

Progress Updates for the Hanford Waste Treatment and Immobilization Plant Project – 16281

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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, located 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 56 million gallons of radioactive waste stored in Hanford's 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. The WTP includes several facilities that will contribute to waste processing: (1) the Pretreatment (PT) Facility, which is designed to receive waste retrieved from the Hanford tank farms and separate it into low-activity and high-level waste streams; (2) the Low-Activity Waste (LAW) Facility, which will vitrify the low-activity waste stream; (3) the High-Level Waste (HLW) Facility, which will vitrify the high-level waste stream; (4) the Analytical Laboratory (Lab), which will support both vitrification facilities' operations; and (5) the Balance of Facilities (BOF), which will provide industrial support capabilities and infrastructure, like electricity and steam, needed for WTP operations.

In 2012, DOE suspended production work on the WTP's Pretreatment (PT) Facility and to a lesser degree the High-Level Waste (HLW) Facility because of unresolved technical issues associated with those facilities. DOE has established 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. This approach enables LAW treatment to begin before the PT and HLW facilities are completed by transferring low activity waste directly from the Hanford tank farms to the LAW Facility – referred to as Direct Feed LAW (DFLAW).

ORP has placed the highest priority on completing the Low Activity Waste Facility, Balance of Facilities, and Analytical Laboratory (collectively known as LBL) in support of the planned phased start to the Hanford Tank waste treatment mission. DOE has requested, and the WTP contractor has delivered contract modifications proposals for: (1) design of a permanent capability to accommodate DFLAW in WTP; (2) procurement and construction of modifications to enable DFLAW operations in WTP, and (3) completion of LBL work scope in the current contract through hot commissioning in a manner to accommodate a phased start toward completing the WTP mission. DOE is reviewing and approving contract modifications in a sequence and schedule that allows for an orderly completion of the LBL Facilities and to begin treating low-activity tank waste as soon as practicable.

In August 2014, ORP authorized the WTP contractor to resume all engineering work necessary to finalize the design of the HLW Facility. Authorization for HLW equipment procurements and construction is forthcoming, based on conditions that must be satisfied for a full release of these activities, including completion of an update to the Preliminary Documented Safety Analysis.

DOE has also established a comprehensive plan for resuming production activities for the PT Facility that is similar to the process established and implemented for the HLW Facility. Resolution of the technical issues and establishment of a revised safety basis are key prerequisites to resuming engineering, procurements, and construction.

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 m³ (56 million gallons) of radioactive and chemical waste stored in 177 underground storage tanks. The WTP includes several facilities that will contribute to waste processing: (1) the Pretreatment (PT) Facility, which is designed to receive waste retrieved from the Hanford tank farms and separate it into low-activity and high-level waste streams; (2) the Low-Activity Waste (LAW) Facility, which will vitrify the low-activity waste stream; (3) the High-Level Waste (HLW) Facility, which will vitrify the high-level waste stream; (4) the Analytical Laboratory, which will support both vitrification facilities' operations; and (5) the Balance of Facilities (BOF), which will provide industrial support capabilities and infrastructure, like electricity and steam, needed for WTP operations.

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 feet) long, 72 m (215 feet) wide, and 40 m (120 feet) tall. When complete, its total area will be more than 45 500 m² (490,000 ft²).

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 feet) in diameter, 4.4 m (14.5 feet) 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.

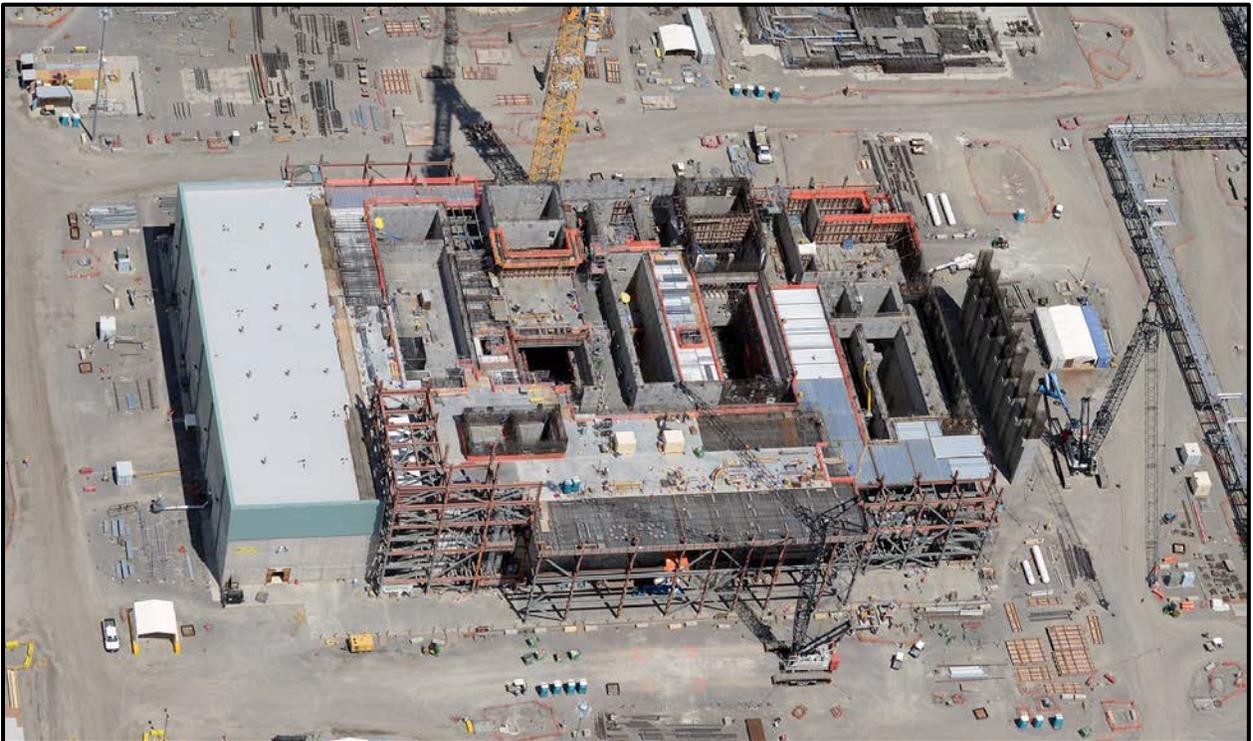


Fig. 2. Waste Treatment and Immobilization Plant High-Level Waste Facility.

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 to 1 422 °K (2,100 °F). The 272 t (300-ton) melters are approximately 6 m (20 feet) by 9 m (30 feet), and 5 m (16 feet) high. The glass mixture will then be poured into stainless steel containers that are 1.2 m (4 feet) in diameter, 2 m (7 feet) tall, and weigh more than 6.4 t (7 tons). The low-activity waste containers will be disposed at a permitted facility on the Hanford site.



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 (Fig. 4). The Lab is approximately 98 m (320 feet) long, 55 m (180 feet) wide, and 14 m (45 feet) 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.

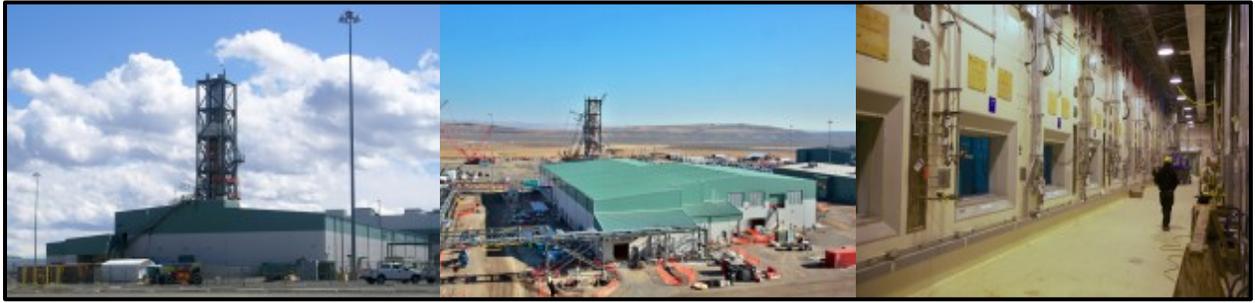


Fig. 4. Waste Treatment and Immobilization Plant Analytical Laboratory.

Balance of Facilities

The Balance of facilities (BOF) makes up the overall support services infrastructure essential for WTP operations (Fig. 5). It comprises multiple support buildings (approximately 13 935 m² [150,000 ft²]) 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 non-dangerous, nonradioactive effluent facility
- Administration building, simulator facility, warehouse, and site infrastructure (e.g., roads, grading, lights, sanitary waste, storm drains).

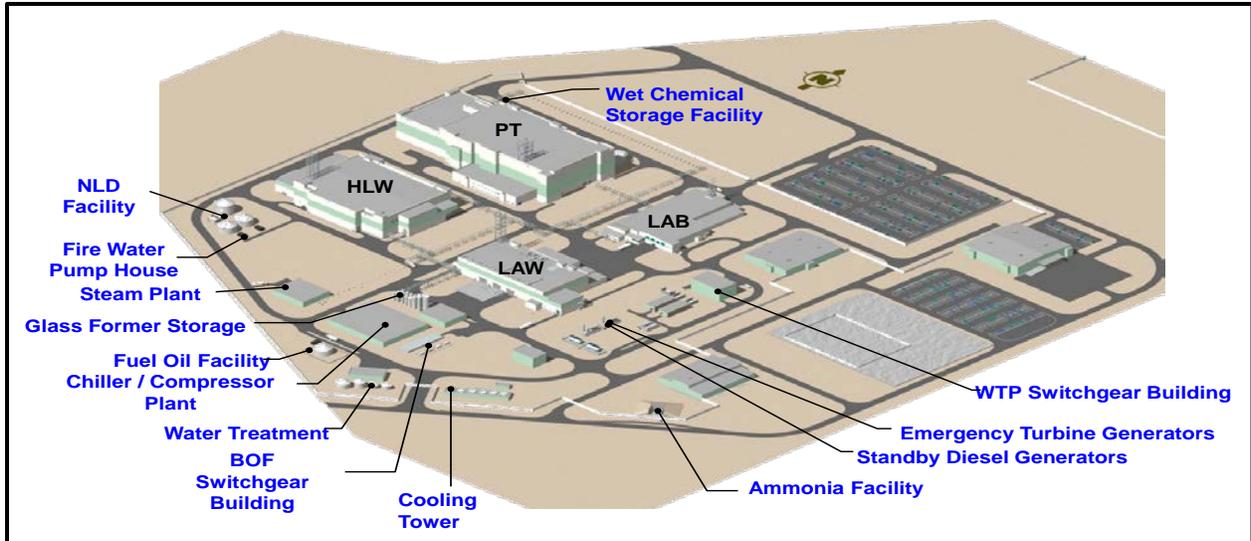


Fig. 5. Waste Treatment and Immobilization Plant Balance of Facilities.

DISCUSSION

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 m³ (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.

Because of the impact of unresolved technical issues on the facility design, the DOE restricted certain engineering, procurement and construction (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 construction 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.

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 phases, starting with the less-complex low-activity waste stream. 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".

The WTP project has begun early implementation of the activities necessary to implement the phased approach to initiating WTP operations as follows:

- Completing construction of the Low Activity Waste (LAW) Facility, Balance of Facilities (BOF), and Analytical Laboratory (Lab), collectively known as LBL;
- Implementing a direct-feed low-activity waste (DFLAW) process to treat low-activity waste independent of the PT Facility;
- Completing the design and construction of the HLW Facility;
- Resolving the technical issues associated with the PT Facility; and
- Completing the WTP facilities to enable integrated WTP operations.

Current Status and Path Forward

ORP has placed the highest priority on completing LAW, BOF and Lab (collectively known as LBL) in support of the planned phased start to the Hanford Tank waste treatment mission. DOE has requested, and the WTP contractor has delivered contract modifications proposals for: (1) design of a permanent capability to process low activity waste delivered directly to WTP from the Hanford tank farms (referred to as Direct Feed LAW, or DFLAW); (2) procurement and construction of modifications to enable DFLAW operations in WTP, and (3) completion of LBL work scope in the current contract through hot commissioning in a manner to accommodate a phased start toward completing the WTP mission. DOE is reviewing and approving contract modifications in a sequence and schedule that allows for an orderly completion of the LBL Facilities and to begin treating low-activity tank waste as soon as practicable.

In August 2014, ORP authorized the WTP contractor to resume all engineering work necessary to finalize the design of the HLW Facility. Authorization for HLW equipment procurements and construction is forthcoming, based on conditions that must be satisfied for a full release of these activities, including completion of an update to the Preliminary Documented Safety Analysis.

DOE has also established a comprehensive plan for resuming production activities for the PT Facility that is similar to the process established and implemented for the HLW Facility. Resolution of the technical issues and establishment of a revised safety basis are key prerequisites to resuming engineering, procurements, and construction. The 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.

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>.