DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 1

September 14, 2021		
9:00 - 9:05 am EDT	Kick-Off	Kurt Gerdes (Director, Technology Development) – DOE EM-3.2
9:05 - 9:10 am EDT	Welcoming Remarks (DOE-EM)	Nicole Nelson-Jean (Assoc. Principal Deputy Asst. Secretary for Field Ops) – DOE EM-3
9:10 - 9:15 am EDT	Welcoming Remarks (DOE-LM)	Carmelo Melendez (Director, Office of Legacy Management) – DOE LM-1
9:15 - 10:30 am EDT	Projects 4 & 5: STEM Workforce Development and Training	FIU, DOE HQ (EM & LM), SRNL, PNNL, WIPP, SRS, ORP, LBNL, WRPS, INL, Grand Junction
10:30 am - 12:00 pm EDT	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
1:30 - 3:00 pm EDT	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
3:00 - 4:30 pm EDT	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, LANL, ORNL
September 15, 2021		
9:30 - 11:00 am EDT	Wrap Up (FIU Projects 1, 2, 3, 4 & 5)	FIU, DOE HQ (EM & LM)

PROJECT 1

Chemical Process Alternatives for Radioactive Waste

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FIU Personnel and Collaborators

Project Manager: Dwayne McDaniel

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

DOE Fellows/Students: Jeff Natividad, Daniel Martin, Sebastian Story, Joel Adams, Thi Tran, Brendon Cintas, Josue Martinez, Raymond Piloto, Aubrey Litzinger, Desmond Sinnott

DOE-EM: Genia McKinley, Pramod Mallick, Robert Seifert, Gary Peterson, Kurt Gerdes

DOE-ORP: Erik Nelson

SRNL: Michael Poirier, Connie Herman, Bruce Wiersma, Jean Plummer, Christine Langdon, Tim Alcott, William Wells

PNNL: Kayte Denslow, Carl Enderlin, Matt Fountain, Matthew Ausmussen

WRPS: Jason Gunter, Kayle Boomer, Jason Vitale, Glenn Soon, Joe Rice, Alex Pappas

SRS: Jane Carter, Saiying Bowers

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Project Tasks and Scope

Task 17: ADVANCED TOPICS FOR HLW MIXING AND PROCESSES	
Subtask 17.2	Evaluation of Pipeline Flushing Requirements for HLW at Hanford and Savannah River Site
TASK 18: TECHNOLOGY DEVELOPMENT AND INSTRUMENTATION EVALUATION	
Subtask 18.2	Development of Inspection Tools for DST Primary Tanks
Subtask 18.3	Development of a Coating Deployment Platform for the H-Canyon Exhaust Tunnel
Subtask 18.4	Long-Term Surveillance of Nuclear Facilities and Repositories using Mobile Systems **(NEW)**
TASK 19: PIPELINE INTEGRITY AND ANALYSIS	
Subtask 19.1	Pipeline Corrosion and Erosion Evaluation
Subtask 19.2	Evaluation of Nonmetallic Components in the Waste Transfer System
TASK 20: CORROSION PROTECTION AND CHARACTERIZATION OF EM INFRASTRUCTURE	
Subtask 20.1	Evaluation of Coatings for the H-Canyon Exhaust Tunnel
Subtask 20.2	Corrosion Evaluation of Steel Canisters for Hanford Integrated Disposal Facility **(NEW)**

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Task 17

Advanced Topics for HLW Mixing and Processes

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Subtask 17.1: Evaluation of pipeline flushing requirements for HLW at Hanford and Savannah River Site

FIU Year 1 Research Highlights & Accomplishments:

- Testing completed for 165-ft experimental loop
  - Fully-flooded, one day sedimentation, 10, 15 and 20% kaolin
  - Gravity-drained, one day sedimentation, 10, 15 and 20% kaolin
  - 15% gravity-drained, one week and two week sedimentation
  - 15% gravity-drained one day pulsation
- 1.0-1.2 FTLV values for trials
- Extension of experimental loop to 330-ft

FIU Year 2 Projected Scope

- Test and commission the loop extended to 330 ft
- Repeat the Test Plan developed for the 165 ft loop
- Analyze the data to determine the effects of pipe length of FTLV ratios
- Develop a CFD model that will be validated with the experimental data and can ultimately be used to evaluate the effects of pipeline geometry on FTLV ratios

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Task 18

Technology Development and Instrumentation Evaluation

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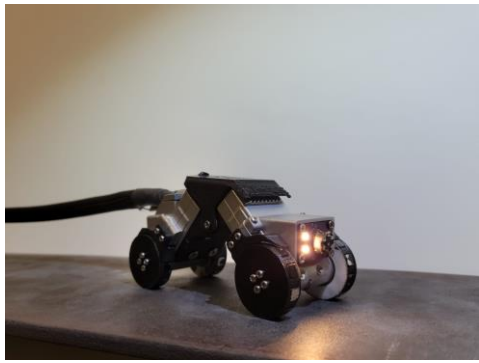
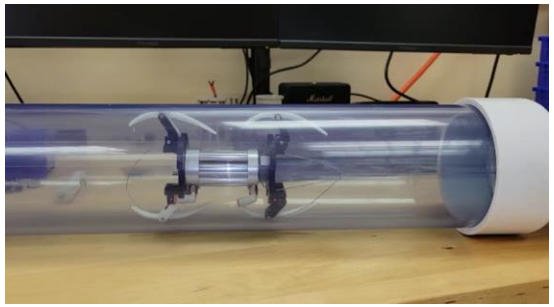
Subtask 18.2: Development of Inspection Tools for DST Primary Tanks

FIU Year 1 Research Highlights & Accomplishments:

- **Minirover** - Initial testing in the DSTs identified areas for improvement – including a flexible chassis for weld seam traversal and a rust removal systems for rust accumulation on the magnetic wheels.
- **UT Rover** - Developed based on the design of the current Minirover system, Includes a UT sensor for point thickness measurements and incorporates a cleaning mechanism to prep the surface and uses water as a couplant.



- **Secondary Linear Inspection Tool**
  - Inspection rover - functional prototype built, embedded electronics integrated
  - Marsupial delivery crawler - electric conceptual redesign finalized, deployment ramp designed, detachment mechanism built
- **Gamma Lateral Scanner for SSTs**
  - Pipe Crawler - design reviewed and improved
  - Embedded electronics - camera upgraded, embedded computer integrated, MU integrated to modules
  - Developing full scale mock up of SST laterals



Subtask 18.2: Development of Inspection Tools for DST Primary Tanks

FIU Year 2 Projected Scope

- Mini Rover
  - Currently being scheduled for re-deployment at Hanford to aid in DST visual inspections early next fiscal year.
- UT Rover
  - Develop a test plan to evaluate the rovers durability, ability to traverse over weld seams and corrosion and remove in case of emergency.
  - Execute test plan in DST mock up at FIU
- SST Pipe Crawler
  - Complete modifications to 3 and 4 inch pipe crawler and test in mock up at FIU
  - Evaluate system at Hanford
  - Incorporate gamma radiation sensor into crawler and develop an automated deployment system
- DST Secondary Liner Inspection Tool
  - Complete modifications to system and test in FIU DST mock up

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Subtask 18.3: Development of a Coating Deployment Platform for the H-Canyon Exhaust Tunnel

FIU Year 1 Research Highlights & Accomplishments:

Control Unit

- Control box developed, wired or wireless communication setup, multiple step-down voltage regulators integrated and IMU integrated

2 DOF Drive Module

- Drive modules designed to allow omnidirectional movement, DC motor enclosure section was shifted outward extending past chassis

Omnidirectional Wall Crawling Platform

- Wall crawling platform is wheeled based and can generate 22 lbs of thrust via ducted fans, platform is capable of front and side transition to vertical plane, system was tested on a concrete wall and was successful in climbing 10-12 feet vertically

FIU Year 2 Projected Scope

- Develop a carbon fiber chassis, continue testing and incorporating modifications of current wall crawling platform in order to increase the load capacity
- Integrate sensors for more robust operation and control and determine optimal nozzle and configuration after coating selection
- Finalize design and prototyping of coating mechanism – integrate into crawler

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Subtask 18.4: Long-Term Surveillance of Nuclear Facilities and Repositories using Mobile Systems (NEW)

FIU Year 1 Research Highlights & Accomplishments:

- Performed a literature review on relevant topics in autonomous surveillance of nuclear facilities and repositories.
- Implemented a compact synthetic data framework for simulation of radioactive environments.
- Customized commercial mobile grounds platforms integrating sensors that create digital twins of facilities.
- Tested state-of-the-art embedded sensory for mapping, localization and field measurement
- Deployed FIU's in-house mapping framework and sensory at Hanford during summer
- Evaluate immersive visualization techniques for digital twin exploration and human-robot interaction including virtual and augmented reality.

FIU Year 2 Projected Scope

- Continue improving FIU's in-house mapping and surveillance framework
- Incorporate higher levels of risk-awareness using object detection and machine learning
- Evaluate and test advanced field sensory for tank farm inspection in coordination with WRPS
- Deploy the improved FIU's mapping framework and sensory package at Hanford during summer
- Extend FIU's surveillance framework to aerial unmanned vehicles and wearables

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Task 19

Pipeline Integrity and Analysis

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Subtask 19.1: Pipeline Corrosion and Erosion Evaluation

FIU Year 1 Research Highlights & Accomplishments:

- Erosion test results
- Corrosion test loop development
  - 2 and 3 inch pipe sections (carbon steel straight sections and stainless-steel elbows).
  - Loop footprint - @5 ft X 2 ft
  - Chemical simulants for realistic corrosion tests
- Corrosion test results (Chemical Simulants**) –** NaOH, $Al(NO_3)3*9H_2O$, Na_2SO_4, $Na_2CO_3*H_2O$, $NaNO_3$, $NaNO_2$ and NaCl

Test	Coupons	Fine Sand (40F) (gallons)	Medium Sand (30/65) (gallons)	Coarse Sand (20/30) (gallons)	Very Coarse Sand (6/20) (gallons)
Test 1	3 SS	1	0	0	3
Test 2	3 SS	2	0	2	2
Test 3	3 SS	0	0	6	2
Test 4	3 SS	4	0	2	2
Test 5	2 SS and 2 CS	0	3.6	2.4	0
Test 6	2 SS and 2 CS	0	2	4	0

FIU Year 2 Projected Scope

- Continue testing the SRNL mass loss coupons using realistic simulants developed by SRNL
- Investigate the effect of simulant flow dynamics in structural integrity assessment using computational fluid dynamic simulations
- Use the experimental sensor data and simulation results to develop machine learning models and predict the remaining useful life of tanks and transfer system components

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

FIU Year 1 Research Highlights & Accomplishments:

- An additional aging system that included four test loops were fabricated that circulated NaOH solutions of 25%, 12.5%, 6.25%, and 0% respectively at 170°F.
- Each test loop consisted of a pumping loop with three hose sections.
- Dog-bone coupon aging consists of a coupon aging vessel submerged in each test loop's storage tank.
- Each vessel contained six EPDM dog-bone samples.

FIU Year 2 Projected Scope

- Specimen aging is expected to be completed by the end of September 2021.
- After aging the material properties of each specimen will be measured and compared to the baseline (unaged specimen) values.
- Analysis using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS) of the HIHTLs and the dog-bone specimens will provide level of surface degradation that occurred during aging and how far the NaOH solution penetrated into each specimen.

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Task 20

Corrosion Protection and Characterization of EM Infrastructure

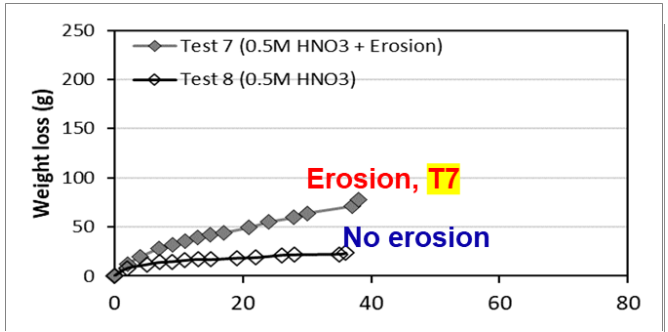
Subtask 20.1: Evaluation of Coatings for the H-Canyon Exhaust Tunnel

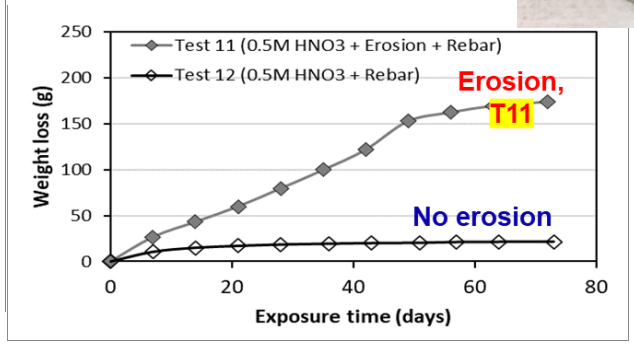
FIU Year 1 Research Highlights & Accomplishments:

- Results of accelerated aging tests
  - Greatest and fastest degradation for specimens exposed to Test 7 & Test 11 aging conditions: enhanced aging + erosion.
  - Weight loss - greatest weight loss for specimens exposed to Test 7 & Test 11 aging conditions.

Test 7 (no rebar)

Test 11 (rebar)





FIU Year 2 Projected Scope

- Continue the development of aged and non-aged concrete surfaces for the evaluation of potential coatings through the Test 7 and Test 11 aging conditions.
- Design and execute a comprehensive test plan for the evaluation of potential coatings.
- Complete the selection of coating candidates for further evaluation.
- Initiate the evaluation of selected coatings through accelerated aging conditions.

Subtask 20.2: Corrosion Evaluation of Steel Canisters for Hanford Integrated Disposal Facility (NEW)

FIU Year 1 Research Highlights & Accomplishments:

- Literature review for the steel corrosion study completed
- Test plan for the corrosion study of potential materials for the canister/container was prepared
- A potentiostat for getting corrosion data of canister materials was procured
- Chemicals procured for the preparation of a test solution that will simulate Hanford IDF groundwater
- Initial samples of 304 SS prepared for the beginning of testing

Experimental setup (left) and sample (right) for electrochemical measurements. Images provided by Mathew Asmussen, PNNL.

FIU Year 2 Projected Scope

- Initiate the execution of the test plan
  - Evaluation of 304 stainless steel
  - Study the effect of weld regions on the corrosion behavior, effect of heat treatment zones on the corrosion behavior, and the effect of various ions on the corrosion process
- Collect and analyze the corrosion data obtained – assessment of steel durability

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Technology Development and Deployment Road Map

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	 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		

Thank You. Questions?