HANFORD SITE RIVER PROTECTION PROJECT HIGH-LEVEL WASTE SAFE STORAGE AND RETRIEVAL

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ABSTRACT

This paper provides an update from last year and describes project successes and issues associated with the management and work required to safely store, enhance readiness for waste feed delivery, and prepare for treated waste receipts for the approximately 53 million gallons of mixed and high-level waste currently in aging tanks at the Hanford Site. The Hanford Site is a 560 square-mile area in southeastern Washington State near Richland, Washington.

Working for the U.S. Department of Energy's Office of River Protection (DOE-ORP), CH2M HILL Hanford Group, Inc. (CHG) made significant progress on preparations to retrieve tank waste for treatment and solved major safety problems with the Hanford Site's radioactive waste tanks that have posed the highest risk. Through the joint efforts of the contractor, the U.S. Department of Energy (DOE), the national laboratories, and the regulatory agencies, significant progress has been made in increasing the margin of safe nuclear operations, allowing us to move closer to cleaning up our legacy waste issues at the tank farms. The Priority I safety issues have been systematically studied, resolutions found and worked. As a result of successes during the past year, those safety issues are now closed and all the tanks are removed from the Wyden Watch List (Figure 1).

Fig. 1. Wyden Congressional Safety Watch List Closed.
Left to Right: U.S. Congressman, Washington, Doc Hastings; DOE-ORP manager, Harry Boston; Senator, Oregon, Ron Wyden.

An aggressive double-shell tank (DST) integrity assessment and tank chemistry control program has been instituted at the tank farms to prolong their lifetime. The DSTs are crucial to disposal waste staging tanks. Major infrastructure upgrade projects have been completed and brought into operational readiness. Infrastructure support for the waste treatment plant has been completed that included new power transmission lines for waste treatment plant construction and operations, roads, and secondary waste stream returns from the waste treatment plant. Tank Farm infrastructure has been enhanced to support retrieval and transfer of waste to the waste treatment plant with transfer pits being upgraded and new transfer system piping being installed. A progressive technology development process has been established including joint demonstrations with DOE Headquarters (HQ) EM-50, Pacific Northwest National Laboratory (PNNL), Sandia National Laboratory, DOE-ORP, and other participants.

INTRODUCTION

The high-level waste is stored underground in 149 single-shell tanks (SSTs) and 28 DSTs. The older SSTs are well beyond their design life and pose a risk to the public, the environment, and site workers from potential leakage over both the near and long term. The newer DSTs will require maintenance and life extension efforts for up to 40 years to support completion of the stored high-level waste disposal mission. A robust, systematic approach to increasing the margin of safe nuclear operations has developed at the Hanford Site.

REDUCING THE RISK: SAFE STORAGE

Congressional Watch List Closed

The congressional watch list (1) -- called the Wyden Watch List -- was named for Senator Ron Wyden of Oregon, who authored the law in the early 1990's requiring the U.S. Department of Energy to watchdog the most dangerous of 177 large underground radioactive waste tanks at the Hanford Site. The law required identification of tanks having the potential for release of high-level waste from uncontrolled increases of temperature and pressure.

Based on this, DOE identified five problem areas that could result in releases of high-level waste: generation of flammable gases; presence of flammable organic liquid chemicals; presence of mixtures of organic complexant salts which in the presence of inorganic nitrates could deflagrate if heated above 200 °C; the presence of potentially explosive ferrocyanide; and water added to SSTs because of high-heat levels generated by certain types of stored wastes posed an additional risk.

A total of 60 tanks had been added to the list since January 1991, and a maximum of 56 tanks were on the list at one time in May 1994. Some tanks were listed for more than one safety issue.

<u>Ferrocyanide</u>: In the 1950s, waste with ferrocyanide was added to some Hanford SSTs. In the late 1980s, concern grew about the potential for an explosion if the temperature in those tanks became too high. Further sampling and analysis of the waste showed the ferrocyanide was too diluted by chemical degradation to low energy forms to cause an explosion and temperatures

were well below and moisture well above the level of concern. The ferrocyanide safety issue was resolved in 1996.

Organics: Because of the potential for uncontrolled energetic reactions, 20 tanks with organic compounds were added to the list. These tanks had the potential for deflagration risks associated with the mixture of fuel rich complexant waste and sodium nitrate, an efficient oxidizer at elevated temperatures. Subsequently, sampling and analysis showed that the chance of the waste igniting in the tanks was extremely unlikely because the radiation and radiolytic heat in the tanks degraded the species present to lower energy forms. The organic safety nitrate salt — complexant issue was resolved in 1999.

Waste in single-shell tank 241-C-103 was of concern because it contained a free-floating organic solvent layer that might be capable of catching fire. Several other SSTs might also contain freestanding pool or organic liquids that posed a comparable risk. A combination of laboratory ignition tests and modeling demonstrated that the composition of the organic liquids coupled with tank conditions did not pose an unacceptable risk. The safety issue was resolved in 1999.

High Heat: Single-shell tank 241-C-106 was the only tank in this category and was a safety concern because of the potential of high temperatures drying out the waste and degrading the concrete dome of the tank. Since the mid-1970's, Hanford Site operators added approximately 6,000 gallons of water a month to prevent the tank waste from drying out. Historically, 67 single-shell tanks had been declared assumed leakers. Continued addition of water to maintain the tank 241-C-106 temperatures posed some environmental risk. The water additions were stopped after waste was removed from the tank, diluted to dissolve gas storage-capable salts, and transferred to other DSTs. The high-heat safety issue was resolved in 2000.

Flammable Gas: These tanks are known to have the capability for flammable hydrogen gas generation, storage of such flammable gases within the waste itself, and potential rapid periodic releases. Double-shell tank 241-SY-101 -- dubbed the "burping" tank -- was the most serious safety concern in this category. Tank 241-SY-101 was removed from the list in January 2001 (2,3) after much of its waste was removed and diluted, eliminating the gas storage potential in that waste. Twenty-four other tanks also had the capability for such gas storage in waste solids. Over 10 years of evaluating tank contents and their behavior led to sufficient understanding of the generation, retention, and release of flammable gases that the flammable gas issue could be resolved (4). These were the last tanks to be removed from the Wyden Watch List in August 2001.

The Tanks Advisory Panel, a DOE-HQ peer oversight group, reviewed the documentation for closure of the five safety issues and agreed with the DOE-ORP recommendation for ultimate removal of Hanford Site tanks of concern from the Wyden Watch List. The Tanks Advisory Panel included nationally recognized experts from several universities and industry with expertise in chemical safety, hazardous waste, radioactive materials, and waste management.

The Office of River Protection Manager Harry Boston announced in August the resolution of significant safety issues resulting in the removal of the final 24 [flammable gas] high-level waste tanks from the Wyden congressional safety watch list. Closure of the final safety issue completed a *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (6) milestone over a month early.

Tank 241-SY-101 Returned To Service

Following safety reviews by the U.S. Department of Energy and its regulators and contractors, the Hanford Site's once-"infamous burping" waste tank has been returned to service. This marks the end of more than a decade of working to resolve serious safety problems, and effectively ended the costly effort to solve those safety issues.

Tank 241-SY-101 will be a key staging point for single-shell tank waste as it is transferred across the Hanford Site to staging tanks prior to treatment in a planned vitrification facility. Returning the million-gallon, double-shell tank to service closes the book on what was once the Hanford Site's and the U.S. Department of Energy's top safety concern.

Aggressive Double-Shell Tank Integrity Assessment

The DSTs play a critical role in the Hanford Site high-level waste treatment complex and activities are, therefore, underway to protect and better understand these tanks. The DST Life Extension Program is focused on both tank life extension and on evaluation of tank integrity (5). Tank life extension activities focus on understanding chemically and physically initiated tank liner failure modes. The CHG studies have resulted in key chemistry and operations controls to minimize tank corrosion and extend useful tank life.

The DST Life Extension Program has two key goals: a) maximize the useful life of the DSTs and b) evaluate DST integrity to accurately predict useful tank life. Program data to date indicate that the useful life of the tanks can be extended well beyond their design life. Tank integrity activities have and will continue to support development and application of key technologies to evaluate the condition of the tank structure and predict useful tank life using quasi-remote nondestructive assay techniques. Extending the design life of the DST's will allow the existing tanks to fill a critical waste staging function within the Hanford Site high-level waste treatment complex in support of the disposal mission. In addition, the tank life may now be more reliably predicted allowing accurate planning for the use and possible future replacement of these tanks. A combination of corrosion modeling and periodic waste sampling will allow better control of chemical factors in the waste [hydroxide, nitrite and nitrate concentration as a function of temperature]. These tanks, therefore, can provide an extended waste receiving and staging function for the Hanford Site high-level waste treatment complex.

The DST Life Extension Program is also developing the necessary capabilities to baseline tank integrity affecting characteristics and to extrapolate the accumulated data to derive ongoing projections of expected DST life. This will allow the Hanford Site high-level waste treatment complex to accurately plan for the use of and the potential replacement of these critical DSTs over the course of high-level waste retrieval and treatment at the Hanford Site.

MAJOR INFRASTRUCTURE UPGRADE PROJECTS

Construction of the infrastructure for the Hanford Site's tank waste Phase I Waste Treatment Plant has been completed more than a year ahead of schedule and $9 million under budget.

The Phase I infrastructure upgrades (Figure 2) consisted of design/build:

- 62.5 million volt amp electrical substation and
- 230-kilovolt transmission lines.

The electrical system, which is capable of providing enough power for 6,000 average homes, has more capacity than was needed at the Hanford Site to produce plutonium for weapons during the Cold War. Power can be received either from the Columbia Generating Station area or from Priest Rapids Dam to ensure that the proposed waste vitrification melters, [which will operate continuously at 2100 °F to convert waste to glass], are not unexpectedly interrupted. Fluor Hanford, Inc. and the Bonneville Power Administration are responsible for operating the electrical power system.

Fig. 2. Electrical Substation and Transmission Lines

Approximately three miles of pipeline have been laid to deliver water for vitrification processes, drinking, and fire fighting. Liquid effluent by-products will be transported to existing treatment and disposal facilities on the Hanford Site via a newly installed piping system nearly two-and-a-half miles long. In addition, water and effluent piping were installed. Fluor Hanford, Inc. and its contractors operate the effluent handling facilities for the Site.

In addition, the 65-acre vitrification plant site was cleared and grubbed, fences and gates were relocated/installed, and embankments were constructed. The infrastructure upgrade project also relocated an existing spoil pile from the center of the vitrification plant site.

Finally, existing roads were widened, reinforced to handle waste treatment plant transportation loads, and streetlights added to three intersections. A new roadway was constructed that encircles the 65-acre area where Bechtel National, Inc will build the waste treatment plant. The upgraded existing Hanford Site roadways will accommodate heavy construction traffic needed to build the waste treatment plant.

PROGRESSIVE CONTRACTING APPROACH

On March 26, 2001, CHG decided that the current construction management services contract with Fluor Federal Services (FFS) would not be extended and that CHG would initiate activities necessary to competitively bid construction services contracts.

On April 9, 2001, CHG issued a request for interest (RFI), which was the first step in initiating the activities necessary to bid a General Construction Contract. Based on the responses received regarding the minimum performance criteria identified in the RFI, a down-selection was made. On June 1, 2001, a Request for Proposal (RFP) (Solicitation No. CHG-RTH-060101) was issued to 14 companies that successfully demonstrated that they met the minimum performance criteria identified in the RFI.

The RFP stated that CHG would select one or more General Contractor(s) to provide construction services in the close proximity to the 200 Area Tank Farms at the U.S. Department of Energy Hanford Site, located in Benton and Franklin Counties, near Richland, Washington. The selected contractor(s) shall furnish construction services, including management, labor, materials, equipment and services to perform construction work including but not limited to, installing structures, piping, valves and major equipment as directed by CHG. In addition, the contractor(s) shall be responsible for accomplishing all work in accordance with task-specific contract releases.

To support this new approach to self-perform construction management, CHG has formed the Construction Management (CM) organization to manage all construction within the CHG workscope. This includes both capital and expense funded construction work. The CM organization will maintain the necessary resources to complete the assigned construction volume.

CONSTRUCTION TECHNIQUES IN CONTAMINATED AREAS

CHG Construction is committed to using innovative remote access techniques in an effort to reduce worker exposure to highly radioactively and or chemically contaminated materials. CHG construction projects have the following innovative techniques for performing construction projects in contaminated areas:

- Pit Viper technology – this technology will be used to remotely remove insulating foam that has separated from the underside of the pit covers, remove debris for the pit floor, scrape debris from the pit walls and high pressure wash the pit walls (Figure 3).

Fig. 3. Remotely Operated Manipulator Known as Pit Viper

- Guzzler Technology – this technology enables excavation through contaminated soils in and around tank farms via equipment (i.e., hoses), through utilization of a vacuum process rather than by laborers using shovels.

- Above Grade Transfer Lines- this technical innovation allows shielded, at-grade installation with minimal excavation, integral heat tracing and insulation to minimize risk of line plugging, and can be deployed in weeks at a fraction of the cost of traditional underground transfer lines.

- Spray-on Liner for Process Pits - this innovation of applying a polyurea coating, like a pick-up truck bed liner, in tank farm pits allows decontamination and refurbishment of pits quickly and will reduce future maintenance time and radiation exposure to personnel.

In addition, CHG is studying other industry construction methods for working in radiological and/or chemically contaminated areas with a target goal of being able to perform all high radiological and hazardous work (i.e., valve pits, Figure 4) remotely.

Fig. 4. Working in a Valve Pit.

PROGRESSIVE TECHNOLOGY DEVELOPMENT PROCESS

Developing and deployment of new technologies and approaches are needed to reduce the River Protection Project (RPP) cost and schedule, reduce risk to workers and the environment and provide a robust and flexible technical baseline for the mission. This paper focuses on the waste storage and retrieval functions, which are an integral and interrelated part of the total RPP project (also includes treatment, disposal, and closure). The RPP is pursuing a process called "roadmapping" which provides a framework for integration of near-term science and technology issues with life-cycle challenges. The end result being an understanding of what science and technology needs and opportunities exist and when those solutions are needed to support decisions or processes.

CHG is working closely with many of the DOE national laboratories including Pacific Northwest National Laboratory, Oak Ridge National Laboratory, and Sandia National Laboratory and several universities across the country to take advantage of their breadth of experience and capability in the relevant technologies and science to support the ORP mission.

The RPP mission cost is substantial so there is a strong financial incentive to reduce cost via science and technology. The opportunity for cost savings from improved science and technology applications in the storage and retrieval area includes retrieval technologies for sound and potentially un-sound SSTs, determination of SST retrieval sequence, management of DST inventory to allow SST retrieval and maintaining and prolonging tank integrity. Any technological solution must be protective of the worker, the public, and the environment. Those solutions may also provide significant improvement in worker, public and environmental safety over the baseline.

Double-shell tanks will exceed their initial design life prior to completion of the RPP mission. Understanding and managing the corrosion behavior of these tanks is a significant challenge. Identification and implementation of techniques to monitor and mitigate tank deterioration will be an important component of risk, cost, and schedule reduction. An additional challenge is the maintenance and creation of additional DST space to support SST retrieval. Unique solutions applied here will have a direct impact in risk reduction by allowing SST waste to be transferred to the newer, safer DST system.

CONCLUSION

Significant progress on preparations to retrieve tank waste for treatment has been accomplished. The past year saw completion of major infrastructure upgrade projects including new power transmission lines for waste treatment plant construction and operations, roads, and secondary waste stream returns for the waste treatment plant. Tank Farm infrastructure has been enhanced to support retrieval and transfer of waste to the waste treatment plant with transfer pits being upgraded and new transfer system piping being installed.

The Priority I safety issues have been systematically studied and as a result of successes during the past year are now closed and all the tanks are removed from the Watch List. An aggressive DST integrity assessment and tank chemistry control program has been instituted at the tank farms to prolong the lifetime of these tanks, which are so crucial to the disposal program. A progressive technology development process has been established including joint demonstrations with DOE-HQ EM-50, Pacific Northwest National Laboratory (PNNL), Sandia National Laboratory, ORP, and other participants.

REFERENCES

1. Public Law 101-510, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation", Section 3137 of the *National Defense Authorization Act for Fiscal Year 1991* (1990).

2. C. L. HUNTOON, "Approval to Close the Flammable Gas Safety Issue for Tank 241-SY-101 and Remove the Tank from the Watch List" (letter to H. Boston, U.S. Department of Energy, Office of River Protection, dated January 11), U.S. Department of Energy, Washington, D.C. (2001).

3. H. L BOSTON, "Closure of the Tank 241-SY-101 Flammable Gas Safety Issue and Removal from the Flammable Gas Watch List" (letter to C. L. Huntoon, dated December 7), U.S. Department of Energy, Office of River Protection, Richland, Washington (2000).

4. G. D. JOHNSON, "Flammable Gas Safety Issue Resolution", RPP-771, CH2M HILL Hanford Group, Inc., Richland, Washington (2001).

5. D. BRYSON, D. NOYES, M. OSTROM, W. BRYAN and, H. BERMAN, "Life Extension of Aging High Level Waste Tanks", paper HL#C5E, Presented at WM02, Tucson, Arizona, U.S. Department of Energy, Office of River Protection, Richland, Washington (2002).

6. "Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)", as amended, Washington State Department of Ecology, U.S. Department of Energy, and U.S. Environmental Protection Agency, Richland, Washington (1989).

Other References of Interest

7. P. A. GAUGLITZ, J. L. BRYANT, G. M. HOLTER, and K. A. GASPER, "Preliminary Integrated Technology Plan (ITP) for the River Protection Project", DOE/ORP-2001-17, Pacific Northwest National Laboratory, Richland, Washington (2001).