Tank Farm Remediation Technology Development Project: An Exercise in Technical and Regulatory Collaboration

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ABSTRACT

The Tank Farm Remediation Technology Development Project at the Hanford Site focuses on waste storage tanks, pipelines and associated ancillary equipment that are part of the C-200 single-shell tank (SST) farm system located in the C Tank Farm. The purpose of the project is to obtain information on the implementation of a variety of closure activities and to answer questions on technical, operational and regulatory issues associated with closure.

INTRODUCTION

Closure of radioactive waste storage tanks is one of the most challenging activities facing the Department of Energy (DOE). To date, the DOE has not completely closed a high-level mixed waste tank farm. However, progress is being made at the Savannah River Site in South Carolina and the Idaho Engineering Laboratory in Idaho. The Hanford Site radioactive waste storage tanks contain a variety of radioactive/mixed wastes and significant progress is currently being made in the development of retrieval technologies. Final closure of waste tanks and the associated ancillary equipment will be carried out in compliance with Federal and State requirements after completion of an Environmental Impact Statement (EIS) currently in preparation. This technology development project will advance the knowledge of remediation techniques that may be applied to implement final decisions.

What has made the development of the scope, focus, and direction of the project unique is that from its inception it has been a collaborative process with two Hanford Site regulatory agencies, the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA). Along with the DOE-Office of River Protection (ORP), and CH2M HILL Hanford Group, Inc. (CH2M HILL) these four entities comprise the Project Team. The team began meeting regularly in November of 2005 to identify priorities and make decisions about project scope and direction. To date, the Project Team is developing a project plan that includes the following focus areas:

- Waste transfer pipelines – The project will evaluate screening, characterization technologies, and closure actions of grouting, and removal of pipelines.
- C-301 Catch Tank – Waste removal options for catch tanks will be reviewed and demonstrated.
- C-200 Series tanks – The removal of one or more stabilized C-200 tanks will be evaluated in an engineering study and the development project will include residual tank waste treatment and stabilization.
- Regulatory processes that are part of the development project include: a Research, Development and Demonstration (RD&D) permit from Ecology and applicable DOE determinations regarding waste disposition.

The following describes the planned activities for each of these focus areas.

WASTE TRANSFER PIPELINES

Nearly 200 miles of abandoned pipelines, dating back to the 1940s, traverse the Central Plateau at Hanford and create a spider web within the tank farms themselves. Over 10 miles of pipeline can exist within a single tank farm. These pipelines were used to transfer multiple waste streams from the reprocessing facilities, as well as between tank farms, and from tank to tank.

Pipeline attributes are diverse and complex, consisting of a variety of construction materials; differing pipeline diameters (2 - 6 inches); pressurized and gravity flow service; as well as direct buried and concrete encased. Pipeline configurations include numerous elevation changes, bends, and connection points. Access to pipelines is often difficult due to their close proximity to the SSTs and other tank farm components. Pipelines are typically buried from 8 to 15 feet below ground and are occasionally surrounded by areas of past releases of liquid radioactive wastes. Some pipelines are known to be plugged with waste or have failed.

The Hanford Federal Facility Agreement and Consent Order [4] (HFFACO) contains a target date for closure of one SST farm (identified to be C-Farm) by March, 2014. A key closure element of the SST farm system at Hanford will be the determination of remedial and closure actions for the pipeline system. In order to define these closure actions, it will be necessary to gain a better understanding of the waste inventory remaining in the pipeline systems through proper characterization.

Characterization

Pipeline characterization is the first step toward development of closure alternatives. Because characterization of pipelines has the potential for being a long and expensive process, it is imperative that cost-effective methodologies which can collect valid information concerning the current state of the pipelines are defined. The decision process for determining the end state for the SST pipeline system is expected to follow an iterative set of steps that would start with non-destructive screening and sampling. Nondestructive analysis (NDA) and sampling technologies for characterizing SST pipelines have not been fully evaluated. Cost and schedule impacts associated with pipeline characterization are not yet understood and could result in delays to SST farm closure. Therefore this early testing and analyses will provide the means to better develop costs and schedules.

The development project proposes to test and evaluate in side-by-side comparison tests, at least four pipeline characterization technologies (e.g., video surveillance, radiological screening techniques, inorganic screening techniques, non-destructive analysis determination of plugged or liquid-filled pipelines) for adaptation to the tank farm environment. The number and type of pipeline characterization technologies to be demonstrated and evaluated will be based on recommendations of the DOE Environmental Management (EM-21) funded Technical Assistance report, which is expected to be released in early 2007.

Stabilization

The development project proposes to test and evaluate alternatives for, and deployment of stabilization technologies, such as grout, within SST pipeline systems. Current experience with stabilizing tank farm pipelines has occurred on a limited basis and has been associated with operation and maintenance of functional pipelines, which tend to be small segments of pipeline. These segments usually involve shallow or near-surface excavations and are not considered representative of the long lengths, depths, and numerous bends associated with SST tank farm pipeline system.

Removal

Conventional pipeline excavation of either trenching with a box or trenching with 4:1 side slopes is slow, costly due to the volume of material handling involved to expose the pipe, and could have a significant element of worker risk when applied to radiologically contaminated pipelines. Previous pipeline excavation inside of tank farms has been limited to maintenance activities of short segments. This past experience is not considered to be particularly applicable to removal of longer segments of piping that may be required for closure. Cost and schedule impacts associated with pipeline removal, could result in delays to SST farm and outside farm closures, and are not yet fully understood. Because removal of radiological pipelines has the potential for being a long and expensive process and could present significant worker risk, it is imperative that cost-effective methodologies be defined. This development project is not only intended to develop and demonstrate pipeline removal equipment that might be used for future pipeline exhumation, but also to provide a better understanding of the costs and risks associated with this type of closure activity.

Technology Development

The development project also proposes to identify and test pipeline removal systems that can remove and encase (for transport, treatment, and eventual disposal) small diameter, relatively shallow buried (up to 15 feet below the ground surface) radioactively contaminated pipelines. This will involve the development and testing of new technologies. It is expected that current conventional excavation and trenching equipment which is designed for the placement of pipelines will require significant modification. These modifications would include configuring the equipment to be able to excavate a trench just above the buried pipeline and through a sensor system (e.g., ground penetrating radar) be able follow the alignment of the buried pipeline. In addition, modifications to the equipment would need to be made to lift and continuously feed the excavated pipeline to the ground surface where an automated cutting/crimping system would cut the pipe into manageable length for transport, treatment, and disposal. A key element of the system design would require incorporation of spill prevention and contamination control features in the event a pipeline was cracked or broken during the lifting phase of the operation or if contaminated soils from prior leaks were encountered.

C-301 CATCH TANK

The C-301 Catch Tank is a 36,000 gallon reinforced concrete tank located near the north, northwest boundary of the C Tank Farm. Unlike the SSTs, catch tanks do not have a steel liner and wastes are in direct contact with the interior concrete surface. The catch tank has a flat bottom while the SSTs have a concave bottom which tends to allow waste to “puddle” in the center which, in some circumstances, can aid in waste removal. Access into the catch tank is limited to a series of eight small risers which are located on the perimeter on the tank. The riser configuration limits access of waste retrieval equipment inside the tank. The catch tank is connected to Diversion Boxes C-151, C-152, C-153 and C-252 by two drain lines and received releases from the diversion boxes. To the extent practical, liquids were removed from the Catch Tank in 1985. Current estimates are that the tank contains approximately 9,000 gallons (4 feet) of sludge and approximately 1,500 gallons (7.5 inches) of liquid.

The C-301 Catch Tank presents an important opportunity to field test a number of technologies and approaches that may be needed during closure including waste removal and characterization and remediation of concrete tanks. It also represents an opportunity to reduce total inventory in the C-200 area of the C-Farm. Initially, an engineering study will be prepared to evaluate potential removal technologies for the waste in the catch tank and select a technology for waste removal. The engineering study will be completed in FY 2008. After selection of a technology, design and construction of the catch tank waste removal system, removal of catch tank wastes, and evaluation and reporting on the results of the process and lessons learned including cost and worker exposure data will be completed.

C-200 SERIES TANKS

To close a tank farm by 2014, pursuant to the HFFACO [4] requires decisions on the end state of residuals which have not been made. Alternatives for SST closure are being evaluated in the *TC&WM EIS* [2]. Once the Record of Decision for the TC&WM EIS [2] has been issued, a

Resource Conservation and Recovery Act of 1976 (RCRA) Permit [5] will specify SST closure actions that must be taken. Residual waste stabilization will be required to implement any closure decision regardless of whether the tanks are to be landfill closed (left in place) or clean closed (removed). If tanks and their residual waste are to be closed in place, stabilization of residuals will be necessary to meet the requirements of DOE Order 435.1, *Radioactive Waste Management* [6] and RCRA [5].

Additionally the NAS report [3] states "…it is increasingly clear that there is more time for implementing a research and development program that could improve waste retrieval, tank stabilization and low activity waste immobilization." The NAS report [3] further states, "The committee recommends that DOE initiate a focused research and development program over a 5 to 10 year period, and longer where necessary, to improve fundamental understanding of the long-term performance of tank fill material and tailoring grout formulations to different tanks. The program should involve collaboration among government laboratories, universities, and industry." The development project would initiate and coordinate work with grouts.

Grout Deployment and Performance

Work has been done at the Savannah River Site and by several national laboratories on grout formulations to be used at Hanford. However, critical questions concerning deployment and performance of grout in Hanford SSTs remain unanswered. In order to gain early information regarding grout performance and delivery, the development project has identified several areas concerning grout introduction to the retrieved tank, long-term compatibility with the waste and waste release performance that require resolution prior to initiating any closure action. The four small, 20-foot diameter 200 series SSTs in C-Farm with a nominal 55,000 gallon capacity have been selected for in-situ testing of grout deployment and performance.

The development project has identified information needs to address unanswered questions and collect data associated with tank grout deployment and performance consistent with the data needs identified in the NAS report [3]. The ability of grouted waste and grout-filled waste tanks to provide for long-term radionuclide immobilization depends on several factors such as; limitations on physical access; internal obstructions; and the amount, location, and properties of residual waste deposits. In order to answer the critical questions concerning grout deployment and performance, the following scope has been proposed for the development project:

- Establish grout performance goals
- Define the information needed and the technology to collect data to determine that the performance goals are achievable. This includes flow characteristics, mixing and degree of grout homogeneity, heat generation, and compatibility with residual wastes in the tanks.
- Evaluate and select the tank(s) for residual waste stabilization treatment technologies.
- Evaluate and select stabilization treatment technologies to test based upon residual waste characteristics.
- Complete evaluations and selection of the stabilization material delivery mechanism(s) that will demonstrate the ability to meet pumping and mixing objectives. This portion of the development project is proposed to be conducted in association with testing of a grout deployment nozzle to enhance mixing. This work would involve initial evaluations at the

AEA Technology facilities, with follow on testing performed at the Hanford Cold Test Facility prior to field deployment in a 200 series tank.

- Evaluate and select residual waste/grout mixing technologies.
- Define short-term and long-term grout performance metrics to be measured in-situ (e.g., mixing success would be determined by sampling the grout prior to or shortly after setting while long-term strength, compression, heat generation and moisture content, and contaminant leachability may be evaluated by sensor placement in the grouted matrix or laboratory testing of samples taken from the filled tank).

The development project is to conduct research and demonstration on grout placement in a Hanford 200 series SST that will provide critical information to respond to several of the concerns identified by the NAS. Specific information will be collected concerning pumping, flow characteristics, degree of mixing with and/or encapsulation of waste in grout, heat generation, long-term grout performance monitoring, and compatibility of grout with residual tank waste.

The scope of the development project would include: performing background studies and evaluations that would lead to the design, construction and procurement of the selected tank fill technologies; conducting field work to carry out the demonstrations; sampling and analyzing the grout encapsulated residual waste to assess grout effectiveness in providing short-term and long-term stabilization (including degree of mixing, mixture performance and composition of treated matrix); and preparing reports on the results.

The development project proposes to test and evaluate alternative grout formulations and deployment of grout stabilization technologies within the C-200 Series tanks. This evaluation would include both non-radioactive testing at the Hanford Cold Test Facility, initial dispersion of a grout layer within one or more of the C-200 series tanks, the efficacy of grout/residual tank waste mixing, and the performance of the grout as an encapsulant that minimizes release of contaminants from the residual waste as part of the of the development project.

These studies will support ORP in its closure process. These studies are also expected to support work at the Savannah River Site and Idaho National Laboratory. Placement methods and the development of improved formulations of grout for use in Hanford tanks will require technical development due to basic construction challenges presented. Technical development will also be required to optimize the use of grout materials in order to provide long-term protection.

Experience with stabilizing Hanford SST residual waste is limited to laboratory work with surrogate waste forms. Cold testing has been performed on gravity-placed grout using different grout formulations tailored to SST waste simulants. However, more work is necessary in a hot test environment to determine whether there are placement technologies that can provide better mixing of the waste residuals with stabilizing materials. More testing is also necessary with actual tank waste to determine whether stabilization additives might enhance long-term contaminant containment properties of the grout. No hot testing has been performed in the field.

REGULATORY

An integrated regulatory closure process has been developed by DOE in conjunction with Ecology and EPA to streamline regulatory approval for Hanford Site closure. Implementation of the integrated regulatory closure process is authorized in Appendix I of the HFFACO [4]. The integrated regulatory process uses the existing HFFACO process, action plan, and milestones; completes the Hanford closure process for each set of single-shell tank farms (known as waste management areas or WMA) as negotiated by DOE and Ecology; and completes site closure under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [7] (CERCLA). The process also integrates the applicable requirements of the above regulations consistent with the *Radioactive Waste Management Manual* (DOE M 435.1-1), [8] and *the Atomic Energy Act of 1954* (AEA) [9]. Implementation of the integrated regulatory closure process establishes expectations for the scope and approval of the *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*, DOE/ORP-2005-01 [10] (SST PA). Appendix I of the HFFACO [4] establishes regulatory requirements under which waste within the SST WMAs will be retrieved, and the WMAs subsequently closed pursuant to applicable state and federal laws and regulations.

A critical aspect to Hanford tank closures is a regulatory approach and supporting information that will satisfy the agreed upon regulatory criteria. Having early input from the regulators will be invaluable in understanding and resolving challenges early in the process, so that realistic schedules and costs can be assigned. Ecology, EPA, ORP, and CH2M HILL plan to pursue a RCRA RD&D permit for development activities that require permitting. Currently the demonstration activities of the development project that have been identified as necessary to address in a RD&D permit are the tank and pipeline stabilization demonstrations. Other development activities that require RD&D permitting may be identified in the future, as the project evolves. Ecology, ORP, and CH2M HILL agree that an expedited permit application and review process for the RD&D permit is appropriate for the development project. This will involve both formal and informal processes including a pre-application process, joint workshops to resolve any deficiencies in the permit application, and public involvement.

The regulatory processes required to close the tank farms include the HFFACO [4], RCRA [5], and CERCLA [7] and are varied and complicated. The development project will attempt to define information needs for the various processes, provide that information, follow established or newly applicable DOE processes and procedures, continue open public involvement, encourage State agency participation, and include an independent technical review by the U.S Nuclear Regulatory Commission (NRC). The regulatory insights of the project team will serve to streamline required processes once they have been worked through in the project. In addition to the RD&D Permit from Ecology, these processes may include applicable DOE determinations regarding waste disposition.

Central to a waste determination is the estimation of future risk and impacts from the waste as documented in a performance assessment (PA). DOE intends that the PA will document by reference relevant performance requirements defined by RCRA [5], the *Hazardous Waste Management Act* [11] (HWMA), *Clean Water Act of 1977* [12], *Safe Drinking Water Act of 1974* [13], and the AEA [9], and any other performance requirements that might be applicable or relevant and appropriate requirements under CERCLA [7]. The PA is of larger scope than a risk assessment required solely for non-radiological contaminants. The PA is expected to provide a single source of information that DOE can use to satisfy potentially duplicative functional and/or documentation requirements. An initial version covering all of the single-shell tank farms has been released as [DOE/ORP-2005-01] [10]. A PA will be developed for each WMA and will incorporate the latest information available. These PAs will be approved by Ecology and DOE pursuant to their respective authorities. For Ecology, approval means incorporation by reference, into the Site-Wide Permit through closure plans. The development project will continue interactions with the regulators to evolve satisfactory performance assessments**.**

SUMMARY

The development project focuses on waste storage tanks, pipelines and associated ancillary equipment that are part of the C-200 SST system. This project will be conducted over several years and as information on the different elements of the project is gained it will be modified appropriately. By conducting this development project a broad cross-section of closure issues can be studied which will facilitate the implementation of one or more of the selected alternatives expected to be defined in the TC&WM EIS [2] record of decision. In addition, the project will go a long way in addressing the recommendations of the NAS report [3] involving cementitious grout performance and placement. The development project will serve to streamline required regulatory processes, find answers to key technical issues in a timely fashion and facilitate the timely implementation of closure of the SST system at Hanford.

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