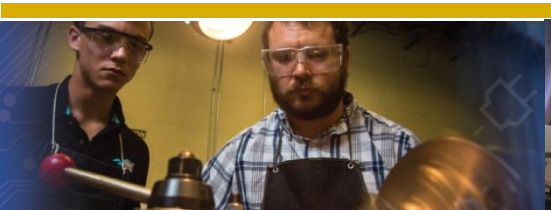
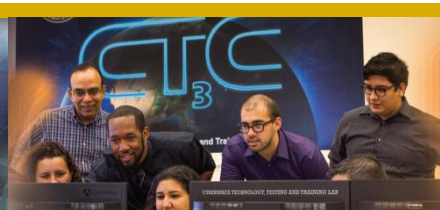
FIU PROJECT 1: CHEMICAL PROCESS ALTERNATIVES FOR RADIOACTIVE WASTE

Dwayne McDaniel

FLORIDA INTERNATIONAL UNIVERSITY





FIU Personnel and Collaborators

Principal Investigator: Leonel Lagos

Project Manager: Dwayne McDaniel

Faculty/Staff: Amer Awwad, Anthony Abrahao, Aparna Aravelli, Jose Rivera, Shervin Tashakori, Mayren Boan, Mackenson Telusma, Dan Martin

DOE Fellows/Students: Christopher Excellent, Edward Nina, Jeff Natividad, Dan Martin, Michael Thompson, Jason Soto, Sebastian Story, Joel Adams

DOE-EM: Gary Peterson, Kurt Gerdes, Genia McKinley

WRPS: Ruben Mendoza, Jason Gunter, Kayle Boomer, Jason Vitale, Glenn Soon, Joe Rice, Steven Kelly

SRNL: Michael Poirer, Connie Herman, Bruce Wiersma, Jean Plummer, Christine Langdon

SRS: Bill Giddings, Jane Carter, Saiying Bowers

PNNL: Kayte Denslow, Carl Enderlin

Project Tasks and Scope

Task 17: Advanced Topics for Mixing Processes

- Investigate formation of sediment beds and pipeline flushing operations via FIU test loop

Task 18: Technology Development and Instrumentation Evaluation

- Development of inspection tools for waste transfer lines and DST primary tanks
- Investigate approaches/coatings to protect the walls in the exhaust channel at H-Canyon

Task 19: Pipeline Integrity and Analysis

- Pipeline corrosion and erosion detection
- Nonmetallic materials evaluation

Task 17 - Advanced Topics for Mixing Processes

17.2 - Evaluation of pipeline flushing requirements for HLW at Hanford and Savannah River

FIU Applied Research Center

Site Needs:

- According to the Defense Nuclear Facilities Safety Board, a number of issues still exist regarding the slurry transport and flushing strategies at Hanford.
- A series of flushing tests can address a variety of technical gaps associated with flushing techniques and would be beneficial to both Hanford and Savannah River.

Objectives:

- Conduct a series of experimental tests to bridge technical gaps associated with the flushing of HLW within the transfer systems at Hanford and Savannah River.
- Tests will continue to be conducted using the flushing loop that were developed in the previous year.
- The loop can be expanded to multiple of its lengths ranging from 165 ft to 825 ft for scale up analysis (study of length effect on flush operation efficiency).

Supernatant Dried on Nozzle 18 in AP Valve Pit.

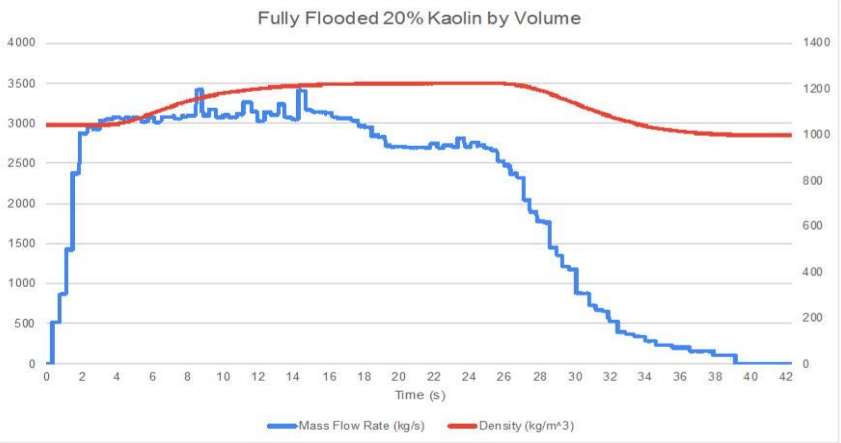
Task 17 - Advanced Topics for Mixing Processes

17.2 - Evaluation of Pipeline Flushing Requirements for HLW at Hanford and Savannah River

FIU Applied Research Center

Accomplishments Year 10:

- Conducted trials for gravity drained and fully flooded systems using kaolin as the simulant. Testing was done for 10, 15 and 20% by volume of Kaolin. Flow to line volume ratio for complete flushing is being determined for each trial.
- Ultrasonic testing to determine repeatability of initial conditions continued. Different UT sensors and analyzers are being used to determine parameters need for TOF.
- Continued with CFD of flushing operation for the 165 ft loop.



Initial - 1 day of settling

Midway through flushing trial

After flushing

Task 17 - Advanced Topics for Mixing Processes

17.2 Evaluation of pipeline flushing requirements for HLW at Hanford and Savannah River

FIU Applied Research Center

Proposed Scope for Performance Year 01*

- Expand test loop to 330 ft
  - Validate the functionality of the system and instrumentation
- Continue to investigate the ability to characterize the initial conditions (fully-flooded and gravity-drained)
- Develop computational tools to create a virtual environment for evaluating different simulants and pipe geometries.
- Investigate the use of different simulants – i.e. higher density particles, complex mixtures.

Task 18 - Technology Development and Instrumentation Evaluation

18.2 - Development of Inspection Tools for DST Primary Tanks

FIU Applied Research Center

Site Needs:

In 2012, tank waste was found in the annulus of AY-102. In addition, thinning (up to 70%) of the secondary liner in the annulus region has also been observed in other double shell tanks (DSTs). Understanding of the structural integrity of all DSTs at Hanford is of paramount importance - thus, the significant need for development of tools/sensors that can provide information regarding the health of the tanks.

Year 10 Objective:

- Develop cost effective inspection tools that can travel through the refractory pad air channels underneath the primary liner and the drain line channels underneath the secondary liner.

Present Tasks:

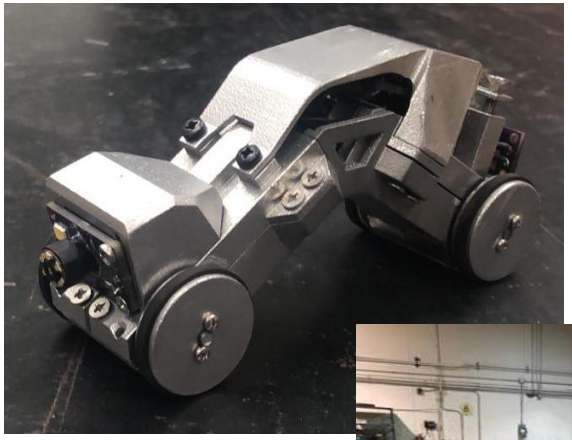
- Continue to test our mini rover for deployment at Hanford.
- Incorporate UT capabilities into the rover and continue developing the 90° system, improving its ability to make difficult turns – found in AY101.
- Continue to develop a marsupial type robotic system for the 6 inch drain lines and ability to investigate the drain slots under the secondary liner.

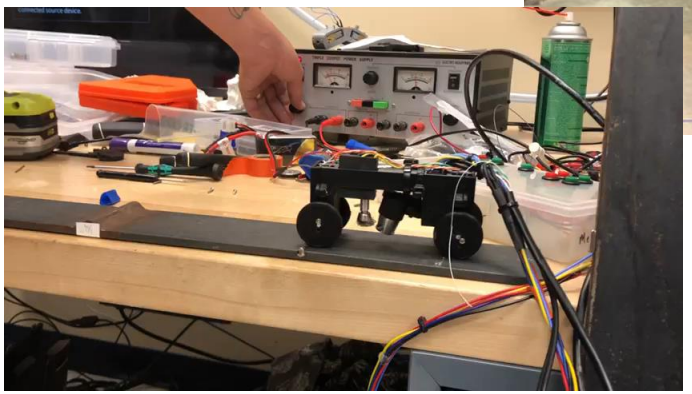
Task 18 - Technology Development and Instrumentation Evaluation

FIU Applied Research Center

Accomplishments Year 10:

- Developed a new mini rover design that can navigate through the standard slots and is more reliable and durable – printed in aluminum.
- Developed test plan for cold test of mini rover at FIU prior to deployment at Hanford.
- Incorporated a UT sensor into the rover and tested the system in FIU's DST mockup.
- Continued to develop a rover for AY101 that can navigate through 90 degree turns.





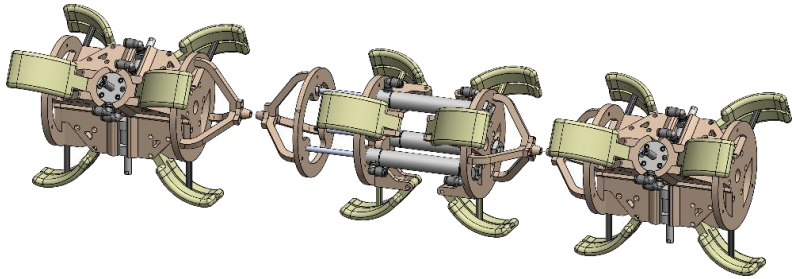
Task 18 - Technology Development and Instrumentation Evaluation

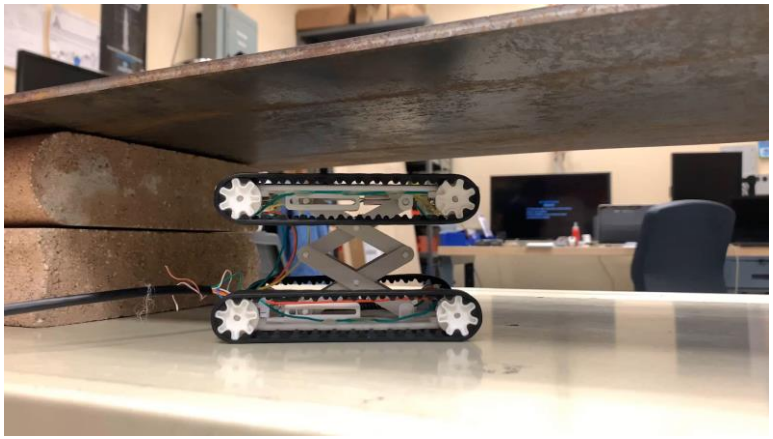
18.2 - Development of Inspection Tools for DST Primary Tanks

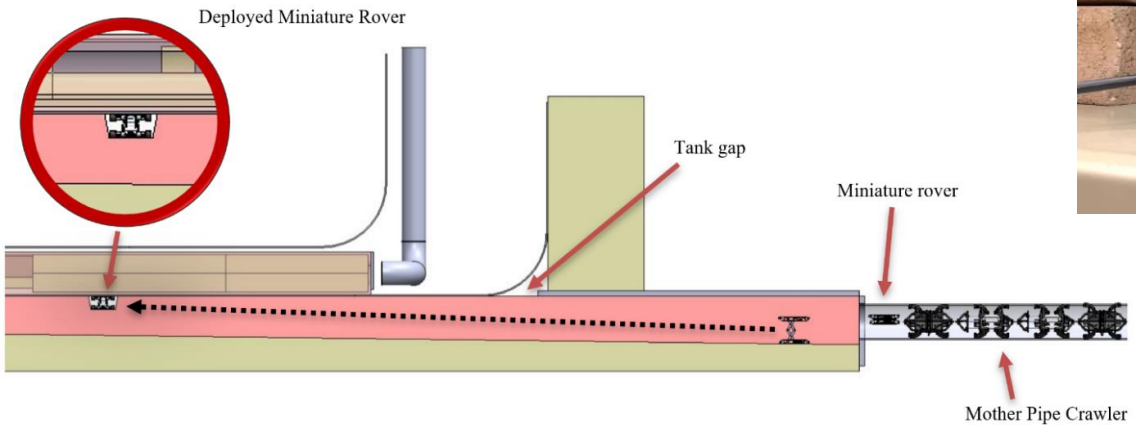
FIU Applied Research Center

Accomplishments Year 10:

- Continued to develop a 6-inch crawler which was more durable than previous prototype
- Developed a rover that can navigate both on the bottom and top of the drain slots and can be contained within a housing module at the front of the crawler.
- Designed a housing module and are currently integrating the crawler, rover and housing module.







Task 18 - Technology Development and Instrumentation Evaluation

18.2 - Development of Inspection Tools for DST Primary Tanks

FIU Applied Research Center

Proposed Scope for Performance Year 01*

Crawler

- Improve and optimize various elements of the crawler/rover system for secondary liner inspections, based on engineering scale testing.
- Incorporate a UT sensor into the rover of the system for thickness measurements.

Miniature Rover

- Deploy current system in hard to access slots at Hanford.
- Improve the UT sensor rover and conduct deployment tests similar to the current mini rover.
- Discuss options for potential deployment of the UT sensor rover with Hanford engineers.
- Continue the development of the 90° mini rover, incorporating sensors and testing in an engineering scale testbed.

Task 18 - Technology Development and Instrumentation Evaluation

18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel

FIU Applied Research Center

Site Needs:

Visual inspections of the H-Canyon exhaust (HCAEX) tunnel showed degradation of the concrete walls. Also, a recent tunnel fragility analysis identified safety issues of the affected concrete regarding their strength [1].

The identification and evaluation of repair materials to mitigate and prevent further degradation of the concrete walls is necessary.

Tunnel view

Degraded concrete exposing the steel rebar (red arrows).

Objectives:

- Develop an aging procedure to create exemplar HCEAX tunnel concrete surfaces.
- Evaluate potential coatings for future application in the HCAEX tunnel.
- Develop a robotic deployment that can navigate on the tunnel walls and apply protective coatings.

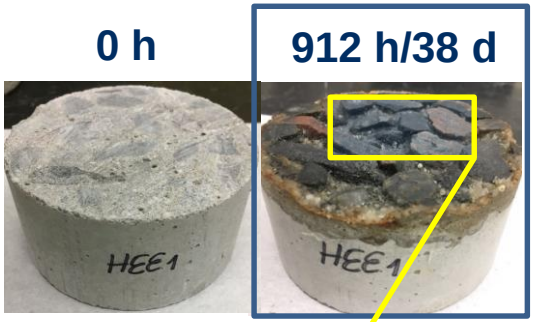
Task 18 - Technology Development and Instrumentation Evaluation

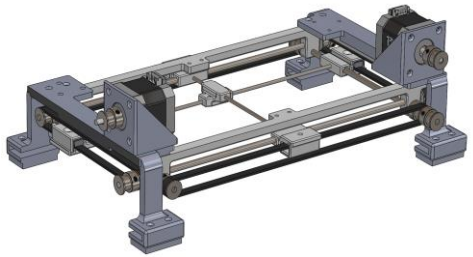
18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel

FIU Applied Research Center

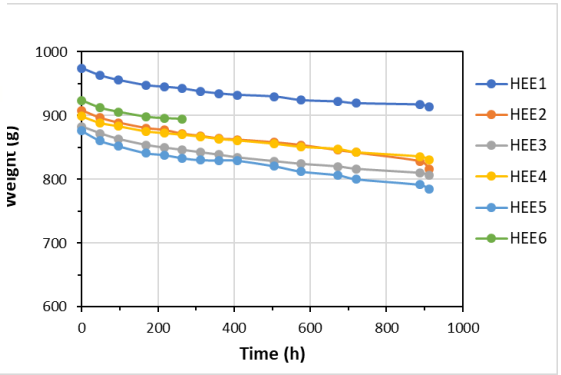
Accomplishments Year 10:

- Developed concrete samples similar to materials used to construct the HCEAX tunnel.
- Generated an accelerated aging process for emulating tunnel walls surface topography and conducted initial tests.
- Investigated adhesion methodologies for a robotic deployment platform and developed initial prototypes.
- Began developing spray mechanisms for applying protective coatings from the platform.





CAD model of 2-DOF mechanism



Task 18 - Technology Development and Instrumentation Evaluation

18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel

FIU Applied Research Center

Proposed Scope for Performance Year 01*

- Continue bench-scale testing of concrete specimens exposed to accelerated aging conditions similar to the H-Canyon Exhaust tunnel environment:
- Conduct bench-scale testing of potential coatings submitted to accelerated aging conditions:
  - Selection of potential coatings for bench-scale testing.
  - Application and evaluation of the selected coatings applied on the aged and non-aged developed concrete surfaces.
- Design of key of tasks for spray mechanism needed to replicate the coating results similar to those obtained from industry protocols
- Augment the platform design by increasing the coverage
- EDF blade testing and damage quantification along with performance analysis
- Complete design of spray mechanism and integrate into platform

Task 19 - Pipeline Integrity and Analysis

19.1 - Pipeline Corrosion and Erosion Evaluation

FIU Applied Research Center

Site Needs:

Due to uncertainties regarding the structural integrity of pipelines at Hanford, a Fitness-for-Service (FFS) program for the Waste Transfer System has been implemented.

A direct inspection and assessment of the condition of buried pipelines is required to evaluate the corrosion and erosion wear rates. To predict the existing system's remaining useful life.

Thickness and Leak detection technologies

Objectives:

- Evaluate alternative approaches for real-time thickness measurements in pipes and waste transfer lines.
- Evaluating technologies that can be used to assess the integrity of pipelines.

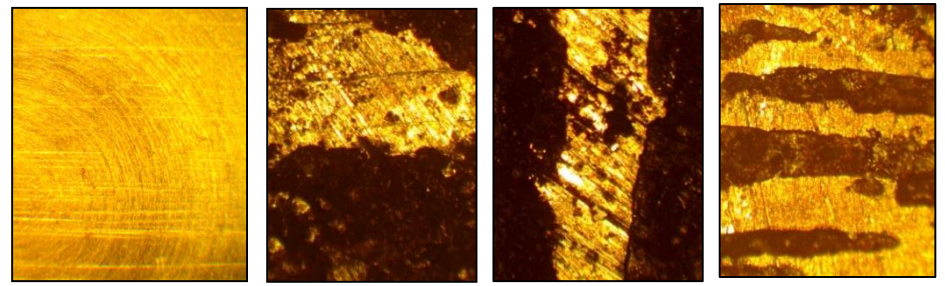
Task 19 - Pipeline Integrity and Analysis

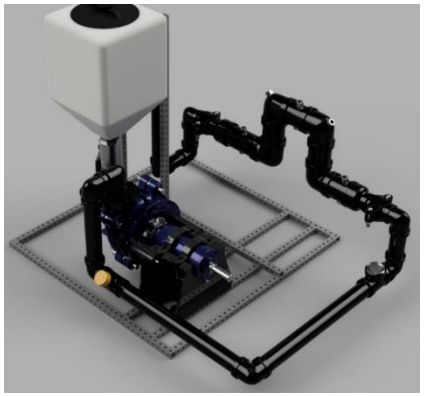
19.1 - Pipeline Corrosion and Erosion Evaluation

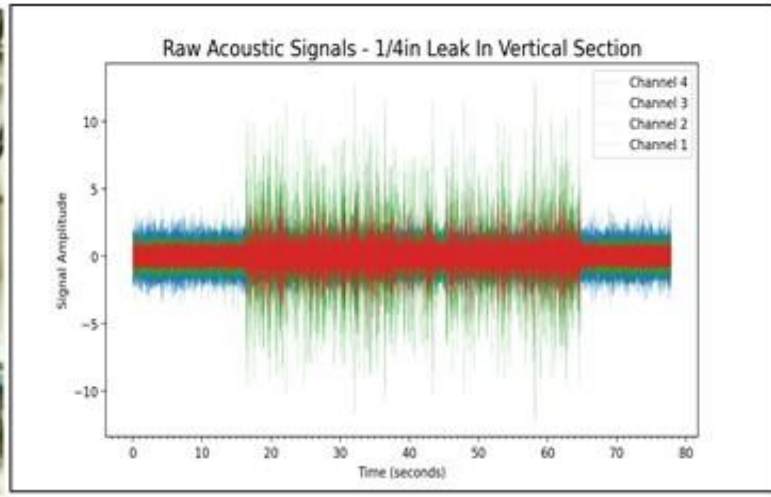
FIU Applied Research Center

Accomplishments Year 10:

- Developed design of next phase of testing for SRNL erosion/corrosion coupons exposed to caustic material.
- Competed the evaluation of the SRNL coupons via microscopy methods.
- Evaluated fiber optic/electroacoustic sensors from Cleveland Electric Laboratories to identify pipeline leaks or cracks. Various conditions were introduced and data was analyzed to assess the sensors ability to detect anomalies.







Task 19 - Pipeline Integrity and Analysis

19.1 - Pipeline Corrosion and Erosion Evaluation

FIU Applied Research Center

Proposed Scope for Performance Year 01*

- Construct the proposed bench scale pipe loop with modular sections.
- Continue testing the SRNL mass loss coupons using realistic simulants.
- Conduct material tests on eroded pipe sections and SRNL coupons.
- Automate the leak detection and leak location process of CEL fiber optic sensor systems.
- Use the experimental sensor data to develop machine learning models and predict the remaining useful life of tanks and transfer system components.

Task 19 - Pipeline Integrity and Analysis

19.2 - Evaluation of Nonmetallic Components in the Waste Transfer System

FIU Applied Research Center

Site Needs:

Nonmetallic materials are used in the US DOE's Hanford Site Tank Farm waste transfer system. These include inner primary hoses in the HIHTLs, Garlock® gaskets, EPDM O-rings, and other nonmetallic materials.

Nonmetallic materials are exposed to β and γ irradiation, caustic solutions as well as high temperatures and pressure stressors. How they react to each of these stressors individually has been well established, but simultaneous exposure of these stressors is of great concern.

Objectives:

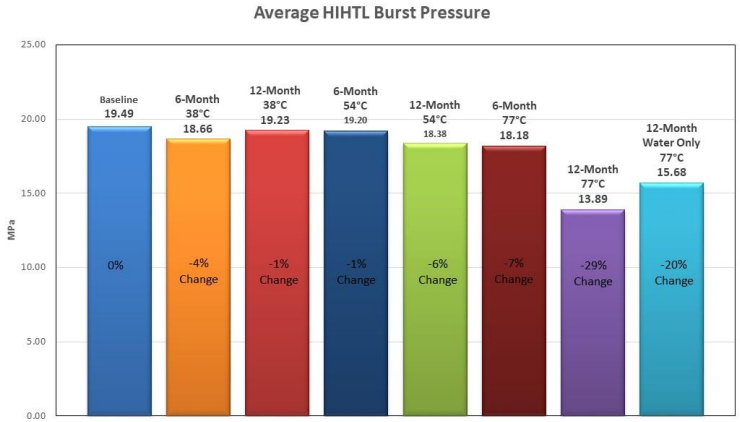
- Provide the Hanford Site with data obtained from experimental testing of the hose-in-hose transfer lines, Garlock® gaskets, EPDM O-rings, and other nonmetallic components under simultaneous stressor exposures.
- Due to experimental testing location limitations, no radiation exposure testing will be conducted.

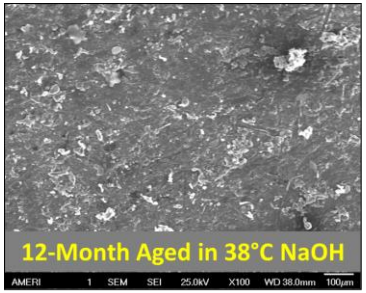
Task 19 - Pipeline Integrity and Analysis

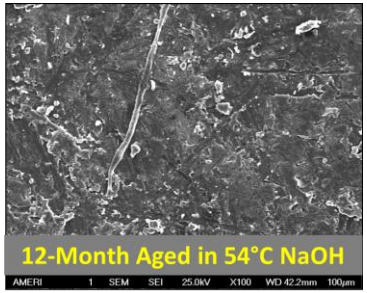
FIU Applied Research Center

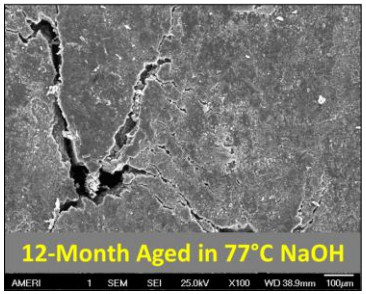
Accomplishments Year 10:

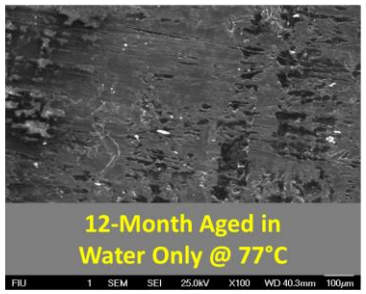
- Completed water only aging at 170°F to assess contributions of temperature verses NaOH.
- Completed the SEM analysis, burst pressure testing and material testing of water only specimens.
- Developed an additional loop for various concentrations of NaOH (6.25, 12.5 and 25% NaOH) and only water at 170°F.











Task 19 - Pipeline Integrity and Analysis

19.2 - Evaluation of Nonmetallic Components in the Waste Transfer System

FIU Applied Research Center

Proposed Scope for Performance Year 01*

- Complete one-year phase III aging of hose and dog bone specimens.
- Conduct burst pressure tests, material tests and SEM analysis
- Evaluate results with Hanford engineers and develop life expectancy model for material under load.

Task 18 - Technology Development and Instrumentation Evaluation

FIU Applied Research Center

Technology	2020	2021	2022	2023	2024
DST Hanford		In-house Deployment	Site Deployment		
		Evaluation	In-house Deployment	Site Deployment	
		Evaluation	In-house Deployment	Site Deployment	
		Evaluation	In-house Deployment	Site Deployment	
H Canyon SRNL		Conceptual Design	Sensor Integration	Evaluation	In-house Deployment	Site Deployment
WIPP		Evaluation	In-house Deployment	Site Deployment		
LM Site		Evaluation	In-house Deployment	Site Deployment		