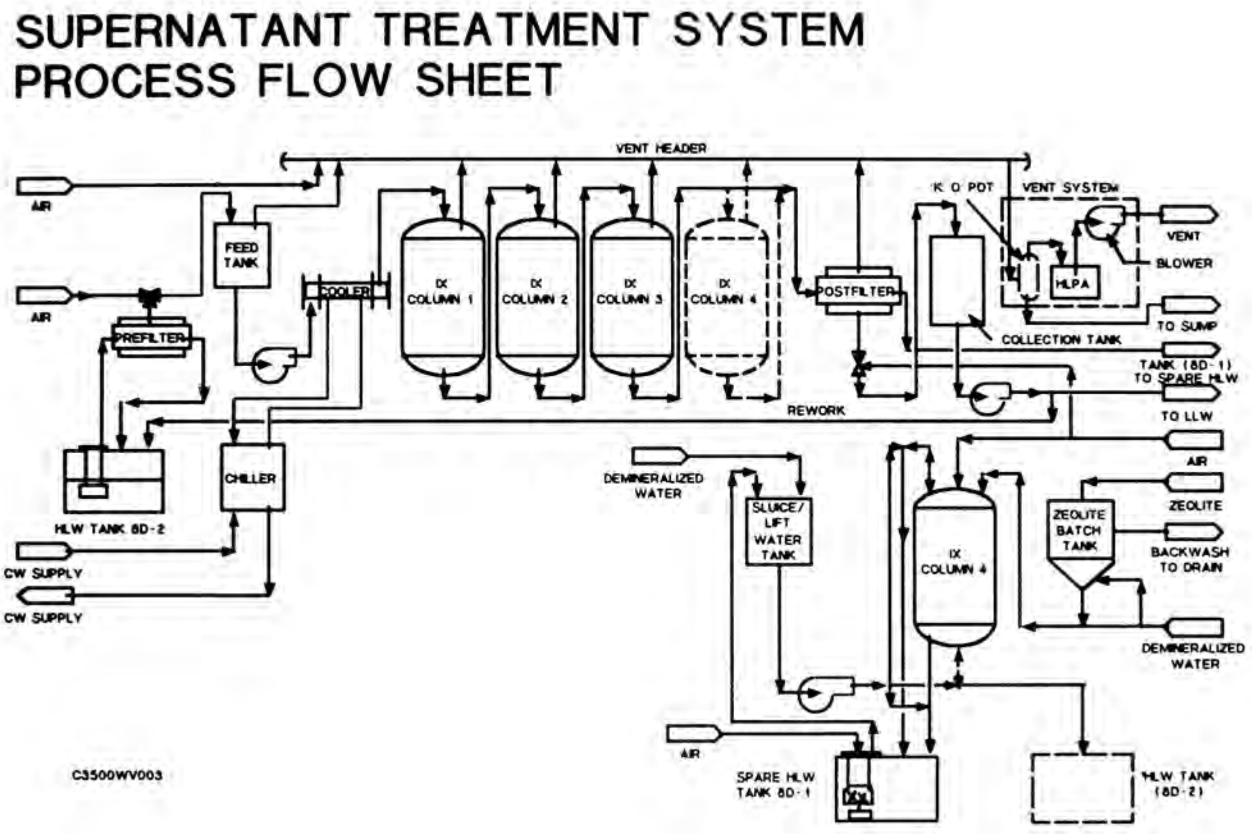

Fig. 1. Process Flow For Treating West Valley Supernatant.

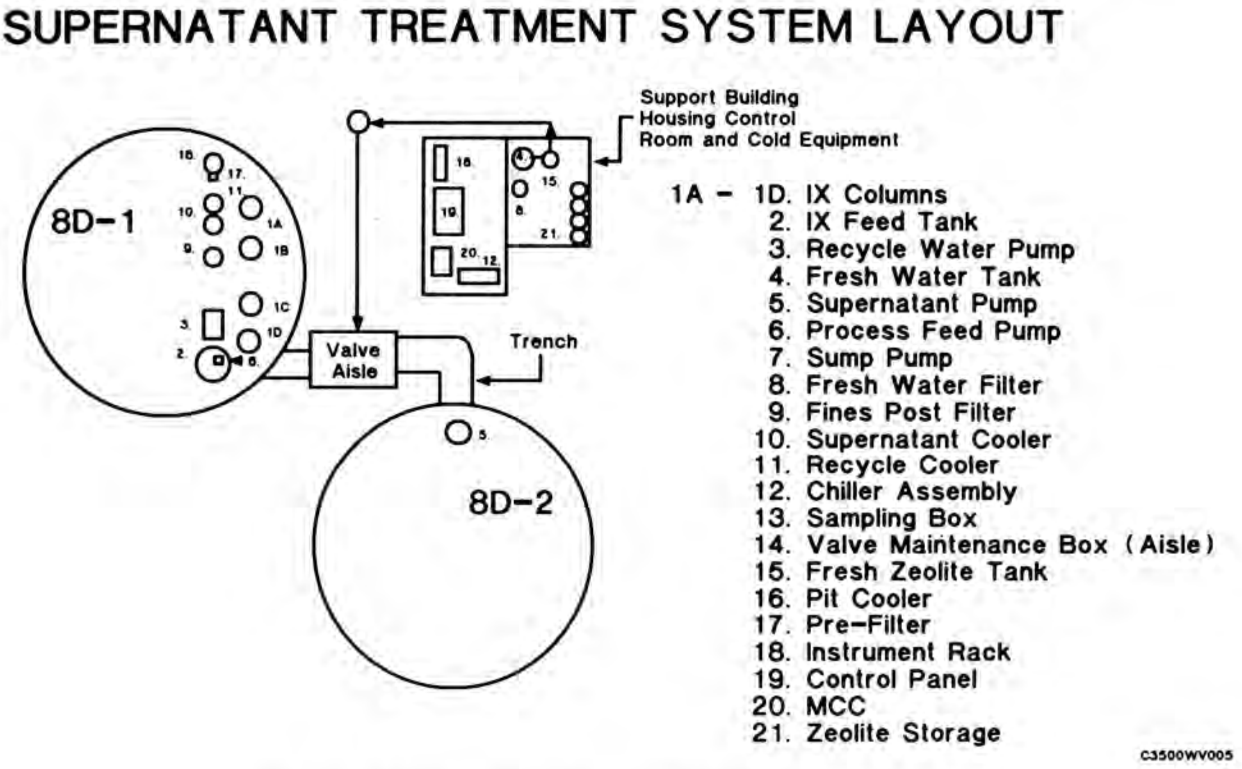

Fig. 2. Interconnection between STS buildings and Structures.

can be added to the tank as a provision for pH adjustments to the column feed if required.

The supernatant is then diluted with water at a one (1) to three (3) ratio and cooled from 90°C to approximately 6°C for optimum processing conditions and therefore obtaining the maximum cesium loading per weight of zeolite. The loaded zeolite should contain a minimum of 80 curies of Cs-137 per litre of zeolite. Following filtration and cooling, the diluted supernatant is passed through three ion exchange columns in series at a rate of 1,380 litres/hr. The supernatant is processed by down flow through 1.8 metres of zeolite in each of the three column beds in series. Each bed of zeolite has 1,200 litres of zeolite. At any time, three successive columns are on-line processing supernatant while the fourth column is off-line undergoing rinse, sluice out and fresh zeolite replacement. When loaded, a bed of zeolite contains approximately 230,400 curies.

Continuous on-stream activity monitoring is provided to detect bed exhaustion and ensuring that an appropriate process DF is achieved. When a zeolite bed is fully loaded, approximately 5,300 litres of residual supernatant at the top of the column is blown back to Tank 8D-2 with air. The zeolite is then rinsed of residual supernatant and this rinse is also sent back to Tank 8D-2. The rinsed zeolite is then sluiced to the bottom of Tank 8D-1 with process water. To sluice the zeolite from the column, the bed is backwashed which expands the bed to about 150 percent of its original height. Once the column bed is expanded, a bottom outlet valve is opened to allow the loaded zeolite bed to fall to the bottom of Tank 8D-1. The loaded zeolite is covered with water and maintained at approximately 60°C for approximately 1-1/2 years prior to delivery to vitrification. Following a final column rinse to Tank 8D-1, the column is ready for a recharge of fresh zeolite.

After ion exchange, the decontaminated supernatant is filtered to remove any suspended zeolite fines. The filtered and decontaminated supernatant is then transferred to the existing underground spare THOREX waste Tank 8D-3. This tank has a working volume of 53,000 litres and serves as both an intermediate storage tank and as a sampling tank. A recycle line is provided back to Tank 8D-2 in case reworking is required. Decontaminated supernatant is transferred to the LWTS from Tank 8D-3 in 11,000 litre batches for incorporation in cement for disposal as a low-level waste. A DF of 1,000 or greater is expected for the radioactive cesium.

In the LWTS the decontaminated supernatant is concentrated to a 48 weight percent salt solution. This concentrated salt solution is mixed with a special formulated cements in a High-Shear Cement Mixing System. The batch is then discharged to a standard 208 litre drum for disposal as LLW. Approximately 10,800 drums of Class "C" LLW will be generated from the processing of the raw supernatant. Table II summarizes the STS process details.

STS Construction Concept

The STS will be located on the WVDP Waste Tank Farm. Location of the STS structures and facilities in relationship to the WVDP site is shown in Fig. 3. Consistent with overall WVDP philosophy, existing facilities are being used to the extent practical. Radioactive process operations of the

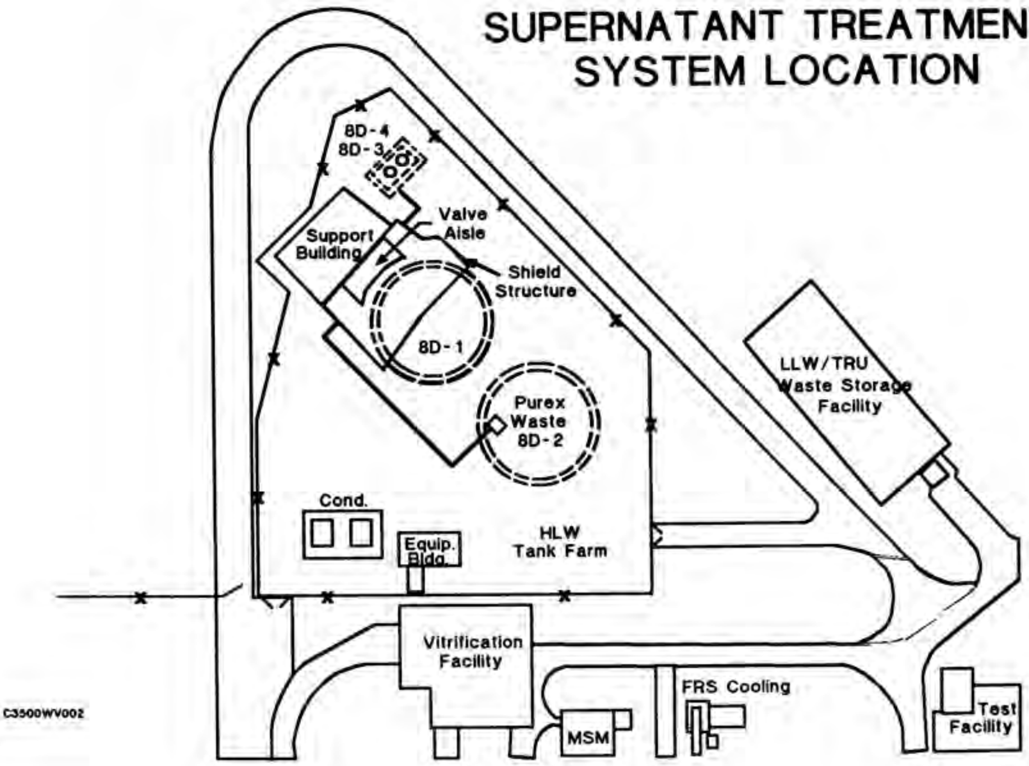

Fig. 3. STS Location.

STS will be conducted within the modified structures of the existing HLW storage Tanks 8D-1, 8D-2, and 8D-3, in a newly constructed pipeway and Valve Aisle adjacent to Tank 8D-1 and within interconnecting double contained piping housed in a containment conduit. The major processing components that will be in radioactive service will be located within the modified structure of Tank 8D-1. Structural modifications had to be made to both the 8D-1 tank and vault for installing and supporting the equipment. Although Tank 8D-1 was never used for waste storage, condensing vapors and entrainment during waste boiling in Tank 8D-2 contaminated the spare tank to the extent radiological contamination controls must be maintained when tank penetrations are made. Fortunately there is no contamination between the tank and the vault and radiation levels average 6 to 8 mR/hr on the tank roof. This allows, outside of tank penetrations, conventional construction methods to be used.

Process components suspended within the 8D-1 tank are structurally supported by a concrete and shield structure erected on top of the 8D-1 vault roof. This structure provides containment and shielding for the top portion of the process components and for the piping runs between the components and the Valve Aisle. The components are suspended from a structural steel lattice which is supported by the 8D-1 vault walls and vault roof support columns. The 0.61 metre thick reinforced concrete vault roof is cut above each required tank penetration. Vault holes in the STS are being made using a ultra high-pressure abrasive, water jet cutting system. Ten holes will be cut in the 8D-1 vault roof for the STS process components.

TABLE II

West Valley Supernatant Treatment System

Supernatant Phase Process Detail

Raw Supernatant Processed	2.55×10^6 kg 2.0×10^6 litres 12.9×10^6 curies
Dilution Factor (Supernatant:Water)	1:3
Zeolite Produced	43,000 kg 67,000 litres
Ion Exchange Bed Size	
Diameter	0.9 m
Height	1.8 m
Volume	1,200 litres
Process Temperature	6°C
Column Cycle Time	
Feed (30 CV* at 0.2 CV/hr) (90 CV at 0.6 CV/hr)[1]	150 hrs
Discharge	4 hrs
Fresh Charge	4 hrs
Total	158 hrs (6.6 days)
Column Changes Anticipated	56
Approximate Column Activity	230,400 curies 300 curies/kg 574 watts
Decontaminated Supernatant	480 litres/hr
LLW Cement Produced	10,800 (208 m^3) drums
Decontamination Factors for Cs	>1,000

* CV - Column Volume

[1] Diluted Supernatant Feed Rate

Risers from the tank roof through the vault are installed to seal the new shield structure from the 8D-1 tank and vault. This allows for future component removal without communication to the existing vault area. The shield structure and its pipeway to the Valve Aisle are epoxy coated to contain any leaks and provides easy decontamination. A collection sump is installed in the pipeway to collect any process leaks. These collected fluids would be transferred to Tank 8D-2. An elevation view of the STS equipment installed in Tank 8D-1 is shown in Fig. 4.

The shielded Valve Aisle will be constructed at the perimeter of the 8D-1 vault below grade. The Valve Aisle will contain shield windows and manipulators to permit remote operation and replacement of components as necessary. All remote connection between valve and instrument jumpers are made using block connectors that can be removed using manipulators. Its shield walls and roof will be constructed with 0.3 metres of steel. The Valve Aisle provides secondary containment between the Operating Aisle in the STS support building and the HLW piping and valves in the pipeway. Design of the Valve Aisle shielding requirements were based on a design dose rate of <0.25 mR/hr in the Operating Aisle.

Attached to the Valve Aisle will be the STS support building which will contain auxiliary support systems and equipment for operating the STS. This structure will house the fresh water and zeolite storage tanks, associated delivery systems, chiller, Control Room, HVAC equipment and utility services.

The multiple containment features and shielding aspects of STS design preclude personnel from coming into contact with radioactive solutions during normal operations of the STS.

Waste Removal System Development

Removing the West Valley PUREX waste as stored required confronting several challenges: waste Tank 8D-2 has only one usable opening in the tank, the tank has a complex internal tank bottom structure, and little was known about the waste itself, especially the 8D-2 sludge layer. To meet these challenges a Waste Characterization Program was put in place and tests in a One-Sixth Scale Tank Model of Tank 8D-2 were performed at West Valley using simulant sludge to determine the number of long shafted pumps required to effectively remove the sludge. Accomplishments of the Waste Characterization Program can be seen in Table III.

The sludge contains approximately 70 percent by weight of iron hydroxide. It is a thick, dark brown substance having the consistency of a fine settled mud one would find at the bottom of a pond. With the exception of cesium, almost all of the fission products originally in the irradiated fuel and 99 percent of the actinides make up the estimated 97,000 kg of sludge settled at the bottom of

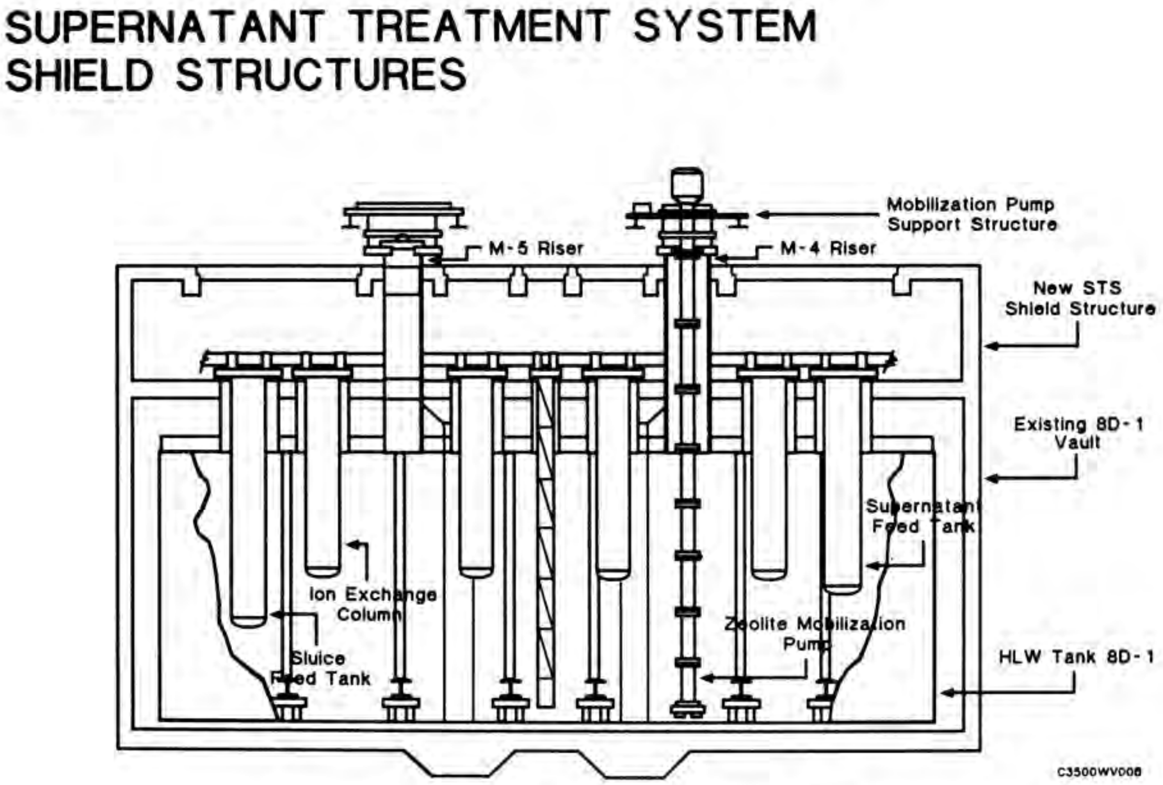

Fig. 4. Elevation View of STS Process Equipment.

TABLE III

West Valley Waste Characterization

Methods and Results

Methods	Results
Shear Vane	Sludge Layer Consistency Sludge Shear Strength
Buoyancy Probe	Supernatant Density and Consistency Sludge Depth Sludge Layer Profile
Sludge Core Sample	Sludge Composition Sludge Shear Strength Sludge Wash Tests Particle Bulk Density Sludge Wash Solution Compositions
Supernatant Sample	Chemical, Physical, and Radiological Makeup
THOREX Sample	Chemical and Radiological Makeup
CCTV	Spare Tanks 8D-1/8D-3 Inspection Verified Crystalline THOREX Phase in 8D-4
Temperature Probing	Sludge Temperature Profile

Tank 8D-2. A total sludge depth of approximately 0.45 metres have been measured, with greater than 90 percent of the sludge resting on the bottom in a more compacted layer 0.23 metres deep. Details of the equipment, methods, and results of these tests performed under this program are given in the following Ref. 8, 9, 10, and 11.

Using the results generated from the Waste Characterization Program, simulant sludge was developed and examined in a One-Sixth Scale Model of Tank 8D-2. The scale model has been used to examine mobilization equipment and methods by simulating this equipment at the reduced scale and testing for sludge resuspension and removal efficiency. Efforts have resulted in the determination of the number and position of the removal equipment required to both wash the sludge and feed a homogeneous waste stream to vitrification. Details of the scale model test methods and results can be found in Ref. 12 and 13.

Optimum results were obtained using five long-shafted centrifugal pumps installed in a special array and placed as close as possible to the tank floor. The pumps to be used at West Valley will operate at 76 litres/sec discharging through two opposing nozzles (38 litres/sec per nozzle) while rotating on a turntable at approximately 0.5 rpm. The important feature of this equipment is that it allows the waste to be agitated in-tank using equipment small enough to fit between and discharge under the tank's complex bottom grid work. These pumps do not require a large opening in the tank roof (0.61 metres) for installation. Pump length requirements to reach the tank floor and at the same time be supported over the vault roof from a truss assembly results in a pump shaft length of 15.2 metres. When the pump is lowered near the tank bottom, the horizontal discharge nozzles provide scouring action to sweep the solids from the tank floor.

Access Modifications to Tank 8D-2

Because five pumps are required to resuspend the 8D-2 sludge, a remote system was designed and built to install new above-grade access ports in the tank roof. Due to the high radiation levels from this tank, this task must be accomplished remotely. In support of the WVDP, Rockwell Hanford Operations (RHO) and Westinghouse Hanford Engineering Development Laboratory (HEDL) were requested to design, fabricate, and demonstrate a system and method to install new risers on the West Valley tank.

To install a new riser, while maintaining containment and minimizing exposure, a number of steps must be performed, most of which are remote.

Since there is no contamination in the vault overburden and the radiation level is low enough (8 mR/hr) excavation may proceed with conventional means. A casing is positioned on the vault roof over a 100 mm pilot hole and serves as the primary load bearing member for the new riser, as well as a supporting structure for a large diameter coring machine. The large diameter coring machine, with a hydraulically driven, diamond impregnated coring bit, is anchored directly to the casing. A core retaining device, passing through the pilot hole in the vault, serves both as an axle for the coring machine and a core retaining device to prevent the core from impacting the tank roof.

After removing the concrete core, direct access to the tank roof is possible. However, since removing the cored plug will allow the radiation level at grade level to increase to about 25 R/hr, the remainder of the installation procedure must be performed with remotely operated machines.

To install the new riser on the tank roof, sections of two interfering rafters on the outside of the tank roof must be removed but without breaching tank. Rafter removal is, therefore, accomplished in two stages. First, the upper part of the rafter is cut away with a flame torch. The torch is carried by an automated machine which moves the torch in two planes cutting the rafter. The operation is then repeated for the other rafter.

Using a semiautomated turntable device and a pneumatic grinder, the lower rafter flanges, in the vicinity of the new riser, are ground away preparing the tank roof for welding. The new riser is then lowered onto the tank roof. Using the same turntable now reequipped with a wire feeder and welding torch, the riser is welded to the tank roof. After preloading the riser to take its weight off the tank roof, a "doughnut" is welded to the riser, and then the riser is allowed to rest on the originally installed casing keep the riser load off the tank roof.

The final operation necessary to complete the riser installation is the actual roof penetration. This operation takes place within a containment tent to prevent the potential spread of contamination. The roof penetration is performed by a flame torch equipped turntable, generically the same as the welder. Since this turntable is likely to be contaminated after initial use, it is kept isolated from the environment during storage and in use. Figure 5 illustrates the new riser installation.

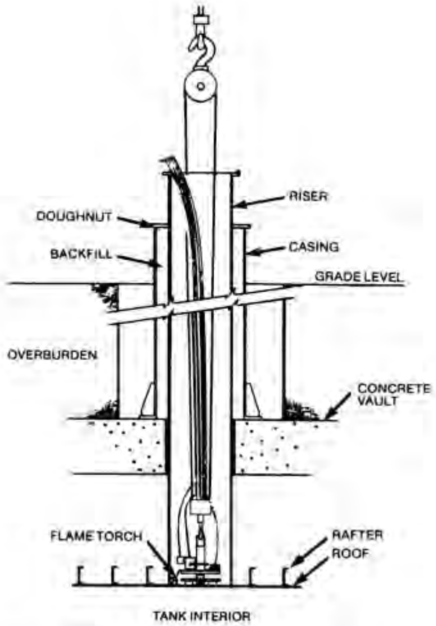

Fig. 5. Remote riser installation.

After equipment evaluation and testing, a system was developed to perform the required steps. The system was functionally tested on a full-scale mockup at Hanford. The equipment is being shipped to West Valley where a demonstration will be performed on Tank 8D-1. Having the luxury of using this equipment to install new risers on an identical tank with no radiation will allow the necessary field testing and operator practice that is required to perform this operation on Tank 8D-2. The original design criteria worker exposure goal of 0.5 man-Rem for each new riser installed on Tank 8D-2 should be easily met based on the final equipment operation and training that will be performed by installing four (4) risers on Tank 8D-1.

Remote riser installation is scheduled to start this June. Installation on Tank 8D-2 for the supernatant removal pump will begin around August of this year.

Waste Removal Construction Requirements

Since the existing vault roof over Tank 8D-1 and 8D-2 cannot support the loads of the five mobilization pumps, a bridge truss structure which spans across the vaults was designed to support these pumps. Three (3) separate truss assemblies will span approximately 28 metres across each tank. Each truss will be supported at each end from four (4) 0.76 metre diameter precast piles. These piles are placed 17 to 18 metres into the existing soil in order to support the required loads. Installation of these structures are scheduled to begin this summer.

Waste Preparation for Vitrification

Upon completion of supernatant treatment, the sludge will be washed with water to remove the interstitial salts contained within the settled sludge. Washing the sludge will reduce the level of soluble salts transferred to the Vitrification Cell. The sodium sulfate dissolved in the interstitial supernatant and the undissolved sodium sulfate on the tank floor is estimated to contain 18,500 kg. It is estimated that almost 300,000 kg of supernatant will also remain. Three washes using an average of 500,000 kg of water for each wash will be performed. This results in 1.7 x 10^6 litre of wash solution to be processed through the STS.

Based on analytical data obtained from wash solutions of actual 8D-2 sludge, there is some concern that dissolution of sufficient transuranics (TRU), e.g., plutonium may lead to some "out of spec" (above Class "C" limits) cement waste. Excessive washing could result in increasing the inventory of solidified TRU waste which will be disposed of elsewhere by as much as 200 to 800 drums. A decision as to when to terminate washing will be made at the time of sludge washing when actual wash solutions are analyzed in the STS feed tank. It is estimated that between 1,750 to 3,850 drums of Class "C" LLW will be generated from sludge wash water processing. Regardless of the number of LLW drums generated, approximately 5,000 kg of cesium loaded zeolite will be produced for solidification in glass.

Because the zeolite particle size is relatively large compared to the solids in the sludge, sampling of the mixed waste in the Vitrification Cell may not be representative. In order to minimize or eliminate the problem, the loaded zeolite will be ground to the smallest practical size before being mixed with the sludge. The zeolite will be slurried from Tank 8D-1 with water using the same method used for sludge removal. The resuspended zeolite slurry is removed out of the waste tank using a long shafted vertical submerged pump. As the zeolite is pumped from the tank it will be fed to an in-line grinder installed in a containment pit adjacent to the tanks. The zeolite removal pump will deliver the slurry at approximately 350 litres/min at a maximum solids concentration of 10 to 15 weight percent. This will result in an estimated 25 to 30 curies of Cs-137/litre. All HLW transfer lines will be buried and shielded to minimize radiation exposure during waste transfer operations. Sufficient shielding will be provided to give a dose rate of 2.5 mrem/hr or less. About 440 kg of loaded zeolite will batch transferred to vitrification to provide one batch of waste in the Vitrification Cell Feed Concentrator. Each batch of feed will provide approximately 2.5 canisters of glass.

The major factor influencing the zeolite concentration in the waste transfer stream is the minimum height of liquid (approximately 0.4 meters) required to prevent the long shafted mobilizing pumps from cavitating. In the case of the fast settling zeolite particles the tank will require constant agitation during zeolite removal. Therefore, water will have to be readded to the tank after roughly 60 percent of the zeolite is removed. From this point the zeolite slurry will continue to be diluted resulting in an increased evaporator load in the Vitrification Cell. However, once 95 percent of the zeolite is removed from Tank 8D-1, oxalic acid will be added to the tank stripping the cesium from the zeolite making it soluble. Now the cesium can be removed as a liquid without the need for continuous agitation and water addition. Tests with zeolite loaded with tracer cesium, have shown that 99 percent dissolution of cesium is possible using oxalic acid. This combination of removal processes will result in greater than 99.9 percent recovery of the cesium added to Tank 8D-1 from the STS process.

The sludge solids will break up from the impact of jet stream of the mobilization pump. However, since a grinder is required for the zeolite, it is planned to pump the resuspended sludge through the grinder to break up any oversized particles or agglomerates that might exist. Solids concentration of the resuspended sludge will be in the order of 10 to 20 weight percent. Although simulant sludge has been tested in the scale model, there will always be some uncertainty involved with resuspending and transporting the sludge to the cell. Therefore, actual sludge concentrations will be finalized during sludge washing. Approximately 890 kg of insoluble sludge solids per batch will be transferred to vitrification. The 34,600 kg of insoluble sludge solids per batch will be transferred to vitrification. The 34,600 kg of THOREX waste will be redissolved with water and transferred as a liquid in 810 kg batches. Each batch will be approximately 500 litres having a radioactiveity concentration of 40 curies/litre.

Ideally an estimated 110 batches of waste will be transferred to vitrification. Each of the three waste streams will be combined with glass formers to produce almost 500,000 kg of borosilicate glass.

Future Design and Developments

Investigations will continue for maximizing waste processing efficiencies both at the tank farm and in the Vitrification Cell e.g., a consistent feed and reduce in-cell evaporation. Simulated THOREX and PUREX wastes are being used to determine the proper waste chemistry to combine the three waste streams into Tank 8D-2 for blending prior to waste transfer to the Vitrification Cell. This will allow all the waste to be mixed at once versus mixing small batches 110 times. Mixing the waste at one time will result in a more consistent melter feed than feeding three separate feeds. This would significantly reduce the number of samples from the feed concentrator for characterizing the melter feed.

This would be carried out by redissolving the thorium in 8D-4 and adding it to the unwashed sludge in 8D-2. The thorium will reprecipitate as thorium hydroxide. The sludge and thorium hydroxide would then be washed together. One disadvantage is that this will result in the production of slightly more zeolite and LLW cement, approximately 2 percent.

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