PROJECT TECHNICAL PLAN

Project 1: Chemical Process Alternatives for Radioactive Waste

Performance Period: August 29, 2016 to August 28, 2017

Date submitted:

September 29, 2016

Principal Investigator:

Leonel E. Lagos, Ph.D., PMP®
Applied Research Center
Florida International University
10555 West Flagler Street, EC2100
Miami, FL 33174

Submitted to:

U.S. Department of Energy
Program Services Division, ME-643.1
1000 Independence Avenue, SW
Washington, D.C. 20585

Cooperative Agreement DE-EM0000598

FIU Applied Research Center
Florida International University

INTRODUCTION

The U.S. DOE Hanford Site has the largest number of high-level waste (HLW) storage tanks and the largest volume of HLW in the United States. The safe storage, retrieval, treatment, and disposal of approximately 53 million gallons of highly toxic, high-level radioactive waste stored in Hanford's 177 underground tanks are a national priority. Retrieval and treatment of waste from these tanks pose a considerable challenge.

DOE EM HQ Contacts:
John De Gregory, CA Technical Monitor, EM-4.11
Gary Peterson EM-4.12, Subsurface Closure
Rod Rimando, EM-3.2, Technology Development

Site Contacts:
Ruben Mendoza, WRPS
Terry Sams, WRPS
Dennis Washenfelder, WRPS
Mike Thien, WRPS
Jason Gunter, WRPS
Chris Gunther, NETL
Dawn Wellman, PNNL

FIU ARC Contacts:
Dwayne McDaniel, Ph.D., P.E.
Project Manager, Sr. Research Scientist
(305) 348-6554 E-mail: mcdaniel@fiu.edu

Leonel Lagos, Ph.D. PMP®
Principal Investigator, Director of Research
Applied Research Center
Florida International University
10555 W. Flagler St., Suite 2100
Miami, FL 33174
(305) 348-1810, E-mail: lagosl@ fiu.edu

Florida International University has been conducting research on several promising alternative processes and technologies that can be applied to address several technology gaps in the current waste retrieval and conditioning plans. Specifically, FIU has been involved in: modeling and analysis of multiphase flows pertaining to waste feed mixing processes, evaluation of alternative HLW instrumentation for in-tank applications and the development of technologies to assist in the inspection of tank bottoms at Hanford.

As appropriate and within the parameters of the DOE-FIU Cooperative Agreement (CA), coordination at the proper level will occur with the sites and national laboratories involved in the project research efforts as well as with the points-of-contact at DOE HQ (e.g., HQ Project Leads, EM-3.2, CA Technical Monitor, COR, etc.).

TECHNOLOGY NEEDS

The implementation of advanced technologies to address challenges faced with baseline plans for HLW operations is of great interest to the Hanford Site. Specifically, the use of field-deployable or in-tank technologies, as well as advanced computational methods can improve the retrieval, transport and conditioning processes of HLW. FIU has worked with site personnel to identify three focus areas related to technology and process improvement needs that can benefit from FIU's core expertise in areas related to HLW operations.

Focus Area 1: Robust computational fluid dynamics capability to accurately and effectively model complex, multi-phase, HLW processes

Prior to retrieval and transport of HLW to holding tanks, double-shell tanks (DSTs) or the treatment plant, the waste needs to be mixed properly with the solids evenly distributed and contained below specified concentration levels. The mixing performance of pulse-jet mixers

(PJM), spargers and other tools used in the mixing process depends on the geometry of the vessel, number and configuration of the mixing mechanism, slurry rheology, cycle characteristics and other variables. This makes the experimental evaluation a big challenge due to the large number of variables and high costs associated with building and testing the mixing process in the tanks. Computational fluid dynamics (CFD) predictions using computer simulations of the multiphase flow physics by solving the governing equations for the multiphase (fluid-solid) flow under turbulent flow conditions can be used to aid in the design estimations and performance scaling calculations for tanks where the mixing processes will be used prior to waste retrieval and delivery.

FIU has partnered with the Office of River Protection, Bechtel Corporation and the National Energy Technology Laboratory to build CFD models that have the correct physical models, boundary conditions, and PDE solvers that will result in accurate simulations and can be used for various waste mixing scenarios that can be created virtually on large computer clusters to obtain relatively quick answers for the design and optimization of mixing and retrieval processes.

Focus Area 2: Technology development and innovative instrumentation evaluation for HLW tanks

Hanford engineers have a need to develop technologies that can provide inspection and possibly repair capability for their DSTs. Small amounts of waste have been found in the annulus of AY-102, prompting the need for developing inspection tools that can identify the cause and exact location of the leak. The inspection tools will have to navigate through complex cooling channels of the DST refractory pad or through air supply lines and provide visual feedback of the tank bottom. FIU has developed and tested initial prototype tools and is currently working with site engineers to expand the capability of the systems and investigate deployment mechanisms.

Additionally, FIU has efforts supporting Hanford's need to evaluate instrumentation and sensors that may improve personnel and environmental safety. These efforts focus on utilizing commercial off-the-shelf-technologies that assist in providing data that can improve the operational processes in the Hanford tanks. Currently, FIU is investigating the use of infrared sensors for the monitoring of internal wall temperatures of the DSTs. Use of these sensors can aid in identifying whether the tank operating parameters are within prescribed limits.

Focus Area 3: Structural integrity analysis for HLW pipelines

Understanding the current and future status of the structural integrity of the waste transfer system at Hanford is of paramount importance to DOE, engineering contractors and the local community. The tank contractor, Washington River Protection Solutions, LLC (WRPS), has implemented a Fitness-for-Service program that focuses on evaluating the structural integrity of waste transfer system components including primary piping, encasements, and jumpers when they are removed for disposal. FIU is assisting site engineers with evaluating sensors that can provide thickness data on transfer system components that are still operating and provide data in real time. The objective is to provide WRPS with a means to measure the remaining useful life of the components and incorporate the data into future design plans.

Additionally, support is needed for Hanford engineers with regard to understanding the integrity of non-metallic components in the HLW transfer system. There are four primary stressors that can affect the performance of non-metallic components. These include temperature, pressure, radiation, chemistry. In general, it has been well established how the non-metallic components respond to the stressors individually, but the cumulative effect is less understood. FIU will assist site engineers with understanding how the combined effect of three of the four stressors (not including radiation) can degrade the performance of non-metallic components via bench scale testing.

TASK DESCRIPTIONS

Based on the aforementioned technology and research needs, three tasks (with a total of five subtasks) have been identified for the next performance period. FIU will work with Hanford Site personnel, national laboratory contacts, and collaborators from industry and academia to identify shortcomings of the baseline approach and past research efforts. This knowledge will be incorporated into the planning and execution of these tasks detailed below. All technology development related activities will also engage the DOE EM Office of Technology Development (EM-3.2).

Note: Task numbers are not continuous because task numbers have been assigned chronologically over the past 5 years and several tasks have been completed.

TASK 17 – ADVANCED TOPICS FOR MIXING PROCESSES

Subtask 17.1 – Computational Fluid Dynamics Modeling of HLW Processes in Waste Tanks

This task will use the knowledge acquired at FIU on multiphase flow modeling to build a CFD computer program in order to obtain simulations at the engineering-scale with appropriate physics captured for the analysis and optimization of various mixing processes. Focus will be given to turbulent fluid flow in nuclear waste tanks that exhibit both Newtonian and non-Newtonian fluid characteristics.

Objective

The objective of this task is to provide the sites with mathematical modeling, validation, and testing of computer programs to support critical issues related to HLW retrieval and processing. FIU engineers will work directly with site engineers to plan, execute, and analyze the results of the research and development. Specific subtasks include:

- Develop a CFD model based on the Star-CCM+ framework to simulate mixing processes in HLW storage tanks and can be used to estimate mixing efficiency parameters. The model will provide a starting point for improving the fidelity of existing modelling approaches.
- To evaluate Star-CCM' s capability of matching experimental data from non-Newtonian sparging mixing vessels and gain insight into the effects of rheological and physical characteristics on mixing times for accurate prediction in PJM operation.

Benefits

The proposed activities under this subtask at FIU will provide the necessary data and computational tools for the engineering staff at the sites to use in order to predict various scenarios that can occur during mixing and retrieval operations at DOE sites involving multiphase flows. Successful completion of the subtasks will result in the development of tools that can be used to reduce efforts on experimental testing, saving labor time and effort and reducing material cost on expensive experimental setups.

TASK 18 – TECHNOLOGY DEVELOPMENT AND INSTRUMENTATION EVALUATION

Subtask 18.2 – Development of Inspection Tools for DST Primary Tanks

As part of the Hanford DST integrity program review, engineers at Hanford are investigating robotic technologies that can be used for the evaluation of DST tank floors. The technologies are intended to provide video feedback of the tank refractory and base pad so that an assessment can be made regarding the structural integrity of the tank bottom. There are three paths of access: 1) refractory air slots though the annulus, 2) 4-in annulus air supply pipe to central plenum, and 3) 6-in leak detection pit drain from the central sump. In previous years, engineers at Hanford have requested information from industry regarding their capability to inspect the tank insulating refractory pad and provide visual feedback as well as potential for conducting repairs.

Objective

The objective of this task is to develop inspection tools that can provide visual feedback of DST bottoms from within the insulation refractory pads and other pipelines leading to the tank floor. FIU engineers will continue to work directly with site engineers to develop and test the alternative designs. Specific subtasks include:

- Develop and improve on design concepts that will allow for the navigation of a remotely controlled device through the refractory pad channels of DST tanks in the AY Farm and provide visual feedback. A prototype of the inspection tool will be evaluated in a full-scale sectional mock-up test bed constructed at FIU.
- Develop and improve on design concepts that will allow for the navigation of a crawler inspection tool that can navigate through a 3-in and 4-in air supply pipe that leads to the central plenum of the Hanford tanks in the AY Farm. A prototype of this inspection tool will also be evaluated in the full-scale sectional mock-up.
- Investigate the design of a larger scale crawler that can navigate through the 6-inch drain pit pipeline.

Benefits

The proposed subtask will provide alternative solutions for monitoring the structural integrity of the bottoms of the DSTs. Tools developed in this subtask will allow for the detection of potential leaks, allowing site engineers to obtain the necessary information that is needed to generate viable approaches for repair. Additionally, the tools can be outfitted with sensors that provide additional information on the environmental conditions within the DSTs as well as the important details on the health of the tank floors.

Subtask 18.3 – Investigation using an infrared temperature sensor to determine the inside wall temperature of DSTs

As part of the Hanford DST integrity program, engineers at Hanford are interested in understanding the temperatures inside the primary tanks and to safeguard against exceeding specified limits (OSD-T-151-00007). These limits are set to ensure that the tanks are not exposed to conditions that could lead to corrosion of the tank walls. Previously, analysis was conducted to determine the viability of using an infrared (IR) temperature sensor within the annulus space to estimate the temperature of the inside wall of the tank. The analysis suggested that variations due to heat loss would be minimal and reasonable estimates using the sensor within the annulus is viable.

Objective

The objective of this task is to evaluate the ability of IR sensors to detect inner tank wall temperatures via bench scale testing. Specific subtasks include:

- Assessing and validating the viability of using the IR sensor for estimating the inner wall temperature of the tank.
- Developing simulation models to understand the heat transfer in the DST walls and inside the tanks
- Investigating the potential integration of the IR sensor with the robotic devices being developed at FIU.

Benefits

Tank integrity at the Hanford tank farms is of critical importance to engineers at the site. Recent leaks found in AY-102 have led to a number of issues that need to be evaluated to potentially understand the source of the leak. Issues include maintaining the tank at specified temperature limits. The proposed subtask will assist engineers with obtaining additional temperature data within the tank and understanding the uniformity of the temperature near the tank walls. This information will aid in the evaluation of various theories of the cause of the tank leak and provides a means to ensure that tank temperatures stay within specified parameters.

TASK 19 – PIPELINE INTEGRITY AND ANALYSIS

Subtask 19.1 – Pipeline Corrosion and Erosion Evaluation

The Hanford Site Tank Farm has implemented a Fitness-for-Service (FFS) program for the waste transfer system. The FFS program, based on API-579-1/ASME FFS-1, examines structural parameters of the waste transfer systems in order to develop erosion/corrosion rates for relevant system components. The FFS information is acquired from opportunistic evaluations of pipelines that have been removed from service. FIU engineers will work closely with key Hanford HLW personnel, on the FFS program, delivering solutions for sensor evaluations, conducting bench-scale testing followed by data acquisition and analysis for corrosion and erosion assessment.

Objective

The objective of this task is to evaluate potential sensors for obtaining thickness measurements of HLW pipeline components. Specific applications include straight sections, elbows and other fittings used in jumper pits, evaporators, and valve boxes. FIU will assess the accuracy and use of down selected UT systems for pipe wall thickness measurements. FIU will also demonstrate the use of the sensors on the full-scale sectional mock-up test bed of the DSTs.

Benefits

The proposed task will provide information that will assist engineers with understanding the failure potential of HLW transfer components due to corrosion and erosion. This information can assist in determining if and when lines need to be removed, saving time and resources on the unneeded excavation of transfer lines. This information will also assist engineers with designing new transfer systems by establishing more detailed/accurate guidelines governing the life expectancy of the transfer system and its components.

Subtask 19.2 – Evaluation of Nonmetallic Components in the Waste Transfer System

Nonmetallic materials are used in the Hanford Site Tank Farm waste transfer system. These materials include the inner primary hoses in the hose-in-hose transfer lines (HIHTLs), Teflon® gaskets, ethylene propylene diene monomer (EPDM) O-rings, and other nonmetallic materials. These nonmetallic materials are exposed to β and γ irradiation, caustic solutions as well as high temperatures and pressure stressors. How the nonmetallic components react to each of these stressors individually has been well established. However, simultaneous exposure of these stressors has not been evaluated and is of great concern to Hanford Site engineers. FIU engineers have worked closely with key Hanford HLW personnel on developing a test loop and an experimental test plan to determine how these nonmetallic components react to various simultaneous stressor exposures.

Objective

The objective of this task is to provide the Hanford Site with data obtained from experimental testing of the hose-in-hose transfer lines, Teflon® gaskets, EPDM O-rings, and other nonmetallic components used in their tank farm waste transfer system under simultaneous stressor exposures. Due to experimental testing location limitations, no radiation exposure testing will be conducted. The stressor exposure experiments will be limited to various combinations of simultaneous stressor exposure of caustic solutions, high temperatures and high pressure stressors. Evaluation of baseline materials will be conducted and compared with materials that have been conditioned with the various stressors.

Benefits

This task will provide information that will assist engineers with understanding how the nonmetallic components of the tank farm waste transfer system react to simultaneous stressor exposures of caustic solutions, high temperatures and high pressure. This will help in determining the service life of the waste transfer system parts that contain nonmetallic components. This information will also assist engineers with designing new transfer systems by establishing more detailed/accurate guidelines governing the life expectancy of the transfer system parts.

FIU PERFORMANCE YEAR 7 TASK EXECUTION PLANS

Subtask 17.1.1 – CFD modeling of waste mixing and retrieval processes (new)

This task will focus on addressing uncertainties that exist in the tank waste feed delivery system at Hanford using CFD simulations. FIU's efforts will focus on improving fidelity issues that currently exist with recent simulations by augmenting the capabilities of existing CFD platforms.

In the first year of this new task, the capability of existing commercial CFD codes, such as Star-CCM+ and COMSOL, will be evaluated for their ability to capture the salient features in waste retrieval. Initially, a comprehensive review will be conducted on modeling techniques of rotating turbulent jets, solid mobilization, suspension, settling, and pipeline transfer. Particular attention will be paid to the capabilities and limitations of the software used in multi-phase simulations. Based on the review, a commercial software package will be selected that demonstrates the most potential. Additionally, an experimental data set will be selected based on the availability in the literature and based on discussions with engineers at Hanford. The first effort will focus on Newtonian fluid systems and the data obtained will define necessary properties such as density, viscosity, and the flow conditions. Small-scale simulations will then be conducted and validated against experimental data. Suggestions for improvement will be developed and discussed with the site engineers.

Future efforts will focus on conducting large-scale simulations of the mixing and retrieval processes and comparing with published data. Improvements will then be implemented to increase the fidelity of the simulations and potentially decrease the computational time.

Subtask 17.1.2 – CFD modeling of non-Newtonian fluid undergoing sparging to estimate PJM mixing times

A critical factor in the use of the pulse jet mixer's at Hanford is the length of operation time needed to reach a fully mixed vessel condition. During a site internship this past summer, one of the DOE Fellows investigated mixing times of non-Newtonian sparging mixing vessels through bench-scale testing.

In an effort to enhance the modeling of the mixing processes, bench-scale tests will be used to evaluate and improve on the performance of models developed using the commercially available code Star-CCM+. Efforts in the previous year's non-Newtonian studies will be incorporated to ascertain Star-CCM's capability of capturing the mixing mechanisms of non-Newtonian sparging. If Star-CCM is capable of matching the experimental data, a closer study of this process will be conducted and evaluated under different rheological and physical conditions. These efforts will aid in approximating mixing times of the waste tanks undergoing pulse jet mixing at the Hanford Site.

Subtask 18.2.1 – Fabricate full-scale sectional mock-up of DST

Over the past few years, FIU has been developing inspection tools to provide visual information of the floor of double-shell tanks at Hanford. The tools include a miniature rover that can navigate through the refractory slots and a peristaltic type crawler that can navigate through the air supply lines. In the previous year, FIU has developed a design for a full-scale sectional mock-up for evaluating the inspection tools and that can also be used to evaluate other sensors and technologies for integrity analysis. The mock-up includes a four-foot wide carbon steel section of the tank floor that stretches the entire radius of the tank and includes the knuckle and approximately 10 feet of wall above the knuckle. The mock-up will also include the refractory material and slots as well as the air supply line. This will allow for the demonstration of FIU's current inspection tools and provide a means to evaluate the development of deployment systems. The mock-up will be modular so various plates thicknesses can be incorporated into the set up and different refractory channel configurations can be incorporated. For this subtask, the mock-up will be fabricated including a structure for supporting the weight of the plates and the refractory pad.

Subtask 18.2.2 – Complete design and evaluation of sensor integration into inspection tools

FIU will augment the functionality of the inspection tools which currently provide only visual feedback by incorporating other sensors into the systems. FIU will work with site engineers to determine the optimal sensors based on information needed as well as the practicality of incorporating sensors that are available off-the-shelf. The sensors to be evaluated will include temperature, humidity, radiation and possibly other environmental sensors. FIU will also investigate the use of sensors for non-destructive evaluation of the tank floors and piping. Additional modules will likely need to be designed for the crawler and design modifications of the miniature rover will be needed to house the sensors. The completed design of the miniature rover will also include a cable management system that will be used to control the length of the tether, minimizing the drag force as the unit is navigating and keeping the tether taut as the unit is being retracted.

Subtask 18.2.3 – Validate inspection tools in full-scale sectional mock-up testbed

Once the full-scale sectional mock-up test bed has been assembled, the various inspection tools and sensors that FIU is developing can be evaluated. The evaluation of the tools will include navigation capability and functionality of the newly incorporated sensors. Loads on the tethers will also be determined to understand if any alterations need to be made to reach the central plenum of the tank. For the miniature rover, the evaluation will include the effectiveness of the cable management system and its ability to control the length of the tether. Different refractory configurations will also be used to understand the limits of the current miniature rover design. For both systems, slight design modifications may be considered based on the testing. Results from the video feedback will determine if alterations need to be made regarding use of the camera. This includes position/attitude, control and functionality.

Subtask 18.2.4 – Develop conceptual design of 6-inch crawler

Over the last two years, FIU has been developing inspection tools that can navigate through the air supply line and refractory slots to get an understanding of the integrity of the tank floor. After discussions with site engineers, there is also a need to develop a crawler that can travel through the leak detection pit pipeline. This line is 6 inches in diameter and also leads to the central plenum. Previous efforts developed by commercial companies showed promise but failed to reach the central plenum in a cold test due to the load placed on the tether. For the next year, FIU will leverage our success with the air supply line crawler to develop a 6-inch version. This will likely require larger actuators, a thicker tether and stronger grippers. FIU will work with site engineers to understand the design parameters associated with the drain line. Based on this information, a conceptual design will be developed and an initial prototype will be manufactured using 3D printed parts and off-the-shelf components.

Subtask 18.2.5 – Develop conceptual design of platform for miniature rover

To deploy FIU's miniature rover inspection tool, a deployment platform will need to be developed. The platform will consist of a means to bring the rover in close proximity to the air channels via the tank annulus, release the inspection tool and be capable of housing the cable management system. FIU plans to conduct a review of commercially available robotic platforms and discuss with site engineers their experiences with platforms that can traverse the side of the primary liner inside the annulus. FIU has also been developing a platform and, based on our review, FIU will develop a conceptual design for a platform that meets these requirements. After approval from the site engineers, FIU will proceed with developing an initial prototype.

Subtask 18.3.1 – Investigation using an infrared temperature sensor to determine the inside wall temperature of a DST

During last year's performance period, FIU worked with Hanford engineers to select an IR sensor that could be used for estimating the temperature inside of the tank walls from the annulus of a DST. The sensor was procured and initial calibration and emissivity tests were conducted. A test plan was also developed and executed to obtain preliminary temperature data using the IR sensor on a bench-scale test set up established at FIU. Based on the initial experiments, it was observed that the IR sensor had sensitivity issues in terms of the repeatability from various locations from the tank wall. This year, FIU will evaluate and assess those issues pertaining to the IR sensor and further enhance the bench-scale testing using additional data acquisition systems and thermocouples to obtain and compare real-time temperature data with the IR sensor data. This would result in gaining insight into the validation of the IR sensor. Also, heat transfer based simulation models will be developed to understand thermal distribution in the tank walls and inside. Further, the IR sensor will be tested on an engineering-scale sectional mock-up test bed being developed at FIU. In addition, the potential integration of the sensor with the robotic devices will be investigated.

Subtask 19.1.1 – Evaluation of alternate UT sensors for erosion and corrosion analysis

In the previous year's performance period, FIU worked with Hanford Site engineers to evaluate and downselect two potential ultrasonic transducer (UT) systems that could be used to obtain real-time data on the structural integrity of pipelines in the waste transfer system. One of the downselected systems is a guided wave system from Permasense which has recently been procured. This year, FIU will initially assess the accuracy of the UT system on various pipe fittings which will include straight sections, elbows and reducers for 2-, 3- and 4-inch pipes. Since long term real-time data is desired, customized installation procedures may be required. A pipe test loop will then be developed with input from site engineers. FIU will investigate approaches (including abrasive simulants) that can be used to age and erode the pipes and the UT sensor system will be evaluated with conditions similar to Hanford and other sites. Finally, the UT system will be investigated for prospective integration with the robotic devices such as the mini rover and the peristaltic crawler being developed at FIU.

Subtask 19.2.1 – Aging of non-metallic materials

In the previous year, FIU fabricated an experimental test setup and commenced the aging of non-metallic materials including inner hose-in-hose transfer lines (HIHTL), EPDM O-rings and Garlock® gaskets used in the Hanford tank farm waste transfer system under simultaneous stressor exposures. The stressor exposure experiment consists of various combinations of simultaneous stressor exposure including caustic solutions and elevated temperatures. Material coupon specimens as well as component in-service configurations are exposed to a combination of simultaneous stressors. The in-service configuration aging experimental setup consists of 3 independent pumping loops with two manifold sections on each loop. Each of the 3 loops is run at a different temperature (100^{o}F, 130^{o}F and 180^{o}F). Each manifold section holds three test samples and is used for a corresponding exposure time of 180 and 360 days. Three samples of the EPDM inner hose and three samples of the EPDM O-rings and Garlock® gaskets are placed in a parallel manifold configuration. The temperature of the chemical solution circulating within each loop is maintained at a preset temperature by an electronically controlled heating system. A 25% sodium hydroxide solution is used as a chemical stressor that is circulated in each of the loops. Each of the three reservoirs baths has two perforated containers with EPDM and Garlock® material coupons in each container. The containers will be submerged in the bath for durations of 180 or 360 days. This subtask will involve the continuation of the non-metallic aging process for a duration of 6-months as well as 1-year.

Subtask 19.2.2 – Experimental testing of non-metallic materials

This subtask will focus on determining the material properties of post-aging non-metallic materials. Experiments will include burst pressure tests of the inner hose-in-hose transfer line (HIHTL) specimens as well as leak pressure tests of the EPDM O-ring and Garlock® gaskets (ASTM D380-94 and ASTM F237-05) to determine the effects of aging on the in-service components. In addition, the material properties (Table 1) of the EPDM and Garlock® coupons will be evaluated and the results will be compared to the baseline values.

Table 1. EPDM Coupon Sample Tests

Test 1	Dimension change (ASTM 543)
Test 2	Specific gravity and mass change (ASTM D792, ASTM 543)
Test 3	Tensile strength (ASTM D412)
Test 4	Compression stress relaxation (ASTM D6147)
Test 5	Ultimate elongation (ASTM D412)
Test 6	Hardness measurements (ASTM 2240)

After results are obtained from the material aged for 6-months, it will be compared with the baseline data to determine any changes in strength and material properties. The results could additionally alter the duration of the planned one-year aging.

Project Milestones

Milestone No.	Milestone Description	Completion Criteria	Due Date
2016-P1-M17.1.1	Complete literature review and selection of baseline experimental cases	Summary email sent to Hanford contacts and DOE HQ	02/3/2017
2016-P1-M17.1.2	Complete CFD simulations of air sparging experiments	Summary email sent to Hanford contacts and DOE HQ	04/21/2017
2016-P1-M18.2.1	Complete assembly of full-scale sectional mock-up test bed	Summary email sent to Hanford contacts and DOE HQ	12/16/2016
2016-P1-M18.2.2	Complete evaluation of sensor integration into inspection tools	Summary email sent to Hanford contacts and DOE HQ	05/26/2017
2016-P1-M18.2.4	Complete conceptual design of miniature rover platform	Summary email sent to Hanford contacts and DOE HQ	08/25/2017
2016-P1-M18.2.5	Complete conceptual design of 6 inch peristaltic crawler	Summary email sent to Hanford contacts and DOE HQ	08/25/2017
2016-P1-M18.3.1	Complete bench-scale testing for temperature measurements using IR sensors	Summary email sent to Hanford contacts and DOE HQ	03/31/2017
2016-P1-M19.1.1	Assess the accuracy of the down selected UT system via bench-scale testing	Summary email sent to Hanford contacts and DOE HQ	05/12/2017
2016-P1-M19.1.2	Develop test loop for evaluating UT sensors	Summary email sent to Hanford contacts and DOE HQ	08/25/2017
2016-P1-M19.2.1	Complete experimental testing of 6 month aged materials	Summary email sent to Hanford contacts and DOE HQ	03/17/2017

Deliverables*

Client Deliverables	Responsibility	Acceptance Criteria	Due Date
Draft Project Technical Plan	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	09/30/2016
Monthly Progress Report	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	Monthly
Quarterly Progress Reports (all tasks and projects combined)	Principal Investigator	Acknowledgement of receipt via E-mail two weeks after submission	Quarterly
Draft Year End Report (all tasks)	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	10/13/2017
Draft Summary Report for Subtask 17.1.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	02/17/2017
Draft Summary Report for Subtask 17.1.2	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	05/5/2017
Draft Summary Report for Subtask 18.2.3	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	06/30/2017
Draft Summary Report for Subtask 18.3.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	04/14/2017
Draft Summary document on UT assessment for Subtask 19.1.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	05/26/2017
Draft Summary Report for Subtask 19.2.2	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	03/31/2017
Presentation overview to DOE HQ/Site POCs of the project progress and accomplishments (Mid-Year Review)	Project Manager	Presentation to DOE HQ and Site POCs	04/7/2017**
Presentation overview to DOE HQ/Site POCs of the project progress and accomplishments (Year End Review)	Project Manager	Presentation to DOE HQ and Site POCs	09/29/2017**

**Final documents will be submitted to DOE within 30 days of the receipt of comments on the draft documents.*

***Completion of this deliverable depends on availability of DOE-HQ official(s.)*

COMMUNICATION PLAN, ISSUES, REGULATORY POLICES AND HEALTH AND SAFETY

Communication Plan

The task has some elements that require significant information from the site in order to proceed with the tasks. Therefore, the communication with the clients and relevant experts at Hanford & SRS is a critical component of the task. The mode of communication will be e-mails, telephone/conference call, and meeting at the site. Though site-specific contact persons have been identified, constant communication will be maintained with client stakeholders at DOE HQ and the Hanford sites to ensure all parties involved are aware of the task progress.

Information Item	Client Stakeholder	When?	Communication Method	Responsible Stakeholder
Status Update Teleconferences	Hanford POC (R. Mendoza, T. Sams, M. Thien, D. Washenfelder, WRPS) DOE EM-4.12	Monthly	Phone call	Project Manager
EM-HQ Status Update Phone Call	DOE EM Liaison to FIU	Bi-Weekly	Phone call	Principal Investigator
Quarterly Report	DOE EM-4.12 WRPS	End of Q1, Q2, Q3,Q4	E-mail	Principal Investigator
Annual Year End Report	DOE EM-4.12, WRPS	45 days after completion of performance period	E-mail	Principal Investigator/ Project Manager
Deliverables, Milestones	Hanford POC (R. Mendoza, T. Sams, M. Thien, D. Washenfelder WRPS) DOE EM-4.12	At completion of Deliverable, Milestone	E-mail	Project Manager/ Principal Investigator
Coordination of project activities	DOE EM, Hanford/WRPS	As needed to discuss issues and reach consensus	Phone, E-mails	Project Manager

Anticipated Issues

Every year, South Florida has a 6-month hurricane season. Twice in the past decade FIU has been closed 1-2 weeks due to hurricane storm damage. Care will be taken to minimize the impacts on the overall schedule of milestones and deliverables due to hurricanes.

Project 1 tasks are supported by DOE Fellows and FIU graduate students. It is anticipated that 7 to 9 DOE Fellows and FIU graduate students will be supporting this project during FIU Performance Year 7. It is anticipated that research under this project may be used by students as the basis for a thesis or dissertation towards a graduate degree and would be impacted by a re-direction of the project task scope. FIU will communicate closely with DOE HQ and site contacts throughout the performance of the research tasks in order to accurately forecast the duration of the research tasks and minimize the potential negative impact of scope redirection on the graduate studies of any students working on that task.

Regulatory Policies and Health and Safety

Since laboratory experiments will be conducted on this project, FIU will ensure test plans are developed and reviewed that cover staff health and safety issues. The nature of waste simulants is that they are chemically the same as HLW and therefore highly caustic and hence hazardous. In addition, FIU will set up, operate, and dismantle experimental test beds using proper procedures from FIU and that comply with standards issued by the Occupational Safety and Health Administration (OSHA). In order to minimize hazards, individuals will require documentation of all needed online and classroom health and safety training prior to their being authorized to work in the lab, on equipment, or on the test beds. Further, mandatory training is provided to these individuals on workplace safety multiple times:

- Safety training at the time of initial assignment.
- Safety training prior to assignment involving new exposure situation (e.g., new equipment or technology).

The Department of Health and Safety at FIU also provides other training relevant to specific tasks or subtasks. Either FIU EHS or FIU ARC may request an audit by FIU EHS of safety documentation, lab set up and procedures when there are any concerns by any staff working on the task.