OFFICE OF INSPECTOR GENERAL

U.S. Department of Energy

AUDIT REPORT

DOE-OIG-20-57 September 2020

TANK WASTE MANAGEMENT AT THE HANFORD SITE

Department of Energy
Washington, DC 20585

September 30, 2020

MEMORANDUM FOR THE SECRETARY

FROM: Teri L. Donaldson
Inspector General

SUBJECT: INFORMATION: Audit Report on "Tank Waste Management at the Hanford Site"

RESULTS IN BRIEF

We found that there is a risk that the Department of Energy may be challenged to safely store tank waste at the Hanford Site until the end of the cleanup mission. Specifically, the conditions of the single-shell tanks (SST) and some double-shell tanks (DST) have deteriorated over time and sufficient DST space may not be immediately available to accommodate additional failed tanks. Despite the deteriorating conditions of the tanks over time, the DSTs will need to contain the tank waste until at least 2047. As of February 2020, DSTs have 5,829,000 gallons of available space. However, only 2,529,000 gallons of this space is usable to store waste from future potential DST leaks because some of this space is restricted due to chemical hazards. As a further complication, tank waste is stored at both the Hanford Site 200 West Area and the 200 East Area, which are separated by about 6.5 miles. We found that the waste pipeline that extends between the two areas is not in service. According to Department officials, the Department has implemented various actions to manage tank waste in a manner that balances risk with cleanup completion. For example, some actions already completed include forming a Tank Integrity Expert Panel, performing SST and DST Integrity Evaluations, performing major upgrades to Tank Farm systems, and addressing the lack of DST space. However, the risks posed by additional tank failures remain a concern. Until the issues we identified are addressed, the Department faces an increased risk to the safe storage of its tank waste while the cleanup mission remains incomplete.

BACKGROUND

The Department of Energy's Office of River Protection manages the River Protection Project at the Hanford Site (Hanford). The Office of River Protection's mission is to safely, efficiently, and effectively treat tank waste. It is responsible for the storage, retrieval, treatment, and disposal of radioactive waste contained in the waste tanks and the closure of all tanks and associated equipment. Washington River Protection Solutions, LLC is the contractor in charge of managing the tank waste until it is prepared for disposal. The mission of the River Protection Project is to protect the Columbia River by safeguarding the nuclear waste stored in underground tanks and to manage the waste safely and responsibly until it can be treated for final disposition.

After decades of plutonium production activities at Hanford, about 56 million gallons of radioactive waste remains stored at Tank Farms. In order to store the waste until treatment and disposal, the Department constructed 177 underground tanks, with capacity ranging from 55,000 to over 1 million gallons each. Of these tanks, 149 are a single-shell tank (SST) design that consists of a carbon-steel tank encased in concrete with a design life of about 20 years. These tanks were built between 1943 and 1964. Currently, all SSTs are well past their design life and do not meet current regulatory requirements.

The remaining 28 tanks were built between 1968 and 1986 with a double-shell tank (DST) design. The DSTs have a carbon-steel inner tank with a separate steel liner surrounding it. The tank liners are separated by an air space, or annulus, of about 30 inches, which is armed with a leak detection system. Unlike the SSTs, the DSTs meet current Federal and state regulations. We initiated this audit to determine if the Department can safely store tank waste at Hanford until the end of the cleanup mission.

RESULTS OF AUDIT

We found that there is a risk that the Department may be challenged to safely store tank waste at Hanford until the end of the cleanup mission. Specifically, the conditions of the SSTs and some DSTs have deteriorated over time, and sufficient DST space may not be immediately available to accommodate additional failed tanks. Further, the Department's response to tank failures in a timely manner is complicated by available emergency tank space that is not conducive to the immediate retrieval of a failed tank.

Despite the deteriorating conditions of the SSTs and DSTs over time, the DSTs will need to contain the waste until at least 2047. Currently, all SSTs are beyond their design life and have been determined unfit for use by the Department based on the 2002 *Single-Shell Tank Structural Integrity Assessment Report*. Furthermore, all DSTs will be 11 to 51 years past their design life before all waste is required to be treated by 2047. After confirming in 2012 that a DST leaked, which was the first DST to leak, the Department subsequently transferred the leaking tank's waste to another sound DST and took the leaking tank out of service. Since that time, the Department has identified several other DSTs that may be at risk for tank bottom corrosion.

In addition, sufficient DST space may not be available to accommodate additional failed tanks. Tank waste is stored at both the Hanford 200 West Area and 200 East Area, which are separated by about 6.5 miles. As of February 2020, DSTs in the 200 West Area do not include sufficient available space to hold the waste if one DST leaked, and DSTs in the 200 East Area do not include sufficient available space to hold the waste if multiple DSTs leaked. Moreover, in order to access the available DST space in both areas, the Department must use the cross-site waste transfer system. Currently, the system is not in service and has not been used since 2007.

Furthermore, the Department has faced challenges initiating emergency pumping of waste from a leaking DST in a timely manner. After the Department determined that a DST had leaked in 2012, it took almost 5 years to empty the tank. To the Department's credit, it demonstrated that it could successfully remove DST waste; however, the Department recognized that the effort was time-consuming and costly. The available emergency tank space is not conducive to retrieving

multiple, simultaneous failed tanks in the 200 East Area in a timely manner because the available space is distributed among 18 DSTs. Each DST has a capacity of at least 1 million gallons; however, 9 of the 18 tanks each have only up to 156,000 gallons of available space. Therefore, any retrieval from a failed tank may require transfers into multiple tanks. It is more complicated to move waste into multiple tanks rather than to one.

We attributed the problems identified in this report to weaknesses in Department oversight as described below. Specifically, the Department has inadequately evaluated the effects of potential multiple DST failures and has not maintained the operability of the tank waste cross-site transfer system.

Furthermore, the Department's plan to facilitate the safe and timely transfer of waste in the event of an emergency is outdated. According to the Department, it will update its plan this year, which includes an evaluation of potential multiple DST failures.

According to Department officials, the Department has implemented various actions to manage tank waste in a manner that balances risk with cleanup completion. For example, some actions already completed include forming a Tank Integrity Expert Panel, performing SST and DST Integrity Evaluations, performing major upgrades to Tank Farm systems, and addressing the lack of DST space. However, the risks posed by additional tank failures remain a concern.

Until the issues we identified are addressed, the Department faces an increased risk to the safe storage of its tank waste while the cleanup mission remains incomplete. Furthermore, the Department faces risks of a contamination event from failed tanks without an adequate path forward to address the situation, which could affect workers, the public, and the environment.

MANAGEMENT RESPONSE

Management concurred with each of the report's recommendations. Its comments and proposed corrective actions are responsive to our recommendations. Management's comments are included in Appendix 3.

cc: Deputy Secretary
Chief of Staff
Under Secretary for Science
Senior Advisor for Environmental Management to the Under Secretary for Science

TANK WASTE MANAGEMENT AT THE HANFORD SITE

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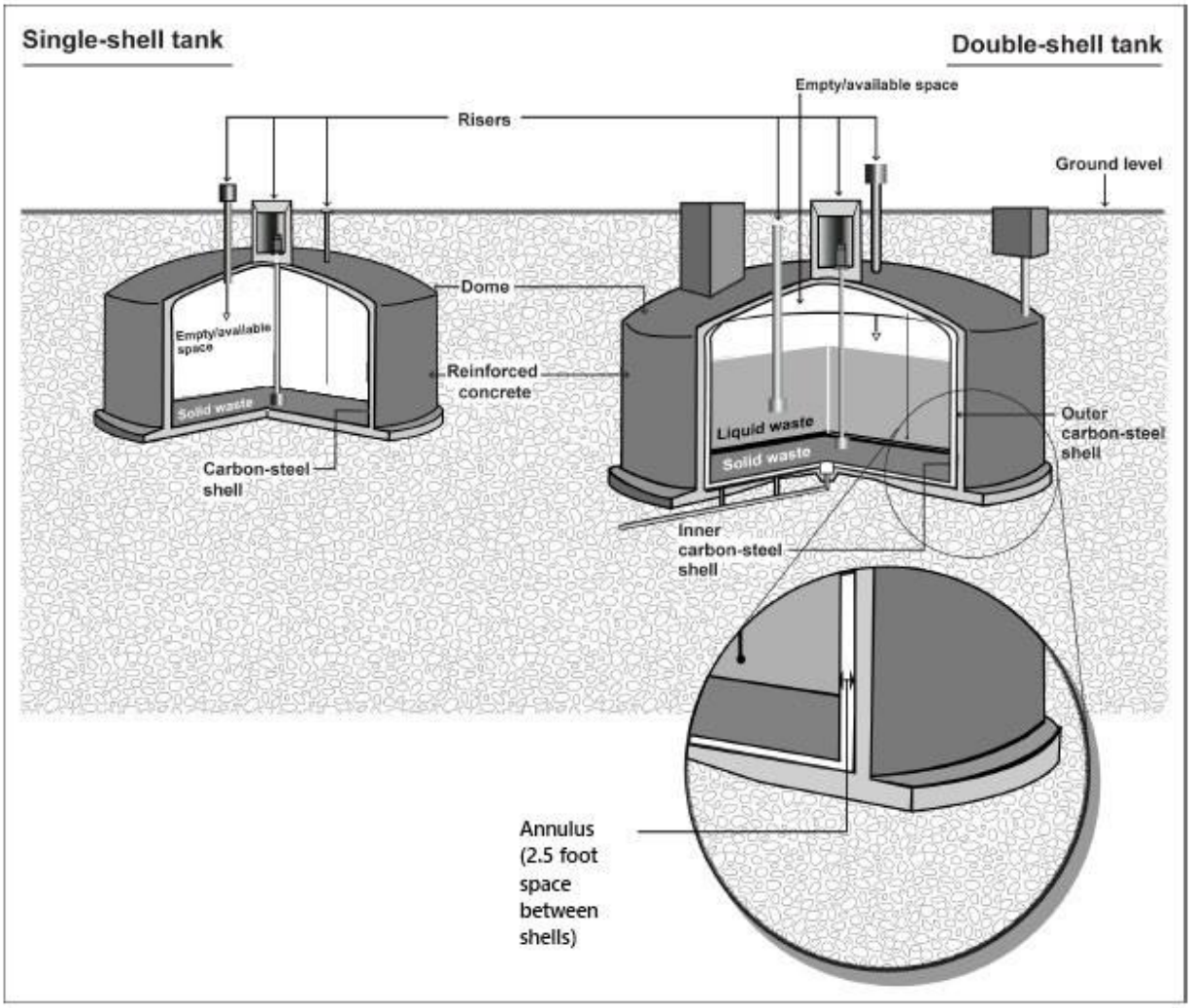
BACKGROUND

The Department of Energy's Office of River Protection manages the River Protection Project at the Hanford Site (Hanford). The Office of River Protection's mission is to safely, efficiently, and effectively treat tank waste. It is responsible for the storage, retrieval, treatment, and disposal of radioactive waste contained in the waste tanks and the closure of all tanks and associated equipment. The Washington River Protection Solutions, LLC (WRPS) is the contractor in charge of managing the tank waste until it is prepared for disposal. The mission of the River Protection Project is to protect the Columbia River by safeguarding the nuclear waste stored in underground tanks and to manage the waste safely and responsibly until it can be treated for final disposition.

After decades of plutonium production activities at Hanford, about 56 million gallons of radioactive waste remains stored at Tank Farms. In order to store the waste until treatment and disposal, the Department constructed 177 large underground tanks with capacity ranging from 55,000 to over 1 million gallons each. Of these tanks, 149 are a single-shell tank (SST) design that consists of a carbon-steel tank encased in concrete with a design life of about 20 years. The Department constructed SSTs between 1943 and 1964. SSTs are considered "interim stabilized," meaning all free liquids have been removed, minimizing the chance of leakage.
Currently, all SSTs are well past their design life and do not meet regulatory requirements.

The Department constructed the remaining 28 tanks between 1968 and 1986 with a double-shell tank (DST) design. The DSTs have a carbon-steel inner tank with a separate outer steel tank surrounding it. The outer steel tanks are separated by an air space, or annulus, of about 30 inches, which is armed with a leak detection system, and routinely monitored by remote cameras. Visual and ultrasonic testing inspections are also routinely conducted to support continued evaluation of tank conditions. Unlike the SSTs, the DSTs meet Federal and state regulations. Nevertheless, the DSTs are starting to show signs of aging; DSTs have a design life between 20 and 50 years, depending on the tank. According to Department officials, it can continue to store waste in the tanks through testing, monitoring, and periodic independent evaluations.

The figure below depicts a cross section of the SST and DST design. The DST annulus allows the Department to use remote leak detection sensors and cameras to detect signs of corrosion or leaks.



Sources: GAO and DOE. | GAO-15-40

The River Protection Project's mission involves two parallel efforts, both aimed at reducing the threat posed by the hazardous radioactive tank waste:

- Retrieve waste from 149 SSTs to 27 DSTs where it can be safely stored awaiting treatment; and

- Treat the tank waste, producing a stable waste form that can be permanently disposed.

These efforts must be performed in parallel because the DST system does not have the capacity to hold all of the waste currently in the SSTs.

Tank Regulations

Federal and Washington State laws and regulations govern the Department's storage of waste at Hanford. The Department's tank waste cleanup program at Hanford is governed by the *Atomic Energy Act of 1954* and the *Resource Conservation and Recovery Act of 1976*, as amended (RCRA), which is implemented by Washington State under its *Hazardous Waste Management Act*.

RCRA governs the treatment, storage, and disposal of hazardous waste and the non-radioactive hazardous waste component of mixed waste. The tank waste at Hanford is considered mixed waste because it contains both chemically hazardous and certain radioactive materials.

For the hazardous waste in the tanks, RCRA establishes three key requirements:

- **Tank Integrity.** Tanks must have a secondary containment shell, and a qualified professional engineer must conduct an integrity assessment to determine whether the tanks are fit for use.

- **Leak Detection.** Tanks must have a leak detection system in place to detect failures of either the primary or secondary containment structure, or any release of waste in the secondary containment system within 24 hours or at the earliest practicable time.

- **Leak Response.** Within 24 hours after leak detection or, if not possible, at the earliest practicable time, the tank owner must remove as much of the waste or accumulated liquid as necessary to prevent further release of waste to the environment and allow inspection and repair or closure of the tank. Any release to the secondary containment structure must be removed within 24 hours or in as timely a manner as possible.

Beginning in the 1970s, the Department began transferring much of the more mobile liquid waste from the SSTs to the DSTs. This process, referred to as interim stabilization, was largely completed by 2005. In 2003, the Department began removing the remaining waste from the SSTs and transferring it to DSTs; this activity is still underway. This work is governed by two main compliance agreements: (1) the *1989 Hanford Federal Facility Agreement and Consent Order*, or *Tri-Party Agreement* (TPA), an agreement between the Department, Washington State Department of Ecology (Ecology), and the Environmental Protection Agency; and (2) a *2010 Consent Decree*, issued by the United States District Court, Eastern District of Washington.

Under the *October 2018 Amended Consent Decree*, the Department is required to retrieve waste from nine SSTs (transferring the waste to DSTs) by September 30, 2026, and under the *March 2016 Amended Consent Decree*, is required to have the Low Activity Waste facility commissioned by December 2023. In addition, the TPA requires the Department to retrieve all SST waste by 2040 and to retrieve and treat all DST waste by 2047.

DETAILS OF FINDINGS

There is a risk that the Department may be challenged to safely store tank waste at Hanford until the end of the cleanup mission. Specifically, the conditions of the SSTs and some DSTs have deteriorated over time, and sufficient DST space may not be immediately available to accommodate additional failed tanks. Further, the Department's response to tank failures in a timely manner is complicated by available emergency tank space that is not conducive to the immediate retrieval of a failed tank.

Age and Condition of Tanks

The conditions of the SSTs and some DSTs have deteriorated over time, but the DSTs will need to contain the waste until 2047. Currently, all SSTs are beyond their design life, and all DSTs will be 11 to 51 years past their design life before all waste is required to be treated by 2047.

Single-Shell Tanks Past Design Life

Currently, all SSTs are well past their design life and are unfit for use. These tanks were built between 1943 and 1964 and had design lives of about 20 years. The TPA requires the Department to perform integrity assessments to determine whether the SSTs have the structural integrity to prevent collapse, rupture, or failure. The first integrity assessment completed in June 2002 determined that the long-term leak integrity for the liquids remaining in the SSTs could not be proven given the prior SST leak history and the condition of the tanks. Therefore, SSTs were declared unfit for use and could not be used to store additional waste. However, the integrity assessment also concluded that the reinforced concrete tank structures had an adequate collapse margin, justifying continued safe storage of the waste through retrieval and closure.

In addition, the integrity assessment declared the ancillary equipment unfit for use. Ancillary equipment includes subordinate tank systems, vaults, transfer pipelines, pump pits, lift stations, catch tanks, unloading stations, and other components used to treat, store, or transfer the waste within the boundary of the SST system. Consequently, the Department and Ecology negotiated and agreed to a comprehensive series of enforceable milestones in the TPA to allow temporary continued use of SSTs and ancillary equipment pending SST closure.

Furthermore, 59 of the 149 SSTs are assumed leakers. An assumed leaker is a storage tank where surveillance data has indicated at one time or another a potential for the loss of liquid to the environment that is attributable to a breach of integrity. For example, in 2013, the Department found that tank T-111 was leaking waste into the ground at a rate of about 640 gallons a year. Currently, this is the only SST the Department is aware of that is leaking. In addition, water continues to intrude into the SSTs. For example, in 2014, the Department examined all SSTs and found that water was intruding into at least 14 tanks and adding 10 to 2,000 gallons of water annually to each tank. In January 2019, the Department provided information indicating that it had examined 84 SSTs and found that 24 SSTs had water intrusion ranging from 12 to 1,000 gallons of water annually to each tank. Water intrusion adds to the amount of waste in each tank and makes it difficult to determine whether a tank is leaking.

An estimated remaining useful life for the SSTs cannot be determined. In 2018, the Department conducted a second integrity assessment that was limited to a structural review of the SSTs. The focus was limited because the 2002 integrity assessment had declared the SSTs and associated ancillary equipment unfit for use. Washington Administrative Code 173-303-640 requires that an estimated remaining useful life of the tanks be determined, if practical. However, the 2018 integrity assessment could not make this determination due to the lack of SST structural data.

According to Department officials, available structural data includes visual inspections of the concrete dome, the part of the tank above the carbon-steel liner, and testing of actual rebar and concrete specimens from a limited selection of SSTs. Data is unavailable for wall thicknesses or visual observation of about 40 percent of the tanks. Dome deflection surveys, visual inspections, and evaluation of concrete and rebar samples have shown an insignificant degradation in the structure of the SSTs.

Deteriorating Double-Shell Tanks

The DSTs are at risk for tank bottom corrosion and thinning of the secondary liners. For example, in 2012, the Department found that DST AY-102 was leaking waste from its primary shell. Initially, the Department suspected that construction problems caused the leak, but a WRPS inspection in 2017 found that the leak was due to internal corrosion problems. The Department subsequently removed DST AY-102 from service and emptied the waste from the tank. In 2018, the *Internal Tank Bottom Corrosion Study for Double-Shell Tanks* concluded that while early transfers to DST AY-102 were unique, several other DSTs might be at risk for tank bottom corrosion because they had similar risk factors as AY-102. Of highest concern are tanks AY-101, AZ-101, and AZ-102. Furthermore, these tanks are past their design lives. For example, AY-102 and AY-101 were put into service in 1971 with a 40-year design life, and AZ-101 and AZ-102 were put into service in 1976 with a 20-year design life. All DSTs will be 11 to 51 years past their design life by 2047, which is the TPA milestone date to have all tank waste removed and treated.

In addition, ultrasonic testing found thinning of the steel in the bottom of the secondary liners for 9 of 11 DSTs tested. The testing determined that tank AP-102's secondary liner was up to 70 percent thinner in the small area tested. According to the Department, it will inspect the area again in another 5 years to confirm that thinning is not progressing, as recommended by the Tank Integrity Expert Panel. The Department is only able to test a small area of the secondary liners and may have insufficient information to determine the full extent of corrosion in the secondary liners. Currently, WRPS can only investigate a maximum of 8 percent of the secondary liner floor from the annulus due to limitations of the inspection process. Of that 8 percent, only 25 percent can be practically inspected due to obstructions in the annulus. Based on the results gathered, the DSTs are still in working condition. Additionally, WRPS recently deployed new visual and ultrasonic testing equipment that is capable of inspecting the bottom of the primary tank. According to the Department, the annulus floor space inspected is adequate to project the condition of the liner.

Limited Double-Shell Tanks Availability

The Department may have insufficient DST space available to store waste from additional DST leaks. As of February 2020, DSTs have 5,829,000 gallons of available space. However, not all

of this space is usable to store waste from future potential DST leaks for various reasons. For example, some of this space is restricted. Restricted space is associated with flammable gas due to hydrogen generation in certain tanks, resulting in safety issues. In addition, DST space will be needed for five planned waste transfers from SSTs to DSTs, which will occur through 2024. Furthermore, not all of the available DST space is located in the same geographic area. For example, DST waste is stored in both the Hanford 200 West Area (3 DSTs) and 200 East Area (25 DSTs), which are located about 6.5 miles apart, limiting their accessibility.

The following chart illustrates the usable available space after considering the restricted space, required planned waste transfer space, and geographic locations of the DSTs.

	All DSTs	3 DSTs 200 West Area	25 DSTs 200 East Area
Total Available Space (Gallons)	5,829,000	1,099,000	4,730,000
Restricted Space	1,156,000	427,000	729,000
SST Waste Transfers	2,144,000	N/A	2,144,000
Total Usable Space	**2,529,000**	**672,000**	**1,857,000**

Considering these factors, if a DST leaked in the 200 West Area, there is not enough usable space in the other two 200 West Area DSTs to store the waste. DST capacity ranges from 1 million to approximately 1.3 million gallons. As a further complication, the Department cannot transfer waste from a DST in the 200 West Area to the 200 East Area. To access the available space in the 200 East Area, the Department must use the cross-site transfer system. Currently, both pipelines of the transfer system are not in service. The transfer system is configured in two pipes: one pipe for liquids (also known as supernates) and one pipe for solids (also known as slurry). Specifically, the Department has not used the liquid pipeline since 2007, and the solids pipeline was never placed into service. The transfer system is the only RCRA compliant system that can transport waste between the 200 West Area and the 200 East Area. Its operation is a critical component to access usable DST space in the event of a leak. The Department has been planning to place the supernate pipeline into service in 2025.

Furthermore, if multiple DSTs leaked in the 200 East Area, there would not be enough space available to store the waste. There is a risk that this could occur. For example, as previously discussed, the Department concluded that several other DSTs might be at risk for tank bottom corrosion, DSTs AY-101, AZ-101, and AZ-102. These tanks are located in the 200 East Area and store a combined total of 2,494,000 gallons, as of February 2020, which exceeds the current usable space. In addition, according to Department officials, sufficient space is available if a single DST failed. If more than one failed before the Waste Treatment and Immobilization Plant (WTP) is operational, there would not be enough available space to address the leaks without impacts to other mission elements such as SST retrievals.

The Department's current plan to address the limited DST space availability is to process DST liquid waste through the WTP's direct feed low-activity waste approach. This approach treats low-activity liquid waste from the DSTs and turns the waste into glass. According to a Department official, once the WTP's direct feed low-activity waste approach is operational, it

will eliminate the concern regarding sufficient DST space availability. Currently, the Department plans to begin treating waste using this method before the end of calendar year 2023. However, until this approach is operational, the risk remains that sufficient DST space will not be available to handle additional failed DSTs. Any delays in implementation of the direct feed low-activity waste approach could lengthen the period for storing the waste in the tanks.

Currently, the Department does not have plans to construct new DSTs to address space availability. However, the Department has considered three scenarios in its System Plan that estimated the number of new DSTs required to achieve predefined SST retrieval completion goals. For example, the most conservative scenario examined the construction of 12 DSTs at a cost of $5 billion, which includes operations and tank closure costs.

Challenges to Tank Waste Removal

The Department has faced challenges initiating emergency pumping of waste from a leaking tank in a timely manner. For example, although the Department had been aware of the leak in DST AY-102 since August 2012, it did not begin pumping operations until March 2016. The RCRA requirement is to begin emptying waste from the primary tank until further leaking is not possible, and remove leaked waste from the secondary tank within 24 hours of leak discovery, or as soon as practicable. In addition, Ecology had requested that the Department start pumping operations since October 2012 of the primary tank contents. According to a Department official, it delayed pumping operations because it identified a sludge layer that was still generating heat. Had pumping operations taken place before addressing the sludge layer, the heat could have caused a nuclear safety issue.

Eventually, Ecology and the Department reached an agreement in September 2014 to begin pumping the waste no later than March 2016 and to have the waste removed by March 2017, almost 5 years after the leak was first discovered. However, even though the Department delayed pumping for safety reasons, it took 3 years to retrieve DST AY-102 after Ecology and the Department reached their agreement. The retrieval of the waste cost $90 million and required about 2 years to design, procure, fabricate, install, and test transfer equipment, and then an additional year to pump out the waste. Like DST AY-102, many of the DSTs will require additional equipment installation to transfer liquids to an emergency tank, and all of the tanks require additional equipment installation to transfer solid waste. According to a Department official, the greatest risk to the environment is liquid waste, which can be pumped much easier than solid waste. Finally, to the Department's credit, it demonstrated that it could successfully remove DST waste; however, the Department recognized that the AY-102 effort was time-consuming and costly.

Difficulty Accessing Emergency Tank Space

Emergency tank space is not conducive to the immediate retrieval of waste from a failed tank in a timely manner. The Department's plan for emergency pumping is to have 1,265,000 gallons of DST space available. The available emergency tank space is distributed amongst 18 DSTs. However, 9 of the 18 tanks each have up to 156,000 gallons of available space; therefore, any retrieval from a failed tank may require transfers into multiple tanks. This would complicate

retrieval operations and increase the time needed to empty a failed tank. In addition, the Department must consider waste compatibility when transferring waste between tanks, further complicating transfer operations.

According to the Department, once the WTP's direct feed low-activity waste capability is operational, it will eliminate the concern regarding sufficient DST space availability. The Department plans to begin treating waste using this method before the end of calendar year 2023.

Weaknesses in Federal Oversight

We attributed the problems identified in this report to weaknesses in Department oversight as described below. Specifically, the Department has inadequately evaluated the effects of potential multiple DST failures and has not maintained the operability of the transfer system. Specifically, the Department has inadequately evaluated the effects of potential multiple DST failures and has not maintained the operability of the transfer system. Furthermore, the Department's plan to facilitate the safe and timely transfer of waste in the event of an emergency is outdated.

Inadequate Plans to Address Tank Failures

The Department has inadequately evaluated the effects of multiple DST failures. The TPA requires the Department to prepare a System Plan every 3 years. The System Plan Revision 8, dated October 2017, evaluated 11 technical scenarios, or alternative strategies, and provided rough cost and schedule estimates for completing the River Protection Project mission. The System Plan's primary purposes are to provide a baseline for executing the mission and to explore alternate operating scenarios for the River Protection Project tank waste treatment complex in support of the TPA. The TPA, combined with the Consent Decrees, form many of the underlying requirements in the scenarios. The System Plan includes the following minimum information for each scenario evaluated:

- A system description for each system utilized in the planning;
- Planning bases for each case; and
- A description of key issues, assumptions, and vulnerabilities for each scenario evaluated, including a description of how such issues, assumptions, and vulnerabilities are addressed in the evaluation.

We noted in our review of the current System Plan that the Department did not include scenarios that evaluated the effects of multiple DST failures. This appears contrary to the Department's concern about other DSTs that are past their design lives and are similar to the first DST (AY-102) that has already failed, as previously mentioned. According to the Department, the next System Plan, due in 2020, will include an evaluation of potential multiple DST failures.

Inoperability of the Cross-Site Transfer System

The Department has not maintained the operability of the cross-site transfer system. Current transfer system issues include the reliability of the leak detection system and the integrity of the piping system. Upgrades to the transfer system will be required before tank waste can be

transferred between the 200 East Area and 200 West Area. These upgrades include installation or replacement of pumps, replacement of some valves in the pits that are used to route the waste, and activation of the transfer system. In January 2019, WRPS developed a plan to restore the operability of part of the transfer system. Specifically, the plan will only restore the operability of the liquid pipeline, which WRPS plans to complete in fiscal year 2022. This plan does not address the operability of the solids pipeline. Both pipelines were installed in 1998; however, the solids pipeline did not pass its readiness testing and was never placed into service. Since that time, the Department has not taken action to place the solids pipeline into service. According to Department officials, due to unresolved nuclear safety issues with the solids line and no near-term need for the solids line, only the liquids line was placed into service.

Outdated Emergency Pumping Guide

The Department's *Double-Shell Tank Emergency Pumping Guide* (Guide) is outdated and does not facilitate the safe and timely transfer of waste in the event of an emergency. The Department last revised the Guide in 2009. According to the Department, an update to the Guide will be completed in 2020. The purpose of the Guide is to provide as much preplanning as practical for pumping waste out of a DST's primary tank system and annulus in the event of a leak. However, it took the Department 3 years to design, procure, construct, install equipment, and fully retrieve waste leaking from DST AY-102. Additionally, the Guide identified eight transfer pipelines as necessary for emergency pumping. The pipelines listed as non-compliant in the Guide had not been pressure tested, as of January 2019. In the event of a leak, the non-compliant lines will need to be pressure tested prior to pumping operations and could delay the timely transfer of waste. According to a Department official, Ecology is currently negotiating TPA milestones to have these non-compliant lines tested prior to the next integrity assessment scheduled in 2026.

In response to the efforts made to resolve the DST AY-102 primary tank leak, the Department is reevaluating its plan to address future tank leaks. Specifically, according to Department officials, it is working with Ecology to draft a new DST Leak Response Plan that guides any DST leak response effort through four phases: (1) Evaluation; (2) Near-Term Action; (3) Remaining Waste Retrieval; and (4) Inspection and Return to Service or Closure. This new process incorporates the specifics for any given situation into a Response Work Plan, similar to the Department's efforts for SST retrieval. Currently, this new DST Leak Response Plan is undergoing further Department review.

Current Efforts

According to Department officials, the Department has implemented various actions to manage tank waste in a manner that balances risk with cleanup completion. For example, some actions taken include forming a tank integrity program and a Tank Integrity Expert Panel, performing SST and DST Integrity Evaluations, performing major upgrades to Tank Farm systems, and addressing the lack of DST space.

The Department has established a tank integrity program to monitor and control the tank conditions and waste chemistry to reduce the risk. In 2015, the Department formed a Tank Integrity Expert Panel, comprised of experts from a variety of fields, to advise the Department on best practices to safely manage the tank waste in both the SSTs and DSTs. The Department has

implemented recommendations from the Tank Integrity Expert Panel. From these efforts, technology solutions have been put in place to enhance the Department's ability to monitor and manage tank conditions.

In addition, the Department employed an independent, qualified, registered professional engineer to perform periodic evaluations of the SSTs in 2002 and 2018, and DSTs in 2006 and 2016. These evaluations helped the Department further understand the integrity of the tanks and their ability to continue to store the waste. Moreover, the Department conducts many annual inspections of the DST system and has accomplished major upgrades in the various Tank Farm systems, such as ventilation, camera, and vapor-monitoring. The results, to date, have shown the DSTs remain fit for service, and, according to the Department, are likely to have many decades of useful life.

Furthermore, according to the Department, it is aware that limited DST space is available to address multiple DST failures and has taken action to address the issue. For example, the Department has performed structural and seismic analysis of the tanks to support raising the maximum capacity of some DSTs. In addition, the Department is pursuing a phased initiative to pretreat and grout select liquid tank waste for shipment to a Department-contracted disposal facility in Texas. Phase One of this initiative was completed using 3 gallons of tank waste. Phase Two, which is under consideration, will process 2,000 gallons of tank waste, and if successful, Phase Three could pretreat several hundred thousand gallons of tank waste. Finally, the Department's current plan to process DST liquid waste through the WTP's direct feed low-activity waste approach will address the limited available DST space. According to a Department official, once this approach is operational, it will eliminate the concern regarding sufficient DST space availability. In the meantime, however, the risks posed by additional tank failures require the implementation of further mitigation efforts.

Impact

As a result of the issues identified in this report, the Department faces increased risk to the safe storage of its tank waste until the cleanup mission is complete. Furthermore, the Department faces risks of a contamination event from failed tanks without an adequate path forward to address the situation, which could affect the safety of workers, the public, and the environment. A major long-term leak from one of Hanford's waste tanks could allow significant quantities of contamination to enter the soil and groundwater. Contamination in the groundwater could eventually reach the Columbia River, which provides drinking and irrigation water for a significant portion of the Pacific Northwest, as well as a habitat and spawning area for several endangered species of salmon.

RECOMMENDATIONS

To address the concerns identified in this report, we recommend that the Senior Advisor for Environmental Management to the Under Secretary for Science direct the Manager of the Office of River Protection/Richland Operations Office to:

1. Develop plans to address and evaluate the effects of additional double-shell tank failures;

2. Develop the ability to transfer tank waste from the 200 West Area to the 200 East Area, such as upgrading the cross-site transfer system to ensure that it is operational; and

3. Update the *Double-Shell Tank Emergency Pumping Guide*.

MANAGEMENT RESPONSE

Management concurred with each of the report's recommendations. Management stated that it is committed to the safe, efficient, and effective treatment of tank waste and has undertaken significant measures in its oversight and management of tank waste at Hanford. Management stated that managing Hanford tank waste requires a balanced approach that considers, among other factors, safety, risk, cleanup progress, and the availability of funding.

Management's verbatim comments are included in Appendix 3.

AUDITOR COMMENTS

Management's comments and proposed actions are responsive to our recommendations.

OBJECTIVE, SCOPE, AND METHODOLOGY

Objective

We conducted this audit to determine if the Department of Energy can safely store tank waste at the Hanford Site until the end of the cleanup mission.

Scope

This audit was performed from August 2018 through October 2019. We conducted the audit at the Department of Energy's Office of River Protection in Richland, Washington. This audit was conducted under Office of Inspector General project number A18RL045.

Methodology

To accomplish the audit objective, we:

- Reviewed Federal and Department laws and regulations to identify those relevant to the audit objective;
- Interviewed Department and Washington River Protection Solutions, LLC officials;
- Reviewed documents related to the condition and age of tanks;
- Reviewed documents related to the Department's ability to respond to tank failures;
- Evaluated documents to determine if the Department had plans to address tank failures; and
- Reviewed the *Double-Shell Tank Emergency Pumping Guide* to determine if it facilitates the safe and timely transfer of tank waste in the event of an emergency.

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. Accordingly, we assessed significant internal controls and compliance with laws and regulations necessary to satisfy the audit objective.

Because our review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. We relied on computer-processed data to satisfy our objective related to tank waste management at the Hanford Site. However, we did not conduct a data reliability assessment because none of the data used to materially support our findings was obtained from data extracts from databases, data warehouses, or data collected from forms or surveys. We primarily used information that was widely accepted and

obtained from sources generally recognized as appropriate. If an audit relies on information that is used for widely accepted purposes and is obtained from sources generally recognized as appropriate, it may not be practical or necessary to conduct procedures to verify the information.

An exit conference was held with management officials on September 2, 2020.

RELATED REPORTS

Office of Inspector General

- Audit Report on *Accelerated Tank Waste Retrieval Activities at the Hanford Site* (DOE/IG-0706, October 2005). The audit disclosed that, in terms of both schedule and cost, the Department of Energy would not meet its Tri-Party Agreement milestone for the retrieval of waste from the single-shell tanks located at the C-Farm. Based on the Department's latest schedule baseline, completion of retrieval activities in the C-Farm would not be completed until March 2007, or 6 months after the Tri-Party Agreement milestone. Of greater importance, we examined the path forward for completion of retrieval activities in the C-Farm and we were not encouraged by the likelihood of meeting the Departmental schedule or cost goals. For example, the Department's schedule baseline, which was very aggressive, was dependent upon operating 24 hours a day, 7 days a week. However, we found that at the time of the audit, CH2M Hill had not hired any additional personnel needed to enable the contractor to operate on such an expedited schedule. Further, the Department estimated that waste retrieval costs had increased to $215 million, more than doubling the initial estimate.

Government Accountability Office

- Report to the Honorable Ron Wyden, U.S. Senate on *Hanford Cleanup: Condition of Tanks May Further Limit DOE's Ability to Respond to Leaks and Intrusions* (GAO-15-40, November 2014). The Department of Energy's schedule for managing the tank waste did not consider the worsening conditions of the tanks or the delays in the construction of the Waste Treatment and Immobilization Plant, a facility being constructed to treat the waste and prepare it for final, long-term disposal. First, the leak in AY-102, combined with planned waste transfers from single-shell tanks, had reduced the available double-shell tank (DST) storage capacity. Future leaks and intrusions, which become more likely as the tanks' conditions worsen, would place additional demands on the already limited DST storage space, and it was unclear how the Department would respond. According to the Department, recent efforts to evaporate some of the water from the waste had already freed up 750,000 gallons of DST space. Second, in March 2014, the Department announced further delays in the construction of the Waste Treatment and Immobilization Plant and that these delays would affect the schedule for removing waste from the tanks. However, the Department had not estimated the impact of the Waste Treatment and Immobilization Plant's delays on its schedule to remove the waste from the tanks. As a result, the Department could not estimate how long the waste would remain in the aging tanks. In addition, the Department officials and members of a 2014 expert panel who convened to examine the integrity of the DSTs said that corrosion was a threat to DST integrity and that there were deficiencies in the Department's understanding of corrosion in all of the DSTs. The Department lacked information about the extent to which the other 27 DSTs may also be susceptible to corrosion similar to that of AY-102. Without determining the extent to which the factors that contributed to the leak in AY-102 were similar to the other 27 DSTs, the Department could not be sure how long its DSTs could safely store waste.

MANAGEMENT COMMENTS

Department of Energy
Washington, DC 20585

August 8, 2020

MEMORANDUM FOR TERI L. DONALDSON
INSPECTOR GENERAL

FROM: WILLIAM I. WHITE
SENIOR ADVISOR FOR ENVIRONMENTAL MANAGEMENT
TO THE UNDER SECRETARY FOR SCIENCE

SUBJECT: Management Response: "Draft Audit Report: Tank Waste Management at the Hanford Site"

The Department of Energy (DOE) Office of Environmental Management appreciates the work done by the DOE Office of the Inspector General (OIG) in conducting a review of Tank Waste Management at the Hanford Site.

Consistent with its mission statement, the DOE Office of River Protection is committed to the safe, efficient, and effective treatment of tank waste. DOE has undertaken significant measures in its oversight and management of tank waste at the Hanford Site, including formation of a Tank Integrity Expert Panel, performing tank integrity evaluations, developing technology, and performing major upgrades to tank farm systems.

The Tank Integrity Program (TIP) at Hanford is a robust, comprehensive program that enables effective, efficient, and timely efforts to safely manage the waste tanks and ensure their continued viability. As a key part of the program, industry experts routinely evaluate and assess current conditions, offer ideas for evolving techniques, and suggest technology opportunities to enhance longevity. The single-shelled tank and double-shelled tank integrity programs will continue to evolve to enable the tanks to support mission needs.

Management of the tank waste at Hanford requires a balanced approach that considers, among other factors, safety, risk, cleanup progress, and the availability of funding. DOE is currently pursuing a path to treat waste via the Direct-Feed Low-Activity Waste approach while also evaluating alternative treatment processes to accelerate the cleanup mission. Ultimately, the best course of action to address issues with tank waste management and to remove waste from aging tanks is the treatment of the waste currently stored in the tanks.

The attachment details the specific actions being taken by Hanford to address your recommendations.

If you have any questions, please contact Mr. Rob Hastings, Assistant Manager, Tank Farms, Office of River Protection, at (509)376-9824 or robert_hastings@orp.doe.gov.

Attachment

Response to Report Recommendations

Recommendation 1: *Develop plans to address and evaluate the effects of additional DST failures.*

Management Response: Concur

As mentioned in the Office of the Inspector General's (OIG's) Report, the Department of Energy (DOE) has identified several double-shelled tanks (DSTs) with a potentially higher risk of failure due to tank bottom corrosion. In order to assess this risk, DOE is pursuing multiple actions, including waste sampling and enhanced tank inspections of DSTs. For instance, samples of waste from the bottom of AY-101 have been obtained and are currently being analyzed in the laboratory. Furthermore, in conjunction with Pacific Northwest National Laboratory and industry, DOE has developed new technologies to inspect the bottom of DSTs using cameras and ultrasonic technology mounted on miniature robotic crawlers to assess the corrosion of tank bottoms. Hanford continues to explore additional technology advancements to sufficiently assess the integrity of the aging DSTs and to identify the tanks with the highest risk of failure.

The most effective and efficient way to address the effects of a future DST failure is to create storage space within the existing DST system to enable transfer of waste from tanks that are potentially compromised. In order to create sufficient space to mitigate the effects of potential DST failures, waste must be removed from the tanks and treated for disposition, which is currently scheduled to begin as soon as 2022, via the Direct-Feed Low-Activity Waste (DFLAW) process. In addition to DFLAW, DOE concentrates DST waste by utilizing the 242-A Evaporator to create additional storage space within the existing DST system. Upgrades to the 242-A Evaporator are currently underway, with resumption of operations scheduled in 2022, to ensure the continued ability to significantly reduce the volume of DST waste within the current tank system. Structural analysis of two tank farms that may result in increasing the operational storage capacity of 13 DSTs by approximately 1 million gallons is currently underway and expected to be completed in 2020.

DOE recently finalized guidelines for determining the transfer flow within the existing DST system of waste from a potentially failed DST, addressing the potential for additional DST failures and potentially reducing response time. Furthermore, DOE is evaluating the effects of additional DST failures as part of the next revision to the River Protection Project System Plan (System Plan). Through collaboration with the Washington State Department of Ecology (Ecology), DOE is modelling multiple hypothetical tank failures, including but not limited to AY-101, AZ-101 and AZ-102, the results of which will be included in Revision 9 of the System Plan, scheduled to be finalized on October 31, 2020. DOE has separately modeled a number of scenarios in which multiple DSTs are hypothetically assumed to fail using the same modeling tools as those used in the System Plan. Results of these modeling scenarios demonstrate that, while additional DST failures would be problematic, the likelihood of additional failures significantly affecting the overall mission or capability to protect the workforce, public, and environment are low.

Recommendation 2: *Develop the ability to transfer tank waste from 200 West Area to the 200 East Area by, for example, upgrading the cross-site transfer system to ensure that it is operational.*

Management Response: Concur

DOE has identified the necessary upgrades to the cross-site transfer system and is planning to perform the upgrades to support 200 West Area waste treatment operations at the Waste Treatment and Immobilization Plant in alignment with mission need, and in order to make the best use of available cleanup dollars. Furthermore, DOE is evaluating potential opportunities for Low-Level Waste Offsite Disposal (LLWOD), previously referred to as the Test Bed Initiative, to take advantage of opportunities to pretreat and grout tank waste for shipment off-site to a DOE-contracted disposal facility. Permitting activities to support LLWOD are planned in 2020. The near-term benefits of such an approach would make DST space available in the 200 West Area until the cross-site transfer system can be upgraded in alignment with mission need. Deployment of similar processes in the east area could also make additional DST space available. Treatment and shipment of the tank waste would result in safe, meaningful environmental risk reduction.

Recommendation 3: *Update the Double-Shell Tank Emergency Pumping Guide.*

Management Response: Concur

DOE has consulted with Ecology to make suitable plans in the event of a DST failure. For instance, DOE coordinated with Ecology to replace the overly prescriptive DST Emergency Pumping Guide with a DST Leak Response Plan. This plan, completed on June 30, 2020, outlines the process for DOE and Ecology to follow in producing a Response Work Plan based on the actual conditions that exist in the given leaking tank.

FEEDBACK

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Office of Inspector General (IG-12)
Department of Energy
Washington, DC 20585

If you want to discuss this report or your comments with a member of the Office of Inspector General staff, please contact our office at (202) 586-1818. For media-related inquiries, please call (202) 586-7406.