THE OFFICE OF RIVER PROTECTION—PAST, PRESENT, AND FUTURE

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ABSTRACT

The U.S. Department of Energy, Office of River Protection (ORP) manages the River Protection Project (RPP) at the Hanford Site in Washington State. ORP is responsible for safe storage, retrieval, treatment, and disposal of the 200,000 cubic meters (53 million gallons) of highly toxic, high-level radioactive waste stored in 177 large underground tanks located within 7 miles of the Columbia River. Most of these tanks are decades beyond their design life and more than one-third have leaked, resulting in an estimated 3800 cubic meters of waste into the soil.

For the past decade the major effort was to improve tank waste storage conditions to assure that the waste is stored safely, and to initiate actions to acquire waste treatment and immobilization capability so that a permanent solution can be achieved. Most of this work is finished and the focus has shifted to acquiring a Waste Treatment and Immobilization Plant (WTP) and preparing to retrieve waste from the tanks and deliver it to the WTP. ORP was proceeding to acquire privatized waste treatment services from BNFL Inc. for Phase 1 of the project that would treat and immobilize 10% of the waste mass and 25% of the radioactivity by 2018. However, in April 2000 that contractor submitted an unacceptably high price and that contract was terminated. ORP proceeded to acquire the WTP under a cost-plus-incentive fee completion contract. An expedited procurement was conducted and the WTP contract was awarded to Bechtel National Inc. on December 11, 2000.

The focus for the future is to finish the WTP design and get it constructed and started up by 2007. Tank waste retrieval and waste feed delivery systems need to be put into place and immobilized waste storage and disposal facilities constructed to receive the waste products from the WTP. Ways to improve and optimize the waste treatment complex will be pursued. ORP is also implementing project management controls so that the RPP is managed as a single, integrated project.

INTRODUCTION

The U.S. Congress established the U.S. Department of Energy (DOE), Office of River Protection (ORP) in 1998 to manage the largest and most complex DOE environmental cleanup project. The Manager of ORP reports directly to the DOE Assistant Secretary for Environmental Management and is responsible for managing the River Protection Project (RPP). The RPP mission is to build and operate the Waste Treatment Complex to complete the cleanup of Hanford's highly radioactive tank waste. The DOE Richland Operations Office (RL) manages cleanup of other Hanford waste sites that also could affect the Columbia River.

BACKGROUND

The Hanford Site in southeastern Washington State has one of the largest concentrations of radioactive waste in the world. That waste is the legacy of 45 years of plutonium production for nuclear weapons, which began with the Manhattan Project in the 1940s and continued through most of the Cold War. Two hundred thousand cubic meters (53 million gallons) of high-level radioactive waste stored in 177 underground tanks threaten the Columbia River and must be dealt with before more waste leaks to the soil and groundwater. Sixty-seven of the 149 older single-shell tanks have leaked an estimated 3800 cubic meters (1 million gallons) of waste. Some of that waste has been detected in the groundwater that flows to the Columbia River seven miles away. The 51-mile stretch of the Columbia River that flows through and adjacent to the Hanford Site, known as the Hanford Reach, was recently designated a national monument to ensure preservation.

DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology signed a comprehensive Hanford Site cleanup and compliance agreement in May 1989 called the *Hanford Federal Facility Agreement and Consent Order*, commonly referred to as the Tri-Party Agreement. This agreement includes legally enforceable commitments and milestones on storing, treating and disposing of the tank waste.

THE PAST

For the past decade, RPP focused on improving the safety of the stored waste. In 1990, Congress passed the *Safety Measures for Waste Tanks at Hanford Nuclear Reservation* law, calling for the Secretary of Energy to take special precautions on tanks that had serious potential for release of radioactive waste due to increases in temperature or pressure. Fifty-four such tanks were identified and put on a "Watch List". Special precautions were then taken with those tanks and actions were taken to resolve the safety concerns. Also by the end of the cold war in 1991, the tank farms' physical condition and management had deteriorated, resulting in a weak safety culture, poor conduct of operations, and inadequate management.

Throughout this period Hanford was unsuccessful in its attempts to acquire waste treatment and immobilization capability. The Hanford Waste Vitrification Plant Project was cancelled just prior to starting construction in 1993 because DOE decided to plan on retrieving all the single-shell waste, increasing the amount of waste to be vitrified four-fold thereby exceeding the vitrification plant capacity. The efforts to upgrade and modify the B-Plant to pre-treat the waste and to grout the low-activity fraction of the tank waste were also cancelled.

In 1994, DOE decided to acquire waste treatment and immobilization services through "privatization" whereby a private company would build and operate a Waste Treatment and Immobilization Plant (WTP). The private firm would finance and own the facility and DOE would pay fixed unit prices for immobilized waste products. This effort evolved as the original concept of acquiring two demonstration scale facilities that would compete for additional business became too costly. One contract was then awarded to BNFL, Inc. in 1998 to proceed with the design and development of the WTP to treat and immobilize 10%of the waste mass and 25% of the radioactivity by 2018.

Last May, RPP received a setback when the BNFL, Inc. contract was terminated. The primary reasons for the termination were a price that was unaffordable to DOE, poor management by the contractor in communicating the magnitude of price increase earlier in Part B-1, and unacceptable shifting of risks to DOE. The price reported to Congress twenty months earlier was $6.9 billion (1997 money values) vs. $15.2 billion (1999 money values). DOE then abandoned the privatization approach for this work and proceeded with an expedited procurement to contract with another firm to design, construct, and commission a government owned WTP.

When the contract with BNFL Inc. was terminated, the facility design was approximately 20 percent complete. The technical work; that is the process and equipment development, process flowsheet, and process and facility design; were judged to be sound and is available for the new contractor to use. The new contractor is responsible for designing, constructing and starting up the facility to assure it will work as promised. The contract includes incentives for cost and schedule performance. Until the new contractor came on board, CH2MHILL Hanford Group, Inc., the tank farm contractor, was responsible for acquiring the WTP team and continuing the design effort.

THE PRESENT

At the present time, most of the safety concerns are resolved and a new cost-plus-incentive-fee completion contract exists to design, construct, and commission the WTP. The status of some of the more important project activities is discussed below.

High-Heat Safety Issue Closed

The high-heat safety issue was related to Tank 241-C-106 and was resolved in December 1999. Tank 241-C-106 is a single-shell tank (SST) that was used for high-level radioactive waste storage beginning in mid-1947. High heat was caused by radioactive decay in the sludge in that tank. Beginning in mid-1971, water was added periodically to Tank 241-C-106 to keep the sludge wet and remove the heat by evaporative cooling. Cooling was required to avoid temperature rise that could compromise tank integrity. This continuous addition of water raised concerns that the SST could leak radioactive waste into the underlying soil. The issue was resolved by removing the 190,000 gallons of waste and transferring it to a double-shell tank (DST) designed to handle the heat load.

Organic/Nitrate Safety Issue Closed

Eighteen SSTs were thought to contain unacceptable concentrations of organic chemicals called complexants. The exact concentrations were not known, but there was concern that if one of these tanks overheated or the waste was ignited the organic mixture might react rapidly, possibly causing tank damage and lead to releases of radioactive materials. This reaction scenario was later shown to have a very low probability of occurrence because the organic chemicals have changed composition and their ignition temperature is much higher than the measured tank temperatures. In December 1998, all 18 tanks were removed from the organics "Watch List."

Two SSTs (Tanks 241-C-102 and 241-C-103) were added to the "Watch List" in 1994 because they contained flammable organic solvents. There were concerns that a floating layer of organic material similar to kerosene could be ignited, releasing radioactivity into the environment. In August 2000, both tanks were removed from the "Watch List" because sampling and analysis results showed that the possibility of such an event occurring is extremely remote and consequences to the environment were extremely low. Upon closing the organic safety issue, the authorization basis was revised, allowing removal of operational controls from these tanks. The tanks can then be used more effectively to store and stage waste for transfer to the WTP.

Flammable Gas Safety Issue To Be Closed Soon

Twenty-five high-level waste (HLW) tanks were believed to have a significant potential for flammable gas generation, entrapment within the waste, and periodic releases. The issue was that the presence of a flammable gas mixture and an ignition source could lead to combustion and a release of radioactive waste. Tank 241-SY-101, the most active waste tank, released concentrations of hydrogen in high enough concentrations to support combustion. To mitigate this problem, a mixer pump was installed in Tank 241-SY-101 in 1993. Periodic operation of the mixer pump caused the retained gas to be released in small amounts that prevented large gas releases.

However, in 1997, DOE discovered that Tank 241-SY-101 was retaining gas in the crust despite operating the mixer pump. Because, The waste surface was rising and the crust was getting thicker at an accelerating rate, it was projected that the waste level would soon exceed the double containment level of the tank. This problem was resolved by diluting the 1 million gallons of waste with 400,000 gallons of water and transferring 520,000 gallons of the waste to another DST. Since it was no longer necessary to operate the mixer pump, the number of monitoring systems and controls were significantly reduced, and the tank was removed from the Flammable Gas Watch List.

Flammable gas concentrations in the other 24 tanks on the Flammable Gas Watch List were far below that measured in Tank 241-SY-101. The gas release data obtained during the dilution of Tank 241-SY-101 waste and more than 5 years of hydrogen gas monitoring on the other 24 tanks support closure of this safety issue and removing all of these tanks from the Flammable Gas Watch List within the next year. The results of the monitoring data allowed RPP to remove ventilation systems and hydrogen gas monitors on the pump pits and domes of SSTs that are being interim stabilized. Progress made toward closing the flammable gas safety issue is already saving millions of dollars each year that is being applied to tank waste cleanup.

Single-Shell Tank Interim Stabilization

To reduce the potential for SST waste to leak to the vadose zone (the soil between the surface and the groundwater table), an interim stabilization approach was developed to remove as much liquid as possible from the SSTs. All but 30 of the 149 SSTs were interim stabilized before 1997, and the Interim Stabilization Program was restarted in late 1998. A Consent Decree was issued by the U.S. District Court in September 1999 establishing specific milestones for: (1) starting to pump the remaining tanks, (2) removing a certain percentage of the pumpable liquid from the remaining tanks, and (3) completing all SST interim stabilization by September 2004.

ORP met all Consent Decree milestones ahead of schedule. The following outlines the status of SST interim stabilization:

- Pumping initiated on 18 tanks since June 1998;
- Pumped over 1 million gallons of liquid waste from SSTs to DSTs; and
- Interim stabilized 6 tanks.

Fig. 1. Innovative double hose system rather than steel piping used to transfer single-shell tank liquids.

Managing Tank Space

Twenty-eight DSTs are available for tank farm waste management activities and are key for receiving waste retrieved from SSTs and transferring it to the WTP. Effective management of tank space is extremely important because there is limited space available in the tanks. The DSTs are the only tanks that will receive liquid waste, as they are the only tanks that meet hazardous waste storage compliance requirements. Additional DSTs may be needed as the project progresses but will only be constructed as a last resort because new tanks would be expensive, take funds away from waste treatment and disposal, and eventually require cleanup and closure themselves.

A 6.5-mile cross-site transfer line between the Hanford Site 200 East and 200 West Areas was completed in May 1998. The transfer line provides a conduit for pumping liquid waste from the aging SSTs in the 200 West Area to the newer DSTs in the 200-East Area. Since the transfer line became operational in the summer of 1998, over 3 million gallons of liquid waste have been transferred between tank farms.

A waste evaporator is used to remove water from tank waste and reduce the waste volume. In the past two years, evaporation has reduced tank waste volume by 1.5 million gallons.

Authorization Basis Updates and Efficiencies

ORP has completed a safety analysis of tank farm operations based on modern standards and documented that analysis in a final safety analysis report approved in March 1999. The technical safety requirements to which the tank farms operate were then revised to reflect those specified in the final safety analysis report. These actions have greatly simplified the safety management process. This year, new waste characterization data and flammable gas release information from retrieving Tank 241-SY-101 waste are being used to reanalyze the safety basis with the goal of removing any unnecessary controls and thereby increase operating efficiency.

Technical Progress in Waste Treatment

The RPP technical progress was sufficient to give ORP confidence in proceeding with construction and operation of the Phase I WTP. Despite the May 2000 decision to terminate privatization of the treatment facility construction and operation, much was accomplished by the privatization contractor and by the interim successor, the RPP tank farm contractor. Prominent technical progress during the past two years includes: process tests with simulated and actual waste have demonstrated that the separations processes will meet or exceed contract requirements, and a one-third-scale melter exceeded design capacity by 50% during pilot plant demonstration runs. These successes generate a high level of confidence that the plant will meet processing requirements.

Waste Treatment Process Development

Under the privatization approach, the contractor initiated an extensive and well-planned process development program to accomplish the following:

- Identify the process design and equipment systems to treat the tank wastes, and
- Demonstrate that the immobilized (vitrified) tank waste would meet waste disposal requirements.

While conducting this technology development program, the following major accomplishments were achieved.

- Demonstrated pretreatment processes for removing key radionuclides using actual radioactive wastes. Test results exceeded requirements for producing an immobilized low-activity waste form.
- Glass waste form samples of immobilized low-activity waste and high-level waste were shown to meet DOE requirements.
- Design capacity tests of a one-third-scale pilot scale glass melter met glass production rates for both the low-activity and high-level waste glass melters.

Fig. 2. Simulated low-activity waste vitrification demonstration in one-third-scale pilot plant melter.

Waste Treatment Facility Design

The WTP will be comprised of three major facilities: pretreatment, high-level waste (HLW) vitrification, and low-activity waste (LAW) vitrification. Additional supporting facilities will include an administration building and an analytical laboratory. The WTP design was approximately 20% complete at termination of the privatization contract. This level of design was sufficient to fix the process flowsheet, process equipment components, civil structural and architectural layout of the facilities, and overall site layout. Initial seismic evaluations of the pretreatment and high-level waste vitrification facilities were completed and information was presented to support an initial construction authorization request. The *Resource Conservation and Recover Act of 1976* (RCRA) Dangerous Waste Permit Application (DWPA) was submitted to the State of Washington.

Waste Retrieval and Delivery

The WTP is only part of the overall process of tank waste storage, retrieval, treatment, and disposal. Excellent progress has been made in the tank farms in preparing to retrieve and provide waste feed to the WTP. The SST waste retrieval sluicing system performed beyond expectations in removing approximately 190,000 gallons of mostly sludge from Tank 241-C-106 while resolving the high-heat safety issue associated with that tank. The full-scale DST mixer pump test conducted in Tank 241-AZ-101 demonstrated the capability to mix the sludge and liquid in these tanks so it can be transferred to the WTP. Additional waste tanks have been sampled and the waste characterized to ensure waste feed will be available if the WTP is operated at a higher capacity. Waste transfer lines, valve assemblies, and tank ventilation upgrades have also been completed.

Waste Treatment Plant Infrastructure

Infrastructure must be provided for the new WTP. ORP and its tank farm contractor have made excellent progress in the past two years in this area. A 65-acre site has been cleared and prepared for construction of the WTP and the required infrastructure is being installed. Work completed to date includes access roads, raw water lines, and potable water lines. Construction work in progress includes running electrical power lines to the WTP site, building an electrical substation, and installing liquid effluent transfer systems. This work will be completed in 2001, ahead of schedule and 10 to 15% under budget.

Improvements in Managing the River Protection Project

In creating ORP in 1998, Congress addressed its concern that the program was extremely complex and should report directly to the Assistant Secretary for Environmental Management. The objective was to achieve more DOE Headquarters visibility and attention for this important cleanup project.

DOE improved tank waste management and after two years of existence, ORP can point to considerable progress, including:

- ORP established a separate identity, funding, and reporting relationships from the DOE Richland Operations Office.
- The ORP Manager is responsible and accountable for RPP.
- The ORP manager was delegated authority for contracting, financial management, safety, and general program management that is equivalent to the authorities of managers of other DOE operations offices.
- ORP is organized to manage the RPP as a single, integrated project.
- ORP consolidated project safety management.
- Managerial and technical capabilities of ORP staff increased.
- There is increased attention and involvement from DOE Headquarters.

Managing Work as One Integrated Project

Improvements were made in ORP project management systems. ORP manages the RPP as a single project. The management approach is designed to handle a large and complex project, such as RPP, and the necessity to ensure integration among RPP prime contractors, ORP, and RL. Key features include assembling an experienced and dedicated management team, clarifying roles and responsibilities, and implementing disciplined and proven project management systems. While project management systems were in use for some time, these systems are being upgraded to focus on the key mission objective of building and operating a waste treatment complex, not just components of the system.

Relationships with Stakeholders

The Pacific Northwest's interests in Hanford Site cleanup are represented by a diverse collection of states (Washington and Oregon), tribes, and environmental and other stakeholder groups who participate on the Hanford Advisory Board. These organizations identified the Hanford Site tanks as one of the most urgent environmental threats to the Northwest and strongly support moving ahead with the RPP. As an example, 41 Hanford Advisory Board members and alternates signed a letter on February 4, 2000 requesting that:

> "The Congress and the Administration must now respond to the public and demonstrate the will to fund the treatment and disposal of Hanford's tank waste. …The Columbia River; worker and public health; the environment; and the region's economy must be protected."

Strong Congressional Support

Congressional support for RPP remains strong. On September 7, 2000, all 14 Washington and Oregon delegates to the U.S. House of Representatives sent a letter to the Chairman and the ranking member of the House Committee on Armed Services urging them to fully fund ORP in fiscal year 2001. The 14 signatures on the letter demonstrate that Hanford Site cleanup is a non-partisan issue that is vital to the citizens of the Pacific Northwest. The letter states that ORP has the support of all the stakeholders and elected officials in Washington and Oregon. In response to this request, Congress fully funded ORP for fiscal year 2001.

In addition, the delegation urged the Committee to support language in conference that would strengthen the role of the ORP Manager. The authors state that the ORP Manager must be provided the necessary authority to successfully manage the RPP. Congress included this language in the *Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001*.

THE FUTURE

The ORP mission for the future is to "build and operate the tank waste treatment complex to complete the cleanup of Hanford's highly radioactive tank waste." In the next three months the WTP contractor will be selecting the plant commissioning contractor and providing a Project Execution Plan and a Project Baseline for the WTP. Our goal is to start construct next year with hot startup in 2007.

Waste Retrieval and Delivery

A number of projects must be completed in the tank farms to close out safety improvements and put us in position to retrieve and deliver waste to the WTP. These include:

- Closing the flammable gas safety issue this year. Closing this last safety issue will enable us to remove the remaining 25 tanks from the "Watch List" thereby allowing these tanks to be used for receiving and staging waste.

- Completing SST interim stabilization by 2004. Removing pumpable liquids from the last 24 of the 149 SSTs completes the near-term actions we can take to minimize any additional tank leakage. The next step will be to retrieve the waste.

- Completing installation of pipelines, valve boxes and instrumentation so that waste can be staged and routed to the WTP.

- Installing pumps and supporting systems in ten double-shell tanks to mix the waste and pump it to the WTP.

Projects must also be completed to support the WTP. These include:

- Completing the WTP site infrastructure to first support WTP construction and then its operation. This includes providing roads, water, electrical power, and liquid effluent transfer systems.

- Outfitting two vaults in the Canister Storage Building to interim store immobilized high-level waste canisters and acquiring a canister transport system.

- Constructing an immobilized low-activity waste disposal facility and acquiring a container transport system.

Waste Treatment Plant

The largest project effort is to design, construct, and commission the WTP. The WTP is currently envisioned as three major production facilities and a number of supporting facilities. The Office of Safety Regulation within the ORP will regulate the WTP radiological, nuclear and process safety using a standard based approach. The Washington State Department of Ecology will also permit the plant for dangerous waste. The WTP will have a design life of 40 years and the government fair cost estimate is $4 billion in today's dollars. The WTP design capacity will be:

- Pretreatment: to provide LAW feed for 60 metric tons of glass per day (MTG/day) and HLW feed for 6 MTG/day.

- LAW vitrification: initially 30 MTG/day with expansion capability to 60 MTG/day by adding a parallel separate facility.

- HLW vitrification: initially 1.5 MTG/day with expansion capability to 6 MTG/day by providing an additional melter cell within the facility and anticipated performance enhancements.

The WTP target schedule is:

- Completion of Acceptance Testing by 2007;
- Start of Hot Commissioning by 2007;
- Completion of Hot Commissioning by 2011; and
- Treatment and Immobilization of a minimum of 10 percent of the Hanford tank waste by mass and 25 percent of the Hanford tank waste by radioactivity by 2018.

Balance of Mission

The plans for retrieving, treating, immobilizing, and disposing the rest of the tank waste will be developed. Waste retrieval demonstrations will be conducted to find more effective and efficient ways to retrieve SST waste, particularly the waste from tanks that have leaked. A risk-based approach to waste retrieval will be developed for consideration in determining how much waste can be left in the tanks. The WTP will continue to treat and immobilize waste but the challenge will be to expand its capacity without building additional large, costly facilities. Improving plant and equipment performance, removing process bottlenecks, and installing better technology hold promise that the plant capacity can be increased significantly during the many years it will operate. A technology development program will be carried out so that better technology will be available in 8 to 10 years when expansion of the WTP needs to be decided.

While the focus has been on the 200,000 cubic meters of waste in the 177 large underground tanks, the project is also responsible for approximately 60 other small miscellaneous tanks containing approximately 750 cubic meters (200,000 gallons) and the disposal of 1933 cesium-137 and strontium-90 capsules. These wastes will also be included in the balance of mission planning.

After the waste is retrieved from the tanks, the tanks will be closed. Closure must meet both DOE and Ecology requirements. A closure plan will be developed and tank closure will begin.

CONCLUSION

As the nation's largest and most important environmental cleanup effort, RPP requires attention and diligence to meet performance expectations and deliver on promises. Approximately $1 billion per year for the next several years will be required for the project to meet commitments. RPP has enjoyed strong support from Congress and is relying on their continued support as merited by the progress made and commitments met in carrying out this important mission.