



DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 2

Tuesday, September 27, 2022		
9:30 - 9:35 am EDT	Kick-Off /Welcoming Remarks (DOE-EM)	Kurt Gerdes (Director, Technology Development) – DOE EM-3.2
9:35 - 9:40 am EDT	Welcoming Remarks (DOE-LM)	Leonel Lagos on behalf of DOE Office of Legacy Management
9:40 - 10:00 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
BREAK		
11:00 - 12:00 pm EDT	Projects 4 & 5 (cont'd): STEM Workforce Development and Training	FIU, DOE HQ (EM & LM), SRNL, PNNL, WIPP, SRS, ORP, LBNL, WRPS, INL, Grand Junction
BREAK		
1:00 - 2:30 pm EDT	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
2:30 - 4:00 pm EDT	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
Wednesday, September 28, 2022		
10:00 - 11:30 am EDT	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, ORNL, LANL, CBFO
11:30 - 1:00 pm EDT	Wrap Up (FIU Projects 1, 2, 3, 4 & 5)	FIU, DOE HQ (EM & LM)

FIU

Applied Research
Center



DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 2

PROJECT 1

Chemical Process Alternatives for Radioactive Waste

Worlds
Ahead

Advancing the research and academic mission of Florida International University

FIU Personnel and Collaborators

Project Manager: Dwayne McDaniel

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

DOE Fellows/Students: Jeff Natividad, Sebastian Story, Joel Adams, Brendon Cintas, Josue Martinez,
Raymond Piloto , Desmond Sinnott, Nicholas Espinal

DOE-EM: Genia McKinley, Robert Seifert, Latrincy Bates, Kurt Gerdes, Jean Papon

DOE-ORP: Erik Nelson

SRNL: Michael Poirier, Connie Herman, Bruce Wiersma, Jean Plummer, Christine Langdon, William
Wells, Mark Kranjc, Eric Skidmore

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

WRPS: Jason Gunter, Kayle Boomer, Glenn Soon, Joe Rice, Doug Reid, Jason Page, Ruben Mendoza

SRS: Jane Carter, Saiying Bowers



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

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



Task 17

Advanced Topics for HLW Mixing and Processes



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

FIU Year 2 Research Highlights & Accomplishments:

- Completed the construction of the 330 ft flushing loop
- Improvements to instrumentation and real-time analysis
- Initiated flushing tests for fully flooded and gravity drained configuration
 - 10 vol.% and 15 vol.% fully-flooded
 - 10 vol.% and 15 vol.% gravity-drained
- 2.4-2.6 FTLV values for trials

FIU Year 3 Projected Scope

- Complete 330 ft tests
- Expand loop to 495 ft and initiate testing
- Analyze the data to determine the effects of pipe length of FTLV ratios
- Investigate the development of 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



Task 18

Technology Development and Instrumentation Evaluation



Subtask 18.2: Development of Inspection Tools for DST Primary Tanks

FIU Year 2 Research Highlights & Accomplishments:

- **Mini rover**
 - Successfully deployed in the AP-105 DST at Hanford in March 2022.
 - Transferred ownership of the unit to WRPS
- **Lateral Gamma Scanner for SSTs**
 - The overall design was also streamlined, and the inspection process was completely automated.
 - System was deployed at Hanford's CTF in July of 2022.
- **Off Riser Sampler**
 - In the Summer of 2022, FIU and WRPS demonstrated the potential of using robotic manipulators to perform off-riser sampling in high-level waste tanks.



Subtask 18.2: Development of Inspection Tools for DST Primary Tanks

FIU Year 3 Projected Scope

Mini rover

- Enhance inspection capabilities by integrating a sampling arm and potentially an ultrasound sensor.
- Implement computer vision techniques to reconstruct refractory channel 3D models.

Lateral Gamma Sensor

- Integrate gamma radiation sensor.
- Enhance localization by adding visual and inertial odometry fused to tether length
- Strengthen the gripper module.
- Streamline automated inspection routine.

Off-Riser Sampler

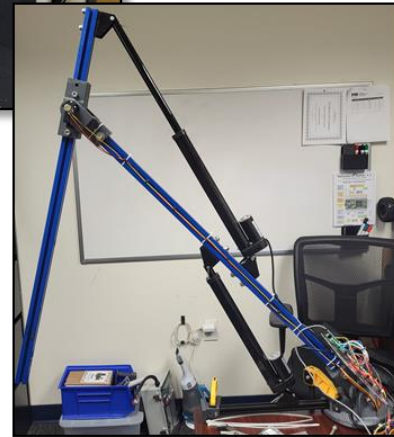
- Integrate tool changers and develop innovative end-effector tooling and samplers.
- Create a more natural interface with the operator.
- Deploy in summer at WRPS's Cold Test Facility.



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

FIU Year 2 Research Highlights & Accomplishments:

- Sand ingestion testing – small grain size did not have significant effect on thrust generation, blade degradation was minimal.
- Support arm – developed 3DOF arm for supporting unit and compensated for reaction forces in coating process.
- Platform – carbon fiber chassis was fabricated, control box was re-designed to minimize weight, controls were improved for surface-to-surface transitioning.
- Coating mechanism – designed and initially testing with water at 2000 psi.



FIU Year 3 Projected Scope

- Platform development – complete design of vector thrust system, develop electronic package to reduce weight, develop power distribution system, incorporate semi-autonomous capabilities for surface transitioning.
- Coating system – incorporate coating company requirements into coating system, begin initial testing on coating system.
- Testing – Develop initial design of tunnel mock-up which will be used for the testing of the wall crawling platform.

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

FIU Year 2 Research Highlights & Accomplishments:

- Continue improving FIU's autonomous mapping and surveillance framework by integrating algorithms to enhance:
 - Robust navigation for mapping extensive indoor environments minimizing dead reckoning drifts in monotonous GPS-denied facilities fusing several sources of odometry estimation.
 - Risk awareness by improving existing obstacle avoidance algorithms considering terrain features and conditions.
- This task also supported other DOE-EM tasks by providing algorithms, localization strategies, sensor integration, and modeling of robotics systems.

FIU Year 3 Projected Scope

- Streamline FIU's autonomous surveillance framework and establish routines for autonomous outdoor surveillance.
- Enhance onboard terrain risk-awareness framework and implement information-driven planning and control algorithm.
- Investigate integrating ammonia sensor.
- Retrofit a Robotic platform provided by WRPS.
- Deploy in summer at WRPS's Cold Test Facility.



Task 19

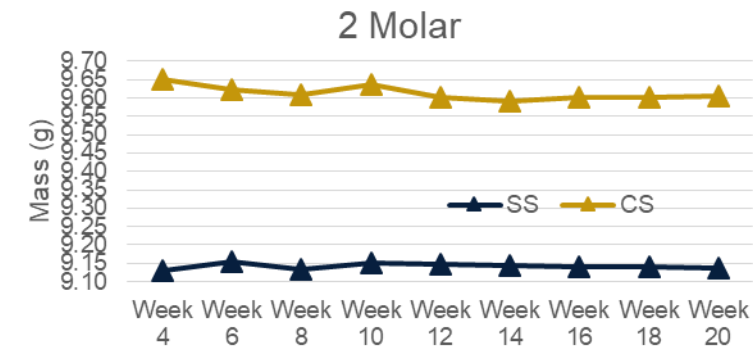
Pipeline Integrity and Analysis



Subtask 19.1: Pipeline Corrosion and Erosion Evaluation

FIU Year 2 Research Highlights & Accomplishments:

- Conducted corrosion testing loop in 2- and 3-inch pipe sections.
- Corrosion chemical Simulants – NaOH, $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$, Na_2SO_4 , $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$, NaNO_3 , NaNO_2 and NaCl
- CFD analysis of loop
- Initiated automated corrosion detection using machine learning models



FIU Year 3 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

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

FIU Year 2 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.
- Specimens were aged for 1-year and hose burst pressure tests and dog-bone tensile strength measurements for obtained.
- SEM analysis was conducted.

FIU Year 2 Projected Scope

- Investigate fundamental aspects of aging and mechanisms of failure
 - This includes wettability and stress risers on the EPDM material
 - Provide and understanding of why the greatest material degradation occurs at the lowest (6.25%) NaOH concentrations.
- Investigate aging and testing of the Viper[®] hose used at SRNL. Provide a technical basis for the Viper hose use.

Aging Type	Average Burst Pressure (MPa)	% Change
Baseline (Unaged)	20.71	0.00
Water Only	12.30	-40.61
6.25%	15.29	-26.17
12.50%	16.90	-18.41
25%	19.40	-6.32
Aging Type	Average Tensile Strength (MPa)	% Change
Baseline (Unaged)	7.70	0.00
Water Only	6.43	-16.49
6.25%	0.95	-87.66
12.50%	1.73	-77.53
25%	1.79	-76.75



Task 20

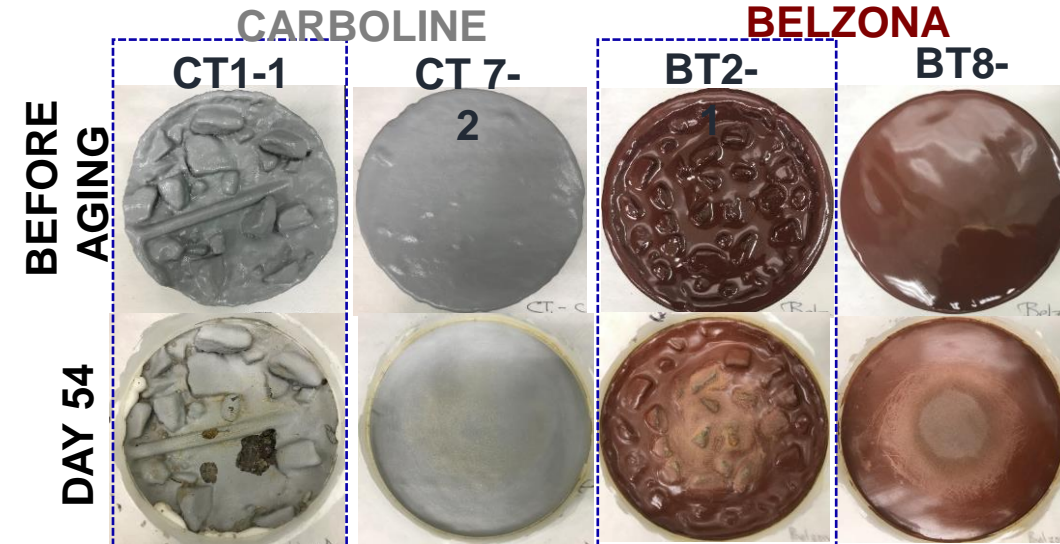
Corrosion Protection and Characterization of EM Infrastructure



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

FIU Year 2 Research Highlights & Accomplishments:

- Potential coatings for the protection of the tunnel concrete walls were identified.
- Carboline and Belzona coated samples initiated with the accelerated aging process and preliminary evaluation was completed.
- Impedance measurements supported the evaluation of the coating's protective properties.



FIU Year 3 Projected Scope

- Continue evaluation of potential coatings through accelerated aging tests.
- Initiate the evaluation of Sherwin-Williams coated samples.
- Study the effect of key variables on the coating's performance.
- Coordinate the preparation of Framatome coated samples at their facilities.
- Perform surface characterization on selected coated samples.

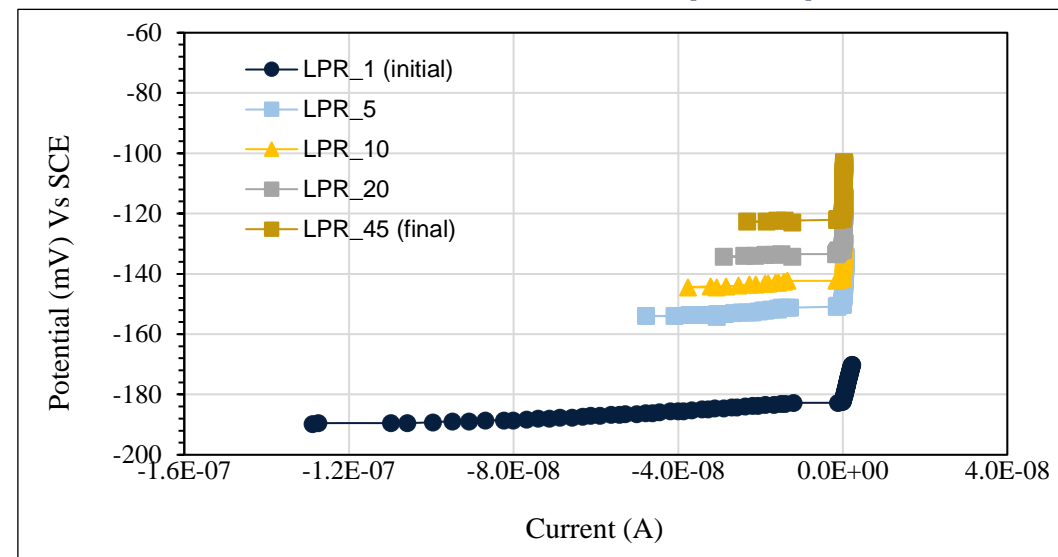
Thickness loss (%), Day 35	Carboline samples	Belzona samples
With surface prep.	10-11	7.4 - 20
No surface prep.	10-14	15 - 23

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

FIU Year 2 Research Highlights & Accomplishments:

- Faraday cage for electrochemical measurements designed and built.
- Initial samples of 304 SS prepared for the testing.
- The potentiostat was setup and overload issues of the potentiostat were resolved.
- Preliminary corrosion data for 304 SS samples immersed in Hanford simulated groundwater were obtained through electrochemical tests (E_{corr} , LPR and PDP).

Polarization resistance (LPR) results

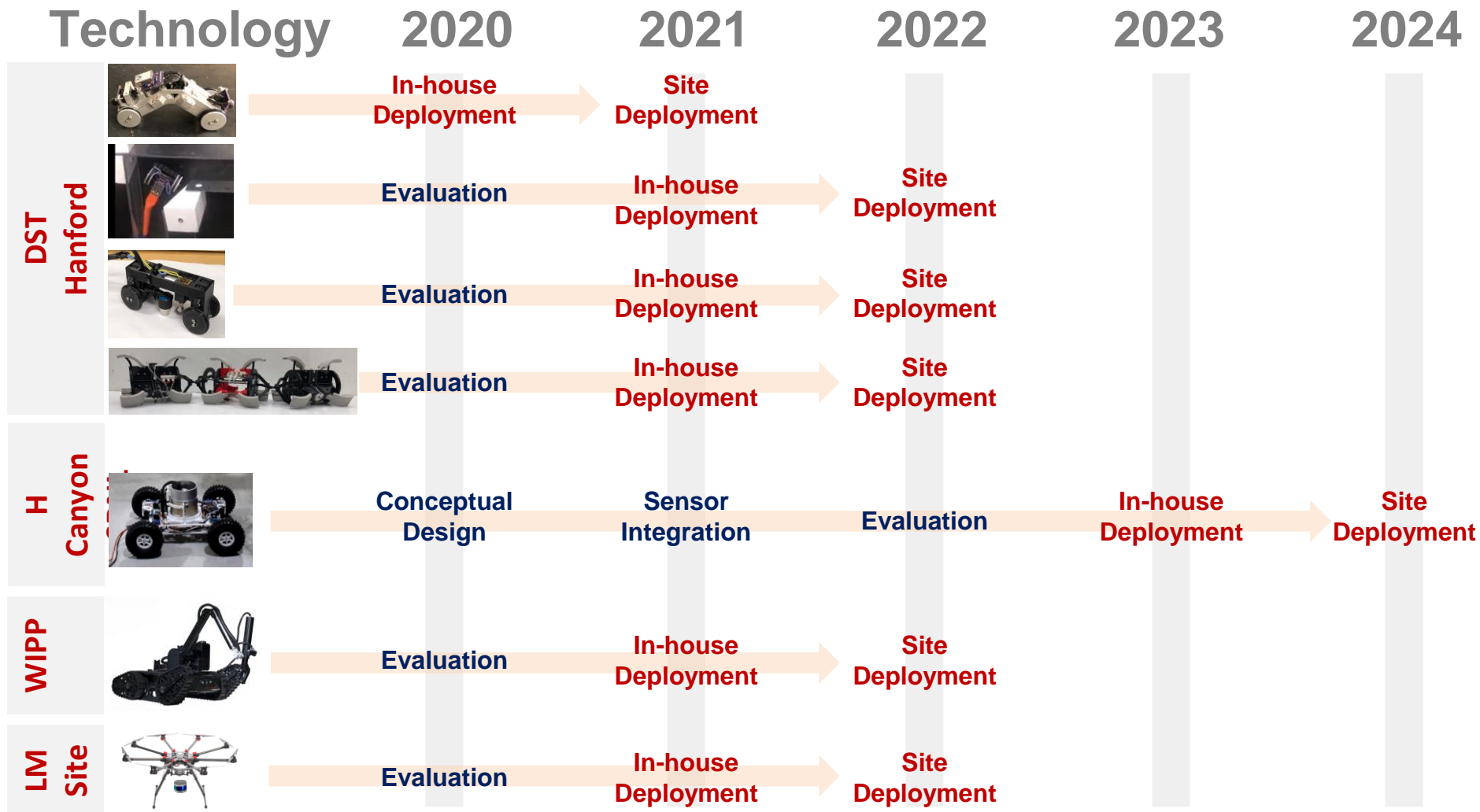


FIU Year 3 Projected Scope

- Continue the evaluation of 304 stainless steel.
- Study the effect of weld regions on the corrosion behavior.
- Study the effect of heat treatment zones on the corrosion behavior.
- Study the effect of certain ions on the corrosion process.
- Obtain and analyze the corrosion data obtained using analytical software.



Technology Development and Deployment Road Map





Thank You. Questions?