PROJECT TECHNICAL PLAN

Project 1: Chemical Process Alternatives for Radioactive Waste

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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.

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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.

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

The mixing performance of pulse-jet mixers (PJM) depends on the geometry of the vessel, number and orientation of the PJMs, slurry rheology, cycle characteristics and other variables which makes the experimental evaluation a big challenge due to the large number of variables and high cost 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 gas-solid multiphase flow under turbulent flow conditions can be used to aid in the design estimations and performance scaling calculations for tanks where the PJMs will be used for the next 40 years in the vitrification process of the nuclear waste in the Waste Treatment and Immobilization Plant at Hanford.

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 that 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 PJM operations. For this purpose, Star-CCM+ software has been identified as the framework where the CFD models will be developed.

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 double-shell tanks (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 initial prototype tools and is currently working with site engineers to determine optimal and cost efficient ways to conduct full scale mock-up testing.

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. Examples include utilizing FIU's solid-liquid interface monitor (SLIM) to aid in identifying precursors to gas release events that could potentially allow for lower flammability limits to be exceeded. FIU is also 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 six 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.

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 PJM mixing performance. Focus will be given to turbulent fluid flow in nuclear waste tanks that exhibit 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 work directly with site engineers to plan, execute, and analyze the results of applied research and development. Specific subtasks include:

- Develop a CFD model based on the Star-CCM+ framework to simulate the turbulent jet-flow in non-Newtonian fluids that show Bingham plastic behavior. The model will provide improved efficiency over standard modeling techniques but still capture the salient features of the fluid flow.
- Execute verification and validation analysis for the uncertainty prediction in the results of Star-CCM+ software for benchmark cases of multiphase flow.

Benefits

The proposed activities under this subtask at FIU-ARC 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 operations at DOE sites that involve multiphase flows involving waste sludge that acts as Bingham plastic. Successful completion of the subtasks will result in time and cost savings and risk minimization, leading to increased environmental safety in the operations at the DOE sites as well as design and operation of future waste treatment tanks to be placed in black cells at the WTP site that will utilize the PJM mixing technique.

TASK 18 – TECHNOLOGY DEVELOPMENT AND INSTRUMENTATION EVALUATION

Subtask 18.1 – Evaluation of FIU's Solid-Liquid Interface Monitor for Estimating the Onset of Deep Sludge Gas Release Events (New)

In recent years, Hanford engineers have been focusing on increasing tank space in DSTs to mitigate issues related to the aging of SSTs. One of the major concerns associated with these transfers is the potential release of flammable gas. This can occur when the sludge levels are exceedingly high in the DSTs and is referred to as a deep sludge gas release event (DSGRE). During the mixing processes prior to transfer, gas could be released. The tank farm contractors are required to maintain various tank conditions including keeping the flammability level in the tank head space below a specified level (lower-flammability limit – LFL). In the process of transporting the waste and the formation of deep sludge levels, gas within the sludge may be released and the LFL in the head space could exceed prescribed LFLs.

To mitigate these types of events, engineers at Hanford have conducted a number of research activities ranging from modeling multiphase systems comprised of the gas and sludge to experimental work involving the use of tall columns to evaluate retention properties of sludge. In this subtask, FIU will investigate the use of our SONAR system to provide images of sludge surfaces and to determine if the sonar can provide topographical information that may suggest a DSGRE is about to occur.

Objective

The objective is this subtask is to evaluate FIU's solid-liquid interface monitor (SLIM) for its ability to image sludge surfaces and determine whether a DSGRE is about to occur. Pilot-scale testing will be conducted to evaluate SLIM's resolution and its ability to identify topographical changes in a sludge surface due to the formation of a gas bubble. Efforts will also focus on how the sludge shear stress may affect the gas bubble size and ultimately the ability of SLIM to detect DSGREs.

Benefits

As the tanks at Hanford continue to age, there is a need to maximize the current available space in the DSTs. This research would serve as a tool to assist in understanding the relationship between sludge depth, sludge shear stress and the potential for DSGREs. This research will provide engineers at Hanford with information that could aid in maximizing tank space as well as providing a means to reduce risk to personnel by predicting the onset of gas release events that could increase gas in the head space to a level beyond the LFL.

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 for the evaluation of Tank 241-AY-102. 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 through the air supply lines. 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 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 the inspection tool will be evaluated in a mock-up test bed constructed at FIU.

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.

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

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:

- Working with Hanford engineers to develop a test plan that can assess the viability of using an IR sensor for estimating the inner wall temperature of the tank.
- Executing the test plan and providing insight to Hanford engineers regarding the expectations and limitations of using the IR sensor for this purpose.

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 United States Department of Energy 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-ARC 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 use of various ultrasonic systems that are either commercially available or used previously at Hanford and select the most promising systems for further evaluation.

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-ARC engineers have worked closely with key Hanford HLW personnel to develop 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 YEAR 5 TASK EXECUTION PLANS

Overall Project Management Task

This task will focus on the control and monitoring components of the project. This task will perform quarterly report development, client interaction, progress tracking, and the development of the final report.

Subtask 17.1.1 – Computational fluid dynamics modeling of jet penetration in non-Newtonian fluids

The capability of the commercial CFD code, Star-CCM+, needs to be improved in simulating the mixing effect created by high velocity jets in non-Newtonian fluids produced by the pulse-jet mixers in large storage tanks with complex geometries, in order to accurately predict the mixing behavior of the nuclear sludge. This is especially important for modeling the flow of Bingham plastics since the waste at the Hanford Site is of that type.

The existing Herschel-Bulkley model in the Star-CCM+ code which combines a Bingham fluid with a power-law model is unable to represent the viscoplastic behavior of the sludge properly under turbulent flow conditions when the computational model is unable to resolve the small scale changes in the fluid using the Reynolds-average Navier-Stokes (RANS) modeling approach. This will be corrected by providing additional information for the shear rates obtained with Direct Numerical Simulation (DNS) methods and correcting the viscosity calculation in the RANS approach. Three dimensional pipe flow under laminar, transitional and turbulence flow conditions will be simulated to verify the modification to the definition of viscosity. Results will be compared against DNS and experimental results.

Subtask 17.1.2 – Computational fluid dynamics validation of jet impingement correlations

Subtask 17.1.2 is one of two new subtasks (the other is subtask 18.3.1) added to the PTP that were not described in the Renewal Application. These two new subtasks will be performed using the level of effort originally planned for Task 20, Innovative Nuclear Separations of High Level Radioactive Waste, which was dropped from the planned scope of work for FIU Year 6. The two new subtasks were determined to be a higher priority for the Hanford Site.

Currently, two correlations from a jet impingement experiment developed by Poreh et al. (1967) are being extensively used in the validation of lightly loaded pulse jet mixing (PJM) vessels. Criticism arises in the application of such correlations due to geometric differences between the experiment from which the two correlations were derived and the PJMs. The correlations dictate whether criticality within a vessel will be reached; therefore, it is imperative to properly validate their accuracy.

Previously, FIU has used StarCCM+ to perform RANS modeling in order to successfully replicate Poreh's experimental results. FIU has also similarly modeled Poreh's experiment with a slight geometric difference which more closely resembles the PJMs. We will continue this effort by analyzing and confirming the two correlations in the simulation. Furthermore, geometrical changes to Poreh's experiment that will approach the PJM's vessels will be simulated and analyzed in succession until full geometric similarity is reached. The efforts of this task will help to ascertain the accuracy of Poreh's correlations as applied to the lightly loaded PJMs vessels.

Subtask 18.1.1 – Bench scale testing of SLIM to detect potential DSGREs

This subtask will focus on the testing of the SLIM sonar to image sludge surfaces when the sludge has gas bubble(s) incorporated into it. The intent is to determine if SLIM can be used as a tool that can identify sludge surface changes that precede DSGREs. With the assistance of Hanford engineers, FIU will develop a test plan and conduct bench scale tests to assess the viability of SLIM for this use. A 3-5 foot diameter tank will be used to contain sludge simulant made from Kaolin clay. Various shear strengths of sludge will be manufactured and various bubble sizes will be used to create undulations on the sludge surface. Images will be taken using SLIM and changes in the surface will be correlated with sludge shear strength and gas bubble volume. Specific details of the bench scale tests will be discussed and finalized with Hanford engineers prior to testing.

Subtask 18.2.1 – Finalize design and complete prototype for tank floor inspection through the refractory pad

During the previous year, FIU has developed a prototype of an inspection tool to investigate DST floors via air channels in the refractory pads. This year, the prototype will be subject to further improvement and modifications. Efforts will focus on determining operational voltage levels associated with the recently incorporated gear motors. Additionally, the tether housing for the power and camera lines will be selected to minimize the drag force. Experiments will be conducted to quantify the overall tether drag and determine the efficiency of the design to navigate through the first 17 feet of the air channels. Additional testing will include the unit’s ability to make turns and pull the tether while carrying potential loads associated with future inspection equipment. After the design and fabrication have been finalized, full scale mock-up testing will be conducted.

Subtask 18.2.2 – Develop full scale mock-up test bed for inspection through the refractory pad

A mock-up of the AY-102 tank refractory air channels will be manufactured at FIU. The intention is to provide a platform for conducting cold tests prior to deployment at Hanford. The mock-up will be designed according to specifications provided by site engineers at Hanford. Extra care will be taken to assure a high correlation between the mock-up and potential inspections in the AY Tank Farm. Finally, the ability of the inspection tool to carry out operations similar to those at the AY Tank Farm will be evaluated using the full scale test bed.

Subtask 18.2.3 – Finalize design and complete prototype for tank floor inspection through the air supply line

In the previous year, a novel functional pneumatic crawler was fully designed, built, assembled, and preliminarily tested. In the upcoming year, FIU will improve and finalize the design of the peristaltic inspection tool which includes:

a) Improved gripper design - A stronger grip is an essential improvement in the existing design. The redesign of the grippers will focus on evaluating other types of locking mechanisms and the selection of rubber materials with superior coefficients of friction. The use of radiation hardened electric actuators will also be considered.
b) Tether design - A lighter tether is another essential improvement in the existing design. The use of micro pneumatic control valves, embedded in the crawler, may reduce the number of pneumatic supply lines in the tether from 8 to 1.
c) Load feedback - The addition of a small load cell will provide information regarding how the tether load cell varies as a function of line geometry. Essentially, the load cell would provide force feedback to the tether drag and indicate whether additional modules need to be incorporated into the design.
d) Instrumentation modules - Additional modules that include instrumentation will be investigated. The extra modules could provide feedback for valuable parameters, such as temperature, pressure, humidity, slope and radiation levels.

The final design will be tested via bench scale tests that simulate several operational conditions and pipeline configurations. The durability of each component and module will be cyclically tested under loading. Final design modifications will be incorporated as needed. Testing will also include retrieval tests, which will demonstrate the safe removal of the tool in case of failure.

Subtask 18.2.4 – Develop full scale mock-up test bed for inspection through the air supply line

A mock-up of the AY-102 tank ventilation header will be manufactured at FIU. The intention is to provide a platform for conducting cold tests prior to deployment at Hanford. The mock-up will be designed according to specifications provided by site engineers at Hanford. Extra care will be taken to assure a high correlation between the mock-up and potential inspections in the AY Tank Farm. Finally, the ability of the inspection tool to carry out operations similar to those at the AY Tank Farm will be evaluated using the full scale test bed.

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

Subtask 18.3.1 is one of two new subtasks (the other is subtask 17.1.2) added to the PTP that were not described in the Renewal Application. These two new subtasks will be performed using the level of effort originally planned for Task 20, Innovative Nuclear Separations of High Level Radioactive Waste, which was dropped from the planned scope of work for FIU Year 6. The two new subtasks were determined to be a higher priority for the Hanford Site.

In this subtask, FIU will work with Hanford engineers to develop a test plan for evaluating an IR temperature sensor to measure the inside thickness of a tank wall. A bench scale mock-up of a tank will be constructed and a space emulating the annulus will be developed. Hanford engineers will also assist in the selection of the specific sensor/sensors that will be evaluated. It is anticipated that the tank will house water that is set to various temperature levels. The tank wall will also have the potential to be varied in terms of thickness. The sensor will be held at variable distances from the outer tank wall to assess how the measurements change as a function of location as well as tank temperature and wall thickness. The space representing the annulus space will also be controlled and may be introduced as a variable depending on the initial results.

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

In the previous year, FIU worked with Hanford site engineers to evaluate the use of various couplants for an ultrasonic transducer system to measure thickness of pipes and fittings in real-time within valve boxes. Based on the constraints of the problem, we focused on evaluating dry couplants with a standard UT sensor. The results showed that the UT sensor selected for evaluation was not compatible with the dry couplants, in terms of obtaining consistent data. Additionally, previous efforts by WRPS demonstrated fallacies in other thickness measuring systems that included PipeWrap in which thumbnail transducers were imbedded in a polymer wrap. Issues arose due to variable tightening of the wrap which led to inconsistent measurements or even failed transducers. This year, FIU will evaluate alternate methods for utilizing/installing the PipeWrap system as well as investigate similar systems that do not have problems related to couplants. After the review, exemplar sensor systems will be procured from the sites or from vendors and bench scale tests will be conducted. We will work with Hanford engineers to understand the limitations of each system and ultimately determine which system has the potential for use at the site. The bench scale tests will focus on measurements for elbows and other fitting and will likely require alternate installation procedures or modification to the systems that allow for reliable installation methods.

Subtask 19.2.1 – Experimental test loop setup for non-metallic aging

This subtask will involve acquiring all the components needed to fabricate the test loop as well as the material for the test specimens. Currently, FIU has ordered and is waiting for the delivery of the inner hose-in-hose transfer line (HIHTL) specimens from Riverbend Inc. Additionally; FIU is working with Hanford site personnel to determine the optimal fittings for testing the EPDM O-rings and gaskets. Once the HIHTL specimens have been received, and the fittings required has been determined, the test loop will be completed.

Subtask 19.2.2 – Baseline experimental testing of non-metallic materials

This subtask will focus on determining the baseline properties for both EPDM coupon samples and the EPDM components. The EPDM coupon samples will have their material properties evaluated as per ASTM standards prior to any exposure. Table 1 provides a list of the tests that will be conducted to provide an understanding of the material properties prior to aging. All coupons will also be measured to assure they meet baseline ASTM property standards. In addition, to limit manufacturing variability, all samples will be derived from the same lot.

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)

Additionally, the EPDM components (HIHTLs, O-rings, gaskets) will be tested prior to aging via leak and hose burst tests. These components will be evaluated in an in-service configuration as per ASTM D380-94 and ASTM F237-05.

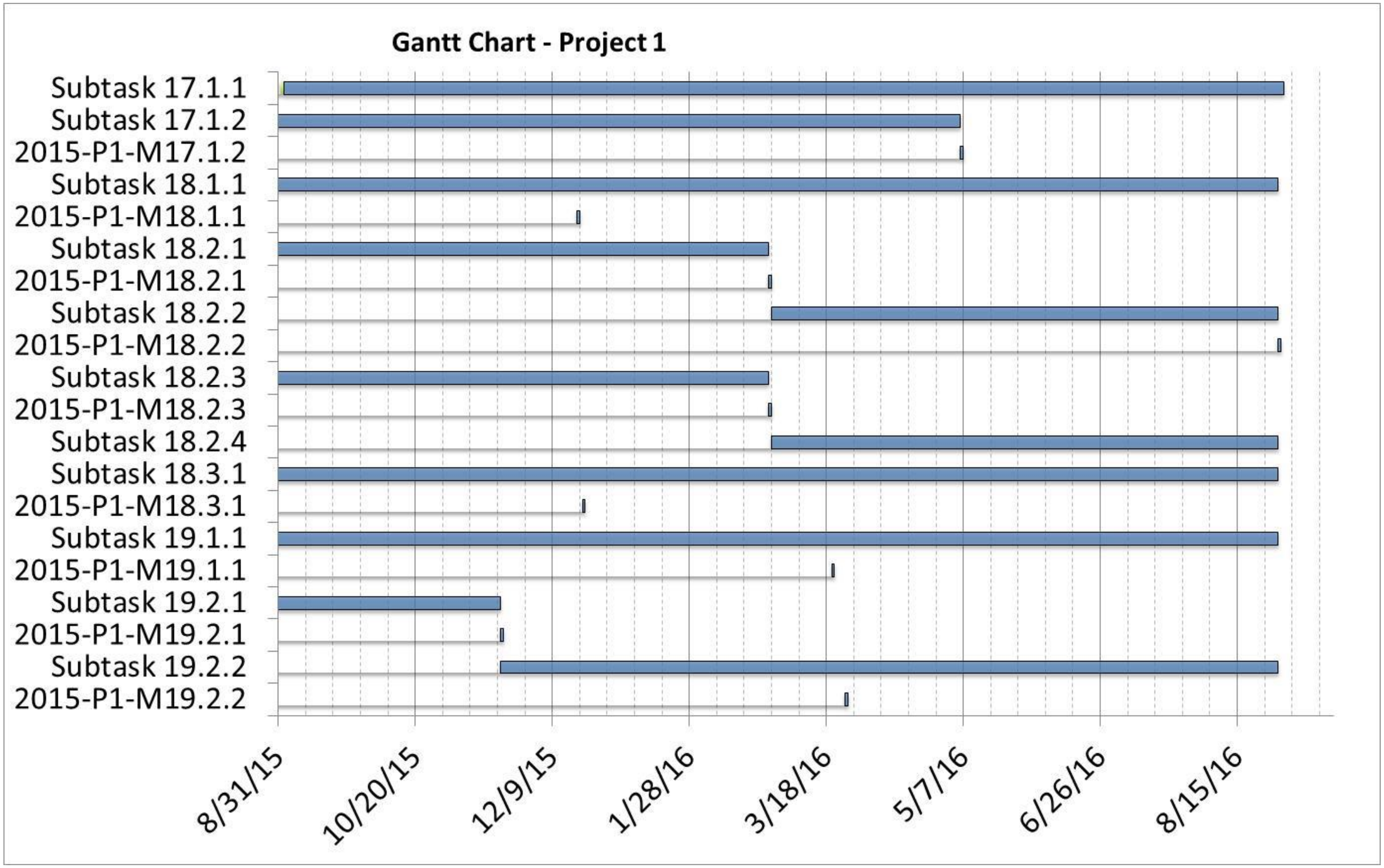
Subtask 19.2.3 – Coupon and component aging

This subtask will involve the aging of the HIHTLs, EPDM gaskets and O-rings used in the Hanford tank farm waste transfer system under simultaneous stressor exposures. The stressor exposure experiments will consist of various combinations of simultaneous stressor exposure including caustic solutions and elevated temperatures. Material coupon specimens as well as components in-service configurations will be exposed to a combination of simultaneous stressors. The in-service configuration aging experimental setup will consist of 3 independent pumping loops with three manifold sections on each loop. Each of the 3 loops will be run at a different temperature (70^{o}F, 130^{o}F and 180^{o}F). Each manifold section can hold up to three test samples and be used for a corresponding exposure time of 60, 180 and 360 days. Three samples of the EPDM inner hose and three samples of the O-rings and gaskets will be placed in a parallel manifold configuration. Isolation valves on each manifold will allow removal of samples without affecting the main loop and the rest of the samples. The temperature of the chemical solution circulating within each loop will be maintained at a preset temperature by an electronically controlled heating system. This configuration requires 9 test samples (for the inner hose and O-rings and gaskets) for each of the three test loops, requiring a minimum of 27 test samples of each component. A 25% sodium hydroxide solution will be used as a chemical stressor that will circulate in each of the loops. The chemical stressor will be sampled every 30 days to ensure that the concentration levels remain constant.

Each of the three reservoirs baths will have three racks with five material coupons suspended on each rack. The racks will be submerged in the bath for durations of 60, 180 or 360 days. After exposure to simultaneous stressors, the material properties (Table 1) of the coupons will be evaluated and the results will be compared to the baseline values.

Similarly, after the EPDM components have been aged, leak and burst pressure tests (ASTM D380-94 and ASTM F237-05) will be conducted to determine the effects of aging on the in-service components.

Task Schedule



Project Milestones

Milestone No.	Milestone Description	Completion Criteria	Due Date
2015-P1-M17.1.2	Complete validation of impingement correlations	Summary email sent to Hanford contacts and DOE HQ	05/6/2016
2015-P1-M18.1.1	Complete test plan for evaluating SLIM's ability to detect a precursor of DSGREs	Summary email sent to Hanford contacts and DOE HQ	12/18/2015
2015-P1-M18.2.1	Finalize the design and construction of the refractory pad inspection tool	Summary email sent to Hanford contacts and DOE HQ	02/26/2016
2015-P1-M18.2.2	Complete engineering scale mock-up testing	Summary email sent to Hanford contacts and DOE HQ	08/28/2016
2015-P1-M18.2.3	Finalize the design and construction of the air supply line inspection tool	Summary email sent to Hanford contacts and DOE HQ	02/26/2016
2015-P1-M18.3.1	Complete test plan for temperature measurements using IR sensors	Summary email sent to Hanford contacts and DOE HQ	12/18/2015
2015-P1-M19.1.1	Evaluate and down select alternative UT systems for bench scale testing	Summary email sent to Hanford contacts and DOE HQ	03/11/2016
2015-P1-M19.2.1	Complete test loop set up	Summary email sent to Hanford contacts and DOE HQ	11/20/2015
2015-P1-M19.2.2	Complete baseline experimental testing	Summary email sent to Hanford contacts and DOE HQ	03/25/2016

Deliverables*

Client Deliverables	Responsibility	Acceptance Criteria	Due Date
Draft Project Technical Plan	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	10/05/2015
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	10/14/2016
Draft Summary Report for Subtask 17.1.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	08/28/2016
Draft Summary Report for Subtask 17.1.2	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	05/6/2016
Draft Test Plan for Subtask 18.1.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	12/18/2015
Draft Summary Report for Subtask 18.2.1 and 18.2.2	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	08/28/2016
Draft Summary Report for Subtask 18.2.3	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	02/26/2016
Draft Summary Report for Subtask 18.3.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	07/29/2016
Draft Summary document for Subtask 19.1.1	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	03/11/2016
Draft Summary Report for Subtask 19.2.2	Project Manager	Acknowledgement of receipt via E-mail two weeks after submission	04/8/2016
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	02/29/2016**

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	08/31/2016**

**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, D. Washenfelder, WRPS) DOE EM-21	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-21 WRPS	End of Q1, Q2, Q3,Q4	E-mail	Principal Investigator
Annual Year End Report	DOE EM-21, WRPS	45 days after completion of performance period	E-mail	Principal Investigator/ Project Manager
Deliverables, Milestones	Hanford POC (R. Mendoza, T. Sams, WRPS) DOE EM-21	At completion of Deliverable, Milestone	E-mail	Project Manager/ Principal Investigator

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 8 to 10 DOE Fellows and FIU graduate students will be supporting this project during FIU Year 6. 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.