

Hanford Waste Vitrification Plant: The Project and Process Systems

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management



Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Received by OSTI

JUL 25 1990

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Printed in the United States of America

DISCLM-2 CHP (2-89)

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Date Published
June 1990

To be presented at
American Nuclear Society's
1990 Annual Meeting
Nashville, Tennessee
June 11-13, 1990

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HANFORD WASTE VITRIFICATION PLANT:
THE PROJECT AND PROCESS SYSTEMS

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INTRODUCTION

Construction of the Hanford Waste Vitrification Plant (HWVP) Project is scheduled to start on the Hanford reservation in southeastern Washington State in 1991. The Project will immobilize liquid high-level and transuranic (TRU) defense wastes stored there and permit ultimate disposal of the waste in the nation's commercial deep geological repository.

The HWVP represents the third phase of the U.S. Department of Energy (DOE) activities that are focused on the permanent disposal of high-level radioactive waste, building on the experience of the Defense Waste Processing Facility (DWPF) at the Savannah River Site, South Carolina, and of the West Valley Demonstration Project (WVDP), New York. In addition, contacts have been maintained and exchanges conducted with members of the international community working on high-level waste disposal activities to ensure incorporation of applicable "lessons learned" from their experiences.

This sequential approach to disposal of the country's commercial and defense high-level radioactive waste allows HWVP to make extensive use of "lessons learned" from the experience of its predecessors. The HWVP will use mature designs from the earlier facilities to achieve economies in design and construction costs while enhancing operational effectiveness.

DISCUSSION

The schedule for HWVP will permit the Project to take full advantage of the "lessons learned" from the DWPF and the WVDP. The Detailed Design phase for HWVP was initiated in January 1990; site construction will begin in mid-1991. By contrast, DWPF has completed construction and is nearing the initiation of integrated cold-run operations. The WVDP already has performed the SF-12 Qualification Run and is undergoing final facility modifications to permit hot operations.

The basic concepts of remote processing in a "canyon" facility were developed for the initial special materials separations activities performed at Hanford in the 1940's. The "canyon" comprises a series of cells with removable roof sections, serviced by an overhead crane with remote impact wrenches. The canyon technology relies on the use of special remote connectors that can be connected and/or disconnected by using a remotely operated impact wrench suspended from the hook of the overhead canyon crane. This technology has been refined over the years and used extensively at Hanford and Savannah River.

Based on experience at Hanford, remote connectors used to connect the electrical, instrumentation, and processing piping connections have been simplified and made smaller and "more forgiving" of tolerances and alignments. The HWVP will use the smaller plutonium/uranium extraction (PUREX) connectors developed at Hanford for the remote electrical, instrumentation, and process connections in HWVP. The DWPF uses the older-style "Hanford" connectors consistent with the Savannah River Site standard for remote connectors.

Like DWPF, HWVP has parallel canyons for conducting remote operations, serviced by a single, remotely operated overhead bridge crane. The canyon facilities have been designed with remotely replaceable pumps, valves, tanks, connecting "jumper" assemblies, and other components to maintain the flexibility to modify operations and/or replace failed components contaminated by radioactivity.

The HWVP represents a concerted effort to optimize the engineering design within the budget constraints of the Project to permit permanent disposal of the Hanford Site high-level waste in an environmentally sound manner. The HWVP is being designed to fully comply with applicable state and federal regulations and Site waste management design requirements, with design margins appropriate to the established safety requirements.

The process design and flowsheets developed for DWPF have been used extensively as the departure point for the HWVP design activities. This procedure has averted the need to perform many of the initial engineering studies normally associated with the design of a large facility such as HWVP. While the DWPF design has provided an extensive baseline from which the design of HWVP has proceeded, a number of design changes have been incorporated to satisfy design requirements imposed on the HWVP design. In addition, value engineering studies have been performed to identify potential areas for enhancing the cost-effectiveness of the design.

While the process flowsheets for the two facilities are quite similar, there are some significant differences. Major differences are in the pretreatment of waste feed streams, and in the site requirements for treatment

of potential TRU wastes. In addition, design requirements differ for the Zone I (greatest potential for contamination) exhaust system.

The pretreatment of the Savannah River Site tank farm waste is performed through in-tank precipitation and processing in the precipitate hydrolysis cell (salt cell) of DWPF. Waste pretreatment for the first HWVP feed will use a settle/decant and ion-exchange process performed at existing facilities at the Hanford Site. Processes for pretreatment of later feeds are under development. Throughout the lifetime of the HWVP Project, the chemical contents of the waste feed stream will vary considerably as a function of the particular type of tank waste being processed. The HWVP will not require special steps used by DWPF to remove mercury from the waste feed stream because it is not present in significant quantities in the Hanford tank wastes. Removal of organics, such as benzene, will not be necessary because of differences in the pretreatment step for the HWVP feed stream.

The DWPF, by contrast, uses an in-tank precipitation process in the waste storage tanks with subsequent processing in the DWPF "salt cell." The washed precipitate from the tank farm is treated in the salt cell, organics are removed from the feed stream, and the precipitate bottoms are input to the melter feed preparation process in the slurry receipt and adjustment tank, where the initial mixing of the melter feed input components is performed. In addition, mercury is stripped from the melter feed stream before the feed stream is mixed with the glass former (frit) in the slurry mix evaporator and the concentrations finally adjusted before sending the slurried feed to the melter feed tank.

The HWVP has no equivalent of the DWPF "salt cell" because of the difference in feed preprocessing. The HWVP does, however, incorporate a TRU waste treatment function not present in DWPF. This function is required because of the differences in the waste composition stored in the waste tanks at the two sites, and because of the Hanford Site waste management requirements to recycle liquid, TRU waste so that only non-transuranic waste will be returned to the tank farms.

In addition, some of the post-fill processing details of the canisters in HWVP are still under evaluation, and they are expected to vary from the processes used in DWPF. The reference design for HWVP uses a gas tungsten arc welding (GTAW) process for the final canister closure. Several options are being evaluated to determine the optimum configuration in the plant. These options are being compared with an option to retain a DWPF-type welder in a "weld cell" located outside the main Vitrification Building. In the extensive value engineering study performed during the past nine months, a large potential cost savings was identified with the change to GTAW as the method of performing the final canister closure weld.

While HWVP has much more in common with DWPF than with WVDP, certain features of the WVDP design have been incorporated into the design of the HWVP to meet specific design requirements. The melter offgas system is a prime example of the specific application of the WVDP design to that of HWVP. The HWVP offgas system will use a submerged bed scrubber and a high-efficiency mist eliminator, followed by high-efficiency particulate air filtration before sending the exhaust stream to the Zone I exhaust system.

Differences in the plant layout between HWVP and DWPF are emerging as a result of the applications of "lessons learned" from the experiences at DWPF, and as a result of additional design requirements being placed on HWVP. The building footprint of HWVP is similar to that of DWPF, but it has been streamlined to provide more space within the facility and ease the structural/seismic computations and qualification. The analytical laboratory in HWVP has been significantly expanded to permit analytical chemistry support for the process chemistry and waste form qualification needs. It has been necessary to add weather and ash-fall protection of the heating, ventilation, and air-conditioning components and other equipment on the roof level of the HWVP. The weld test cell has been deleted from the Vitrification Building and other details of cell arrangements have been modified, although the general configuration remains similar to DWPF. Because of computed differences in the potential release of radionuclides from the two facilities, it has been necessary to seismically qualify the HWVP Zone I exhaust system for the heating, ventilation, and air-conditioning of the areas with airborne radioactivity potential.

An ongoing series of information exchange meetings between the Hanford and Savannah River Sites has resulted in the transfer of detailed information that has been extremely valuable to the HWVP design effort. To expedite the information exchange, HWVP has employed a resident staff person at DWPF to identify specific "lessons learned" to be considered in the ongoing design efforts for HWVP, and to coordinate the information exchanges. The "lessons learned" are being evaluated as part of the detailed design work now underway. These information exchange meetings have often included participation by members of the WVDP Project when topics were of mutual interest.

The DWPF experience has demonstrated that early fit-up and compatibility testing can save substantial time by resolving potential construction problems before they occur in the field. As a result of DWPF experience, HWVP is evaluating plans to include construction of a System Evaluation and Test Facility (SETF) to perform run-in and systems integration testing functions for HWVP. Initial planning indicates that SETF also could be extensively used to perform operator training and qualification testing to support waste form qualification needs prior to the availability of the systems for training and testing in the HWVP.

The DWPF experience shared through the information exchange meetings has stressed the early need for detailed integrated construction and startup schedules. With the broad experience base provided by DWPF, HWVP is in the enviable position of being able to emphasize development of integrated schedules during the design phase of the Project, ensuring construction completion on a schedule that supports necessary startup testing.

Development of the integrated schedule at this early stage of the Project will ensure identification and procurement of long-lead items that could otherwise delay Project construction. It will also permit sequencing of construction activities to support the needs of an accelerated startup program at HWVP. Extensive use is being made of the planning and performance experience from DWPF construction and preparations leading to initiation of the integrated cold-run operations. This experience will permit more accurate estimates of HWVP time-phased funding and staffing requirements than were possible for either DWPF or WVDP.

RESULTS/CONCLUSIONS

The HWVP has a unique role in the DOE program to permanently dispose of high-level radioactive waste. The HWVP will permit an optimized engineering design of a large waste vitrification facility, based on the construction and startup experiences of an essentially similar facility, DWPF, and the WVDP. This should help ensure that HWVP will meet its operational objectives at minimum total Project and lifetime costs through the incorporation of the DWPF and WVDP experience and "lessons learned."