

# Reducing the DOE's liquid waste liability

By Tim Gregoire

Plant startup employees work in the process cell area of the Low-Activity Waste Facility at Hanford's Waste Treatment and Immobilization Plant.



## **In 2020, the DOE announced real progress made in the management of liquid radioactive waste at its sites at Savannah River, Idaho, and Hanford.**

During the annual National Cleanup Workshop, held virtually in September of last year due to the COVID-19 health crisis, William “Ike” White, senior advisor to the under secretary for science in the Department of Energy’s Office of Environmental Management, said that despite the pandemic, 2020 was an inflection year for the DOE and his office.

“The accomplishments we have this year are keeping us on track to realize transformational progress over the decade ahead,” White said. “It is a decade in which we will achieve cleanup work at some sites and finish significant work scope at others.”

Most notably, White continued, the progress the Office of Environmental Management (EM) has made will enable the DOE to begin work on its largest environmental liability, its inventory of liquid tank waste. “Tank waste represents about 60 percent of the total environmental liability for EM and it takes up about 40 percent of our budget annually,” he said, adding that a ramp-up in tank waste activities will significantly accelerate the timeline for the processing of waste.

The DOE has nearly 90 million gallons of liquid chemical and radioactive waste stored in underground tanks at three of its sites: the Savannah River Site in South Carolina (31 million gallons); the cleanup site at Idaho National Laboratory (about 900,000 gallons); and the Hanford Site in Washington (about 56 million gallons). Much of the waste is the result of processing plutonium for weapons production, and the goal at all three DOE sites is to stabilize the liquid waste by converting it to a solid form ready for permanent disposal. At Hanford and Savannah River, the liquid waste will be melted into a glass-like form through vitrification, while Idaho's waste will be converted into a granular solid through a process of steam reforming.

While the processes of vitrification and steam reforming are well-understood and straightforward, in practicality it is a complex process with many challenges, including designing glass/solid formulations best suited to the complex chemical compositions of the different waste streams. The design and construction of glass melters and waste reformers capable of safely

processing large amounts of liquid waste also pose a number of engineering challenges. Facing such difficulties, the DOE's efforts to treat its liquid waste have faced a number of setbacks, particularly at Hanford and Idaho, where technical issues in the design and construction of processing facilities have caused deadlines to be missed and budgets to be surpassed.

As White noted, however, progress has been made at all three sites. In August of last year, the DOE approved the authorization to operate the Salt Waste Processing Facility at the Savannah River Site, with "hot" commissioning starting in October. At Idaho, the Integrated Waste Treatment Unit is expected to begin processing sodium-bearing waste this summer. While at Hanford, the DOE is on track to begin treating low-level radioactive waste by its 2023 deadline using its Direct-Feed Low-Activity Waste approach.

"Collectively, these capabilities at Savannah River, Hanford, and Idaho represent a fundamental shift for EM as we pivot from long-running construction projects into the actual treatment of waste," White said.

A large-capacity processing vessel is lifted into the SWPF during construction in 2012. Photos courtesy of the DOE.



The SWPF at the Savannah River Site as seen during construction. Photo: Parsons.



## Savannah River

Seen as the cornerstone of the DOE's radioactive waste processing strategy at the department's Savannah River Site (SRS), the Salt Waste Processing Facility (SWPF) is the last major piece of the liquid waste system at the South Carolina site. SWPF will treat the majority of Savannah River's salt waste inventory by separating the highly radioactive waste from the less radioactive salt solution.

The remediation of radioactive waste begins by transferring the waste from Savannah River's H Tank Farm to SWPF, where it undergoes a two-step separation process. The first step removes strontium and actinides, such as uranium and plutonium, from the waste. The second step, known as Caustic Side Solvent Extraction, is designed to remove radioactive cesium.

After the initial separation process is completed, the concentrated high-activity waste will be sent to the nearby Defense Waste Processing Facility, where it will be vitrified and stored for eventual disposal. The decontaminated salt solution will be mixed with cement-like grout at the nearby Saltstone Facility for disposal on site. Removing salt waste, which fills more than 90 percent of tank space in the SRS tank farms,

is a major step toward emptying and closing the site's remaining 43 high-level waste tanks.

In 2002, the DOE selected Parsons Corporation to design, build, commission, and operate SWPF with the goal of processing the 31 million gallons of salt waste stored in underground tanks at SRS. Parsons finished building SWPF in April 2016, eight months ahead of schedule and more than \$65 million under the target cost of the contract for construction activities. Under its contract with the DOE, Parsons will operate the SWPF for one year, until January 2022.

As noted, the DOE approved Critical Decision-4 for SWPF in August 2020, which authorized radioactive (hot) operations to begin at the facility. Hot commissioning of SWPF officially began on October 5, 2020, with the transfer of the first batch of radioactive waste to the facility. That first batch of approximately 4,000 gallons of waste took about two weeks to process as the facility went through a series of surveillances and sampling inspections to ensure all aspects of the process worked as designed. By the end of the first month of operation, during the facility's hot commissioning testing phase, SWPF had processed nearly 86,000 gallons of waste, according to the DOE.



A cell within the IWTU where canisters are filled with solidified waste.

“The start of operations enables DOE to now close waste tanks at an unprecedented rate,” said Mike Budney, DOE manager for the Savannah River Operations Office, following the completion of hot commissioning testing.

## Idaho

While construction of the Integrated Waste Treatment Unit (IWTU) was completed in 2012, several equipment and chemistry issues have kept the facility from beginning treatment of Idaho’s 900,000 gallons of liquid radioactive waste. The sodium-bearing waste, stored in three underground tanks at the Idaho Nuclear Technology and Engineering Center, was generated during later phases of spent nuclear fuel reprocessing, which ended in 1992. Located near the research center, the IWTU uses a steam-reforming technology that will convert the liquid to a solid, granular material, which will be packaged in stainless steel canisters and stored in concrete vaults at the site until a permanent disposal facility becomes available.

Delays at the IWTU put the DOE in breach of a 1995 settlement agreement between the federal government and the state of Idaho that set deadlines for waste disposal. That led Idaho Attorney General Lawrence Wasden to block shipments of research quantities of spent nuclear fuel to Idaho National Laboratory (INL) in 2016. Wasden and Gov. Brad Little later signed a deal with the DOE allowing shipments of research fuel, but the IWTU still needs to begin processing waste before INL can receive the fuel.

In 2016, the DOE awarded the Idaho Cleanup Project contract to Fluor Idaho, which has been making modifications to the IWTU to resolve the fluidization, chemical, and equipment issues that have hampered the startup of the facility. In spring 2020, the DOE and Fluor Idaho resolved the last of those problems when it concluded testing of new ceramic filters used in the IWTU’s off-gas system.

On January 19, the DOE announced that SWPF had completed its hot commissioning testing phase, signaling the facility’s entrance into fully integrated operations with the other SRS liquid waste facilities. At that point, more than 320,000 gallons of radioactive liquid waste from the site’s H Tank Farm had been processed by SWPF.

According to the DOE, all SWPF hot commissioning testing objectives were met, on schedule and without incident, including validating facility processing capacity at an instantaneous rate that exceeded the 7.3 million gallons per year required by contract. It is anticipated that SWPF will process up to 6 million gallons of waste during its first year of operations and that nearly all of Savannah River’s salt waste inventory will be processed by 2030.



Startup of the IWTU at the DOE's Idaho cleanup site was to begin late last year but was delayed due to COVID-19. Inset: Stainless steel canisters are stored at the IWTU in anticipation of hot operations.



Previous process gas filters used at IWTU were constructed of a metal matrix. During several demonstration runs of the facility, the metal filters became plugged, reducing their efficiency. A 1,262-hour pilot plant demonstration, concluded last year at Hazen Research, an industrial laboratory in Golden, Colo., showed that ceramic filters were effective at removing fine solids without clogging.

During the most recent outage (Outage J) of the IWTU, the new ceramic filters were installed in the unit's off-gas system. Also during Outage J, wet and dry decontamination technologies that will enable crews to replace equipment during waste treatment operations were installed, along with robotics used to decontaminate stainless steel canisters prior to being placed in concrete vaults.

"Long-term testing has concluded on the ceramic filters—they are still going through the outage, but I'm confident we have addressed the technical challenges that have prevented startup for the past few years, and we hope to get it up and running within the next few months," White said in September.

In January, Fluor Idaho said that the effects of COVID-19 have caused the schedule for completing Outage J to slip at least five to six months, which will delay the start of hot operations. At the time, modifications to the IWTU were nearly complete in advance of a 50-day confirmatory run planned for this year. Following a successful confirmatory run, the IWTU will go through a series of readiness assessments prior to starting radiological operations, Fluor said, adding that the project "will continue with a methodical approach to perform field work within protective guidelines."

The slip in the schedule caused by COVID-19 caused the DOE to miss one of its stated priorities for 2020. Startup of the IWTU was listed under Priority #1 of the department's mission priorities scorecard for the year.

A team conducts walk downs of systems in the WTP's Effluent Management Facility, which will treat effluent generated from the vitrification of Hanford's liquid waste.



## Hanford

At the heart of Hanford's liquid waste program is the Waste Treatment and Immobilization Plant (WTP), also known as the Vit Plant, a complex of buildings that has been under construction for nearly 20 years and, according to a May 2020 report by the Government Accountability Office, costing more than \$11 billion to date, with numerous technical challenges, cost overruns, and schedule delays.

The WTP was to separate Hanford's approximately 56 million gallons of chemical and radioactive tank waste into high- and low-activity waste streams, which would be sent to different WTP facilities simultaneously for vitrification. When technical issues—ranging from the mixture of waste prior to treatment to the potential erosion of piping—halted construction of the WTP's pretreatment facility in 2012, the DOE switched to a sequenced strategy that would allow low-activity waste to be processed before the completion of the pretreatment facility. The approach, known as Direct-Feed Low-Activity Waste (DFLAW), would allow the DOE to meet its commitment to the state of Washington to begin treating tank waste by 2023.

A system of interdependent projects and infrastructure improvements, DFLAW begins with the Tank-Side Cesium Removal System, a pretreatment system that will filter out suspended solids and remove radioactive cesium to produce low-activity waste feed from tank waste liquid. The waste will then be sent to the WTP's Low-Activity Waste (LAW) Facility, where the waste is vitrified and placed into stainless steel containers. The size of one-and-a-half football fields, the LAW Facility houses two large melters that will mix tank waste and glass-forming materials at 2,100 °F. Secondary liquid waste generated by the LAW Facility will be treated at the Effluent Management Facility, which was the final major construction effort to support DFLAW.

In December, workers with Hanford contractor Bechtel National completed construction of the last of 94 systems in the LAW Facility. And in January, the DOE marked the conclusion of construction activities at the WTP, with all engineering, procurement, and construction being completed on the plant's 17 facilities that will be used in the DFLAW approach, including the LAW Facility, the Effluent Management Facility, the Analytical Laboratory, and 14 support structures. With construction completed, the WTP facilities have now been moved to the startup testing and commissioning phases to prepare for operations.



In marking the construction milestone, DOE Hanford Manager Brian Vance said, “As the plant moves to full commissioning, other Hanford contractors continue to drive to prepare for round-the-clock operations by completing projects and infrastructure improvements that must operate for the plant to be successful. We are moving deliberately and safely toward treating tank waste and meeting our commitment to continue to protect our workforce, the people of this region, and our environment.”

As they are completed, the LAW Facility systems are turned over to a startup testing team to ensure they work properly prior to commissioning. As of late December, more than a third of the 94 LAW Facility systems have been tested and handed over to plant management for commissioning.

This includes the testing of transfer lines that will move condensate from the LAW Facility to a nearby

retention facility. Bechtel National, in collaboration with Washington River Protection Solutions, completed the testing of the transfer lines late last year.

Earlier in 2020, Hanford staff finished startup testing at WTP’s Analytical Laboratory, which will analyze up to 3,000 samples of waste each year to make sure it meets disposal requirements.

The DOE said in January that while the full impacts of the COVID-19 pandemic are unknowable, the department is committed to completing commissioning of DFLAW before the December 2023 deadline imposed by the DOE’s consent decree with the state of Washington. A force majeure modification to the decree’s deadlines, approved by a federal court in December, does provide legal accommodation for the realities imposed by the pandemic. Yet the DOE maintains that the modification does not reflect an actual change to its schedule.

“The start of tank waste treatment at Hanford is an existential victory that has been decades in the making,” White said. “It marks the beginning for us of real progress in getting to the single largest environmental liability of any U.S. government agency.”

The first set of 20 containers manufactured by Petersen of Utah were delivered to the WTP in October 2020.

