Progress Updates for the Hanford Waste Treatment and Immobilization Plant Project – 15593

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ABSTRACT

The Waste Treatment and Immobilization Plant (WTP) Project is vital to the U.S. Department of Energy's (DOE) mission to clean up radioactive waste at the Hanford Site in southeastern Washington State. The overall WTP Project objective is to design, build, and commission the facilities and systems that will treat and immobilize approximately 211 983 m^3 (56 million gallons) of radioactive waste stored in 177 underground storage tanks. The combination of technologies in the WTP makes it a first-of-a-kind facility at a scale larger than ever built for radioactive waste processing.

In recent years, the project has encountered issues that affected project design completion, especially in the Pretreatment and High-Level Waste Facilities. These included technical issues, changes in requirements, changes in funding, weaknesses in the nuclear supply chain, identification of new hazards, and new information about the tank waste. The combination of these issues led to a suspension of construction of the Pretreatment Facility and a partial suspension of construction of the High-Level Waste Facility in mid-2012.

Since then, the WTP Project has made significant progress in establishing and implementing a strategy for resolving these issues. This strategy focuses on resuming full production work in a sequence that fully supports the DOE plan for a phased approach for starting treatment of the Hanford tank waste, beginning with the low-activity waste streams.

Concurrent with the technical and programmatic issues, the DOE Office of River Protection has made numerous changes in the processes it uses to manage and oversee the WTP Project. These changes have had a beneficial impact on the progress the project has made in establishing a path forward for resuming production activities, and on planning for the necessary contract and baseline changes needed to complete the project.

INTRODUCTION

The Waste Treatment and Immobilization Plant (WTP) Project is vital to the U.S. Department of Energy's (DOE) mission to clean up waste at the Hanford Site in southeastern Washington State. The project's objective is to design, build, commission, and operate facilities and systems that will treat and immobilize approximately 211 983 m^3 (56 million gallons) of radioactive and chemical waste stored in 177 underground storage tanks. The WTP Project comprises the following five separate but interrelated facilities or groupings of facilities, each fulfilling a key function in the treatment and immobilization of tank waste.

Pretreatment Facility

When all WTP facilities are completed, and WTP is operating as an integrated plant, the Pretreatment (PT) Facility will serve as the starting point in the process of vitrifying Hanford's tank waste (Fig. 1). The PT Facility is the largest of the four major nuclear facilities that compose the WTP. It is 180 m (540 ft) long, 72 m (215 ft) wide, and 40 m (120 ft) tall. When complete, its total area will be more than 45 500 m^2 (490,000 ft^2).

Waste will be pumped from the Hanford tanks via underground pipes to the PT Facility's interior waste feed receipt vessels. There, during the first phase of pretreatment, the waste will be concentrated using an evaporation process. Solids will be filtered out, and the remaining soluble, highly radioactive isotopes will be removed using an ion-exchange process. The high-level solids will be sent to the High-Level Waste (HLW) Facility, and the low-activity liquids will be sent to the Low-Activity Waste (LAW) Facility for further processing.

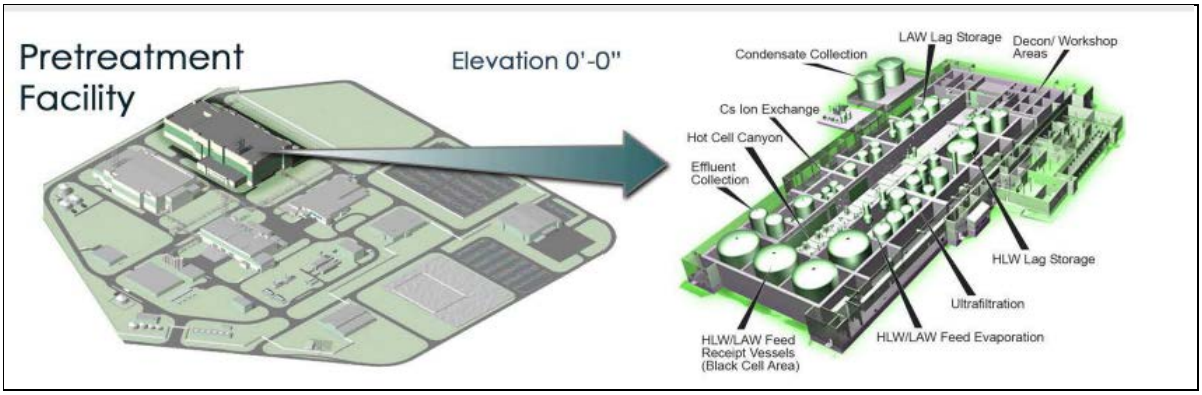

Fig. 1. Waste Treatment and Immobilization Plant Pretreatment Facility.

High-Level Waste Facility

In the HLW Facility, high-level waste will be mixed with glass-forming materials in two 82 t (90-ton) melters and heated to 1 422 K (2,100 °F) (Fig. 2). The mixture will then be poured into stainless steel canisters that are approximately 0.6 m (2 ft) in diameter, 4.4 m (14.5 ft) tall, and weigh more than 3.6 t (4 tons). When fully operational, the HLW Facility will produce an average of 480 canisters per year.

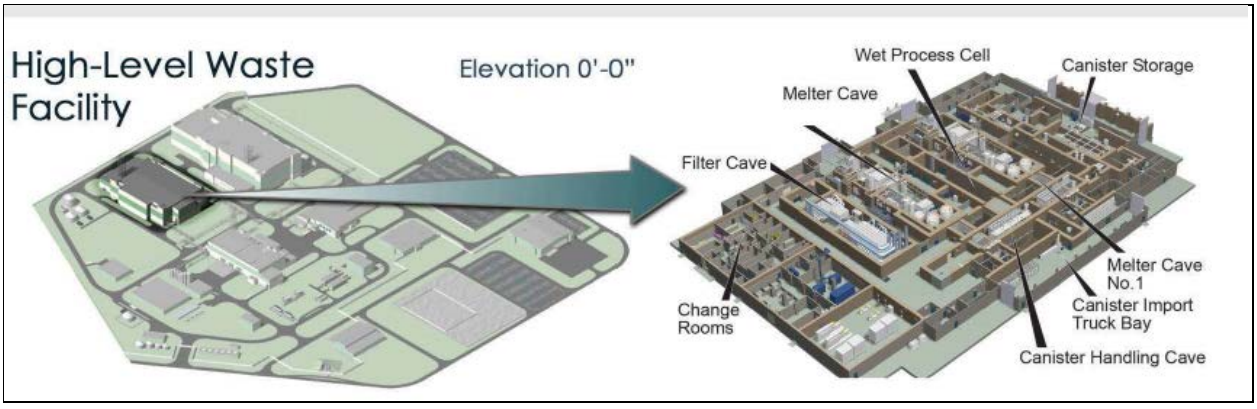

Fig. 2. Waste Treatment and Immobilization Plant High-Level Waste Facility.

Low-Activity Waste Facility

In the LAW Facility, concentrated low-activity waste will be mixed with silica and other glass-forming materials (Fig. 3). The mixture will be fed into the LAW Facility's two melters and heated to1 422 K (2,100 °F). The 272 t (300-ton) melters are approximately 6 m (20 ft) by 9 m (30 ft), and 5 m (16 ft) high. The glass mixture will then be poured into stainless steel containers that are 1.2 m (4 ft) in diameter, 2 m (7 ft) tall, and weigh more than 6.4 t (7 tons). The low-activity waste containers will be stored on the Hanford Site in permitted trenches and covered with soil.

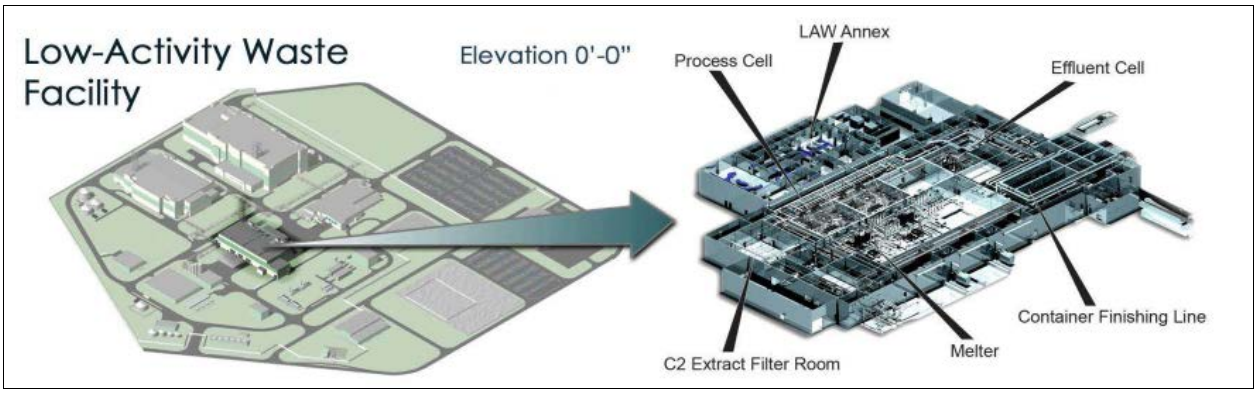

Fig. 3. Waste Treatment and Immobilization Plant Low-Activity Waste Facility.

Analytical Laboratory

The Analytical Laboratory (Lab) will serve as a process link between the PT, HLW, and LAW facilities. The Lab is approximately 98 m (320 ft) long, 55 m (180 ft) wide, and 14 m (45 ft) high. The Lab's key function is to ensure that all glass produced by the LAW and HLW Facilities meets regulatory requirements and standards. Each year, when the WTP is operational, the Lab will analyze approximately 10,000 waste samples. Samples will be used initially to confirm the correct glass-former recipe that will produce a consistent glass form. Once the recipe is identified, the glass-forming materials and the waste will be transferred to the LAW or HLW Facility, as appropriate, for further processing. Samples will also be taken throughout the vitrification process to ensure a high-quality glass product and good process controls.

Balance of Facilities

The Balance of facilities (BOF) makes up the overall support services infrastructure essential for WTP operations. It comprises multiple support buildings (approximately 13 935 m^2 [150,000 ft^2]) and approximately 100 systems across the WTP site, and provides interconnecting utilities and support to the PT, HLW, LAW, and Lab facilities. The BOF infrastructure consists of the following groupings of facilities and types of support buildings:

- Switchgear buildings and emergency generator facilities
- Steam plant and a fuel oil facility
- Cooling towers, water treatment facility, chiller/compressor facility, and a firewater facility
- Glass former storage facility, wet chemical storage facility, and the anhydrous ammonia storage facility
- Spent melter staging pad and the nondangerous, nonradioactive effluent facility
- Administration building, simulator facility, warehouse, and site infrastructure (e.g., roads, grading, lights, sanitary waste, storm drains).

Technical Risks and Challenges

Hanford tanks contain a complex and diverse mix of radioactive and chemical waste in the form of sludge, salts, and liquids, necessitating a variety of unique waste retrieval and treatment methods. The uncertainty and diversity of the physical and chemical properties of the 211 983 m^3 (56 million gallons) of waste make the mission uniquely complex.

As the design and construction of the WTP has progressed, a number of technical issues have emerged involving the tank farms, the WTP, and the interfaces between the two. The issues in WTP are primarily associated with the PT Facility and, to a lesser degree, the HLW Facility. The most significant WTP technical issues are centered on the ability of the PT Facility to mix and transfer HLW slurries with high solids concentrations, and the adequacy of the piping and vessel designs in inaccessible black cells to support the WTP's 40-year operational life. There are also technical issues and uncertainties associated with the requirements and capabilities necessary to ensure that the waste feed delivered from the tank farms to WTP can be adequately and safely processed in the WTP. The bounding characteristics of the waste feed are defined by the WTP waste acceptance criteria. Additional capabilities for staging, sampling, and conditioning waste feed for delivery to the WTP may be required to ensure the waste will comply with WTP waste acceptance criteria and can be treated within the current WTP design envelope.

Because of the impact of unresolved technical issues on the facility design, and a misalignment between the facility design and nuclear safety basis, the DOE restricted certain EPC work on the HLW and PT Facilities in 2012 and early 2013. These technical issues impacted EPC activities in critical areas of the two facilities. As a result, all production EPC work on the PT Facility was suspended. For the HLW Facility, only limited equipment procurements and civil construction work was continued in areas not directly impacted by the technical issues.

DISCUSSION

Hanford Tank Waste Retrieval, Treatment, and Disposition Framework

On September 24, 2013, DOE published the *Hanford Tank Waste Retrieval, Treatment, and Disposition Framework*, to initiate discussions for an approach that would facilitate immobilization of tank waste to begin as early as practicable without waiting for completion of work to resolve the technical issues associated with the PT and HLW Facilities [1]. The Framework established a conceptual approach that would initiate the Hanford tank waste treatment mission in three phases, starting with the less-complex low-activity waste stream. For WTP, the three phases would allow for completion and startup of the WTP sequentially, as follows:

- Phase 1
  - Completion, commissioning, and startup of BOF and Lab
  - Activities to support direct feed of low-activity waste (DFLAW) to WTP
    - Completion of the tank farm infrastructure and an interim pretreatment capability needed to directly feed the LAW Facility
    - Completion, commissioning, and startup of the LAW Facility
    - Final permitting of the onsite Integrated Disposal Facility for low-activity waste
  - Completion of full-scale vessel testing and resolution of technical issues in the PT and HLW Facilities
- Phase 2
  - Completion of the HLW Facility
  - Resumption of PT Facility construction
- Phase 3
  - PT Facility commissioning
  - Initiation of integrated WTP operations.

As stated in the Framework, "This approach would enable DOE to mitigate the impact of the outstanding technical issues at the PT and HLW Facilities by beginning immobilization of the most mobile tank waste at Hanford without awaiting resolution of those technical issues. Because a phased approach allows for LAW operations to begin before PT and HLW Facility construction is complete, and because the volume

of low-activity waste is much higher than the volume of high-activity waste in Hanford's tank farms, this approach has the potential shorten the overall duration of the tank waste mission."

The WTP project has aligned its near-term work priorities and has begun early implementation of the activities necessary to implement the phased approach to initiating WTP operations.

Implementing Direct Feed of Low-Activity Waste

The primary driver for the DFLAW approach is to enable commissioning of the LAW Facility for low-activity waste processing before the PT and HLW Facilities are complete. As such, the functions planned to be provided to the LAW Facility by the PT Facility and the common functionality with the HLW Facility must be refined and modified. The DFLAW approach will provide necessary systems and facilities to provide these enabling functions until the PT Facility is completed or if the PT Facility is not available.

The overall DFLAW concept is to transfer pretreated waste from the tank farms through existing and modified waste transfer piping directly to the LAW Facility. The design would be capable of providing LAW operations feed to produce nominally 21 metric tons of glass per day, using two melters, with the necessary support from Lab and BOF. A new effluent treatment capability would store, treat, and route the LAW liquid secondary waste streams. Additional changes would include modifications in the BOF facilities to operate a subset of the overall WTP; final grade and road modifications; additional support facilities; and fencing to segregate the operating LAW Facility, BOF, and Lab from the PT and HLW Facilities while they are still under construction.

The WTP contractor started conceptual design activities for the WTP DFLAW capability in early 2014. In February 2014, ORP requested the WTP contractor develop separate contract modification proposals for completing: (1) the LAW Facility, BOF, and Lab work scope in the current contract through hot commissioning in a manner to accommodate a phased start to the WTP mission; and (2) initial planning and design for incorporating a permanent capability to accommodate DFLAW in the WTP. The WTP contractor submitted a contract proposal to complete initial planning and design for the DFLAW capability in June 2014, and a subsequent amendment to the proposal in September 2014. DOE authorized the contractor to commence some of the early detailed design activities for the BOF utility modifications and the LAW effluent management capability in mid-2014. Evaluation and negotiations for the full contract proposal are proceeding as of the date of this paper.

Resuming Full Production Engineering for the High-Level Waste Facility

ORP developed a process to systematically address and resolve the technical, management, and quality issues that led DOE to restrict HLW Facility production activities in 2012 and 2013. ORP's plan provided for a phased resumption of HLW EPC activities, with two decision points:

- Decision 1: Conditional authorization to resume EPC activities
- Decision 2: Full authorization to resume EPC.

In August 2014, after a 9-month evaluation period, ORP provided authorization for the WTP contractor to resume all engineering work necessary to finalize the design of the HLW Facility. The WTP contractor had made significant progress in resolving technical issues and establishing work processes to align the HLW design and safety basis. These accomplishments provided the foundation to execute production engineering activities effectively. Full release for HLW equipment procurements and construction is forthcoming based on conditions that must be fully satisfied and demonstrated during the transition period

between Decision 1 and Decision 2, including completion of an update to the HLW Preliminary Documented Safety Analysis.

Path to Resuming Production Engineering for the Pretreatment Facility

In 2006, an External Flowsheet Review Team identified 28 technical vulnerabilities with the plant design or future operability. In 2012, a number of top scientists and engineers conducted a review of the major technical issues associated with the design and operability of the WTP. In late 2012, DOE assembled a WTP Design Completion Team, composed of personnel from ORP, DOE contractors, and national laboratories to provide leadership and oversight for resolution of the technical issues. The Design Completion Team established five technical subteams whose work focused on specific areas. The work of these teams has evolved such that the WTP Project is now focused on eight remaining technical issues for the PT Facility:

(T1) Hydrogen Gas Release from Vessel Solids
(T2) Criticality in Pretreatment Facility Vessels
(T3) Hydrogen in Piping and Ancillary Vessels
(T4) Pulse-Jet Mixing and Control
(T5) Erosion and Localized Corrosion in WTP Vessels and Piping
(T6) Design Redundancy in Black Cells/In-Service Inspection
(T7) Black Cell Vessel Structural Integrity
(T8) Facility Ventilation.

The WTP contractor has since established plans for resolving each of the eight remaining technical issues, and updated their near-term project execution baseline to implement the technical activities needed to resolve the issues. Resolution of the technical issues is expected to continue over a period of several years.

DOE has also established a comprehensive plan for resuming production activities for the PT Facility, similar to the process established and implemented for the HLW Facility. DOE will closely monitor progress on resolving the technical issues; review and approve the WTP contractor's safety design strategy, which will provide the basis for updating the PT Facility safety basis; and establish a process by which the design and safety basis will be brought into alignment. Resolution of the technical issues and establishment of a revised safety basis will be key prerequisites to resuming EPC activities for the PT Facility in the coming years.

Federal Project Management Improvements

Starting in early 2013, ORP's new management team made a concerted effort to identify the barriers that were preventing the project from closing issues in a timely manner. Project and technical management process changes were methodically implemented, allowing the project to move forward with planning for the first phase of contract and baseline changes needed to complete the project. Significant changes included the following:

- Implementing an integrated (Federal) contract and baseline change management process
- Reestablishing a centralized WTP Integrated Project Team and documenting the revised team structure in a formal charter
- Establishing a Senior Technical Authority position at the senior executive level to approve and oversee strategies for technical issue resolution

- Establishing a joint ORP/WTP contractor Technical Issue Resolution Board to jointly eliminate barriers to resolving technical issues
- Establishing a process and contract vehicle to conduct independent design and operability reviews for WTP facilities and systems
- Conducting a series of management workshops to improve team dynamics and establish clear roles, responsibilities, authorities, and accountabilities for the ORP WTP Project leadership team
- Conducting a workshop with DOE Headquarters offices to resolve lingering project and contract management perceptions that had become barriers to effective communication and teaming between headquarters and the field
- Working with the WTP contractor to establish a schedule for the WTP contractor to complete and ORP to review and approve corrective action plans for all outstanding Priority Level 1 assessment findings
- Establishing a periodic bulletin from the Federal Project Director as one tool to ensure project priorities, challenges, accomplishments, and expectations are consistently communicated and understood across the organization.

These changes were made in the context of continuous improvement and building a robust safety conscious work environment, and they have enabled significant progress to be made in establishing a path forward for baseline and contract changes needed to complete the WTP Project.

CONCLUSIONS

Aligning with DOE's framework for a phased start of the Hanford tank waste treatment mission, the WTP Project has made significant progress in establishing and implementing an approach for resolution of the remaining technical issues, and resuming production activities for all of the WTP facilities in the coming years. The WTP Project has focused its priorities on first establishing the capability within WTP to treat low-activity waste feed directly from the Hanford tank farms, while concurrently resuming design engineering for the HLW Facility and resolving the remaining technical issues for the PT Facility.

REFERENCES

1. DOE, 2013, *Hanford Tank Waste Retrieval, Treatment, and Disposition Framework*, U.S. Department of Energy, Washington, D.C. Available online at http://energy.gov/sites/prod/files/2013/09/f3/DOE%20Hanford%20Framework%20FINAL.pdf.