



DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 3

Wednesday, August 23, 2023		
9:00 - 9:05 am EDT	Kick-Off /Welcoming Remarks (DOE-EM)	Rod Rimando (Acting Director, Technology Development) – DOE EM-3.2
9:05 - 9:10 am EDT	Welcoming Remarks (DOE-LM)	Ms. Jalena Dayvault (Site Manager) – DOE LM
9:10 - 10:40 am EDT	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, ORNL, LANL, LBNL, CBFO
10:40 am - 12:10 pm EDT	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
LUNCH BREAK [12:10 – 1:30 pm]		
1:30 - 3:00 pm EDT	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
Thursday, August 24, 2023		
9:00 - 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
BREAK [10:30 – 10:35 am]		
10:35 - 12:00 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 3

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, Mayren Echeverria Boan, Jose Rivera, Mackenson Telusma

DOE Fellows/Students: Sebastian Story, Joel Adams, Brendon Cintas, Josue Estrada Martinez, Phillip Moore, Bryant Pineda, Nicholas Espinal, David Rojas, Theophile Pierre, Gabriel Cerioni, Rafael Velasquez

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

DOE-ORP: Erik Nelson

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

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 18.3 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

Subtask 18.5 Development of Robotic Systems for DOE Sites

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)**



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 3 Research Highlights & Accomplishments:

- Completed all testing for the 330 ft test loop.
 - Includes fully flooded and gravity drained conditions at 10, 15 and 20% by volume.
 - Conducted tests with 1 day and 2 weeks settling time.
- Improvements to instrumentation and pipeline.
 - Upgraded data acquisition system.
 - Addition of gravity drain discharge valve to remove pockets of air.
 - Data analysis improved to provide FTLV ratio as a function of time.

FIU Year 4 Projected Scope

- Investigate how settling time affects flushing operations.
 - Flushing will be conducted with a slurry instead of water after initial transfers have occurred and some specified time has passed.
- Alterations to the pipeline will be made and anticipated pipe lengths include 125, 165 and 330 ft.



Task 18

Technology Development and Instrumentation Evaluation

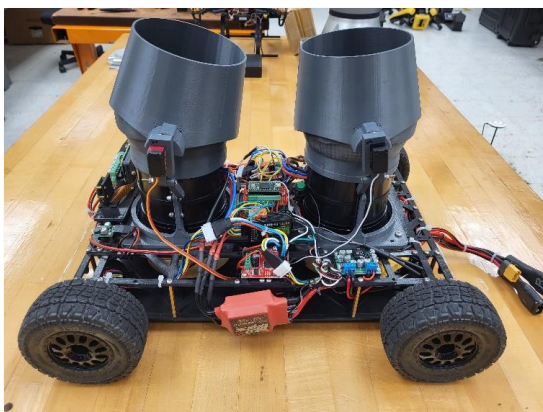


Subtask 18.3: Development of a Coating Deployment Platform for the H-Canyon Exhaust Tunnel

FIU Year 3 Research Highlights & Accomplishments:

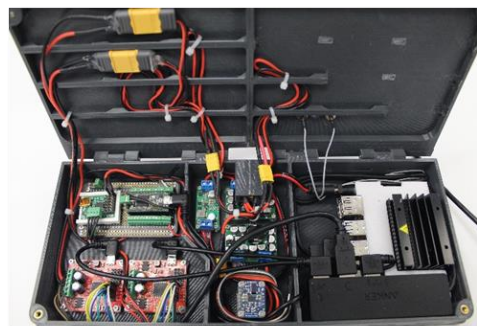
1. Vector Thrust Prototype

Design, assembly and integration of a vector thrust unit



2. Platform Control Unit

Development of a PCB unit which was populated with the required electronic hardware and tested



FIU Year 4 Projected Scope

- Continue to incorporate semi-autonomous functionalities into the platform
- Optimize the vector thrust unit's design to facilitate integration onto the large EDF
- Increase the degrees of freedom (DOFs) within the existing support arm design
- Incorporate coating elements onto the large EDF platform and conduct preliminary tests
- Develop a high-fidelity mockup of a segment within the H-Canyon

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

FIU Year 3 Research Highlights & Accomplishments:

- Upgraded and added sensors to a reconnaissance and first response platform donated by WRPS. Incorporated FIU's navigation and mapping framework onto the platform.
- WRPS' Cold Test Facility Summer Technology Demonstration



FIU Year 4 Projected Scope

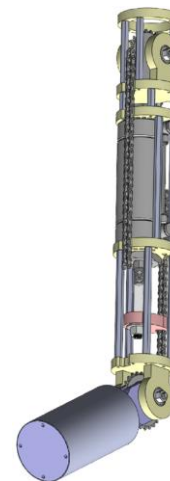
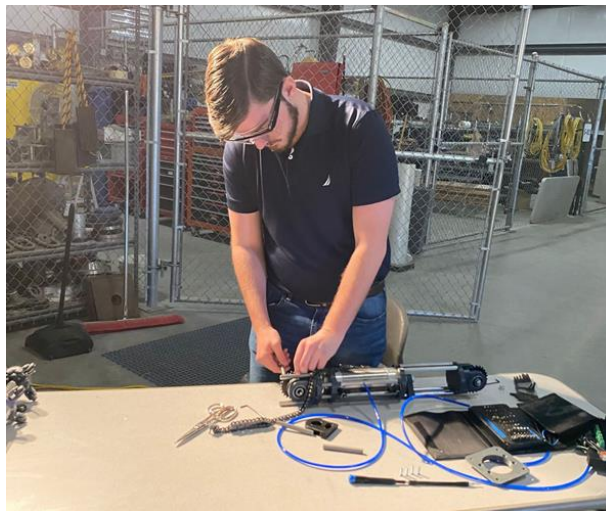
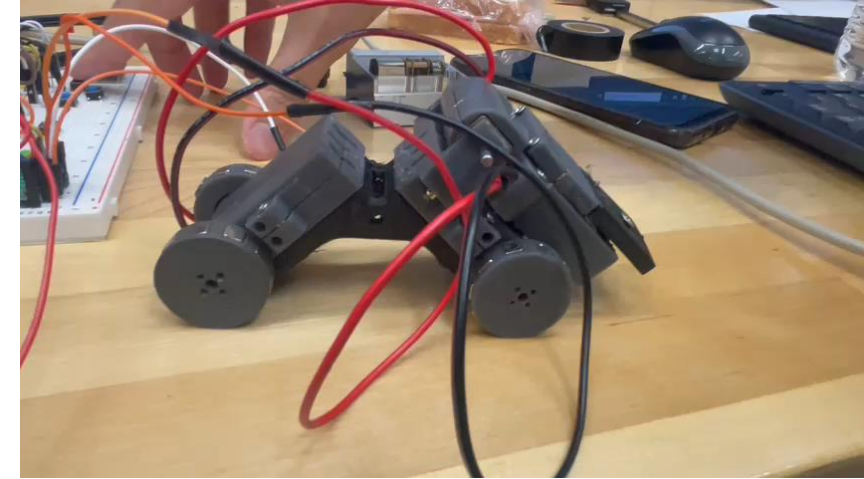
- Continue streamlining FIU's autonomous surveillance framework and enhancing the onboard terrain risk-awareness framework.
- Implement robust information-driven planning and control algorithm and improve radiation field reconstruction algorithm.
- Implement an organic operator interface considering feedback from WRPS engineers and field technicians received during the summer demonstration.
- Redeploy at WRPS's Cold Test Facility next summer.



Subtask 18.5: Developing Robotic Systems for DOE Sites

FIU Year 3 Research Highlights & Accomplishments:

- In 2023, WRPS Engineers requested the integration of sampling systems into the FIU Miniature Inspection Rover.
- FIU's Lateral Gamma Scanner Crawler was improved and **redeployed at WRPS's Cold Test Facility** in 2023.
- FIU continued working on the design of the sampler manipulator for Hanford.



Subtask 18.5: Development of Robotic Systems for DOE Sites

FIU Year 4 Projected Scope

Minirover

- Continue sampling system development and testing for potential summer deployment at Hanford.
- Retrofit the control box to operate the sampling system.
- Implement computer vision techniques to reconstruct refractory channel 3D models.

Lateral Samma Sensor

- Integrate gamma radiation sensor.
- Simulate radiation detection.
- Prepare for potential summer deployment at Hanford.

Off-Riser Sampler

- Complete functional prototype.
- Integrate tool changer.
- Develop innovative end-effector tooling and samplers.
- Create a more natural interface with the operator.
- Deploy for summer deployment at WRPS's Cold Test Facility.



Task 19

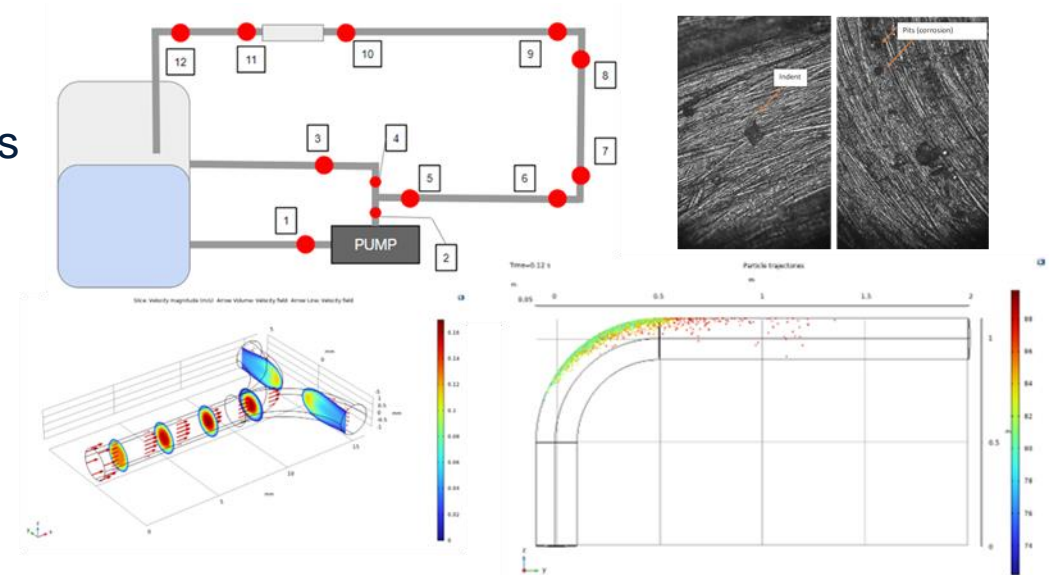
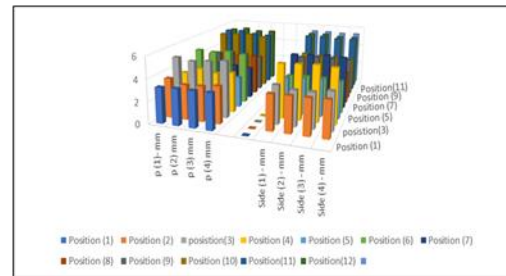
Pipeline Integrity and Analysis



Subtask 19.1: Pipeline Corrosion and Erosion Evaluation

FIU Year 3 Research Highlights & Accomplishments:

- Particle Erosion in Pipe Loop Replicating Waste Transfer Pipes
- Sensor Evaluation - UT and SRNL erosion coupons
- Experimental and CFD modeling



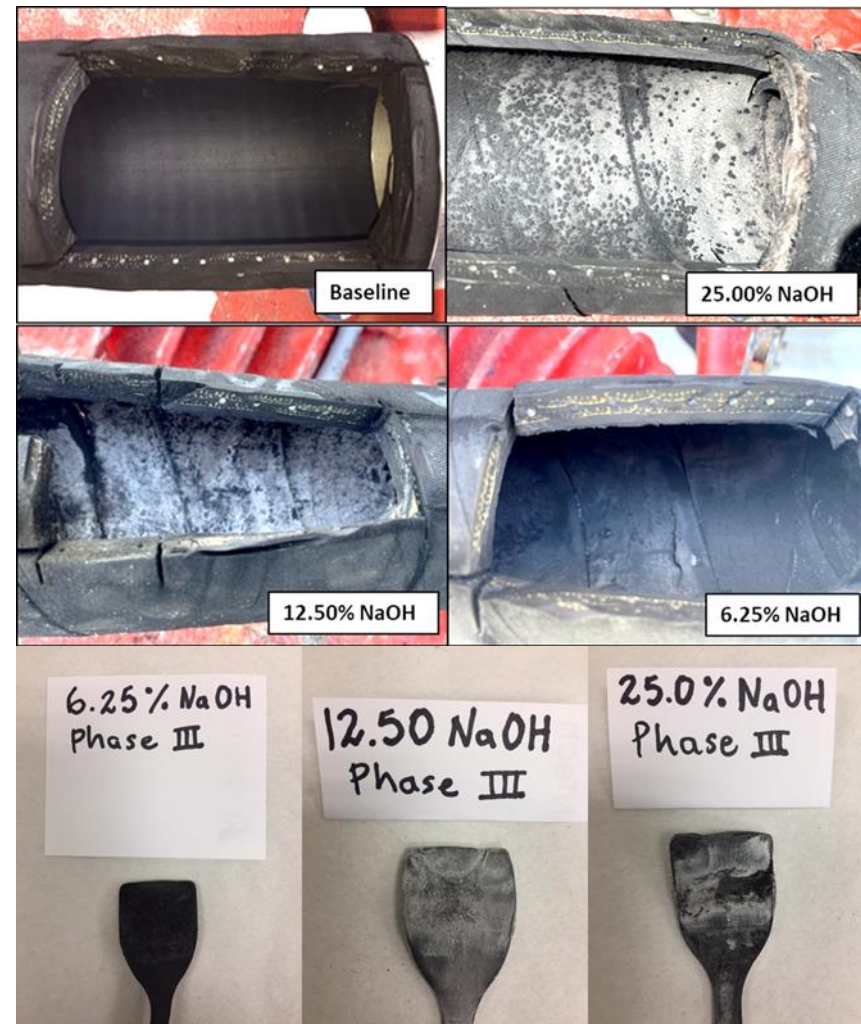
FIU Year 4 Projected Scope

- Simultaneous experimental evaluation of chemical corrosion and erosion using both SRNL coupons and ultrasonic sensors in the flow loop.
- Continuation of the fluid flow simulations (CFD) using COMSOL Multiphysics software for particle erosion and caustic corrosion in waste transfer pipes.
- Development of sensor data fusion models for pipe erosion and corrosion prediction.
- Integration of experimental and simulation-based results to develop data analytics models using machine learning for pipeline degradation assessment and anomaly detection.

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

FIU Year 3 Research Highlights & Accomplishments:

- Results of aging of HIHTL and EPDM dog-bone specimens in NaOH solutions of 25%, 12.5%, 6.25%, and 0% respectively at 170°F showed greatest degradation in material properties occurred at the lowest concentration.
- After aging, a white crystalline material was observed that coated the inner surface of the HIHTL hoses as well as the dog-bones of specimens aged with higher NaOH concentrations (12.50% and 25.00%).
- XRD analysis determined material to be Thermonatrite, a mineral form of sodium carbonate.
- SEM-EDX analysis determined that the presence of Thermonatrite appears to have acted as a barrier, restricting further diffusion of NaOH solution into the EPDM material, subsequently reducing the extent of degradation.



FIU Year 4 Projected Scope

- SEM-EDX analysis will be completed by the end of FIU Year 3.
- Project will be completed at the end of FIU Year 3.

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

Project Research Highlights & Accomplishments:

Peer Reviewed Journal Publications:

- Amer Awwad, Dwayne McDaniel, Leonel Lagos, Jose Rivera, Berrin Tansel, **Effect of temperature and aging duration on ethylene propylene diene monomer (EPDM) nonmetallic components used in caustic liquid waste transfer lines**, *Engineering Failure Analysis*, Volume 128, 2021, 105633, ISSN 1350-6307, <https://doi.org/10.1016/j.engfailanal.2021.105633>.
- Amer Awwad, Dwayne McDaniel, Leonel Lagos, Jose Rivera, Berrin Tansel, **Effect of solution concentration on ethylene propylene diene monomer (EPDM) nonmetallic components used in caustic liquid waste transfer lines**, *Engineering Failure Analysis*, Volume 145, 2023, 107007, ISSN 1350-6307, <https://doi.org/10.1016/j.engfailanal.2022.107007>.
- Amer Awwad, Dwayne McDaniel, Leonel Lagos, Jose Rivera, Berrin Tansel, **Effect of ion penetration on the aging of EPDM hoses used in caustic liquid transfer lines by microscopic analysis**, *Polymer Degradation and Stability*, Currently under review.

Dissertation Defense:

- **Synergetic Effects of Stressors on Nonmetallic Hoses Used in Waste Transfer Lines** - Amer Awwad



Task 20

Corrosion Protection and Characterization of EM Infrastructure

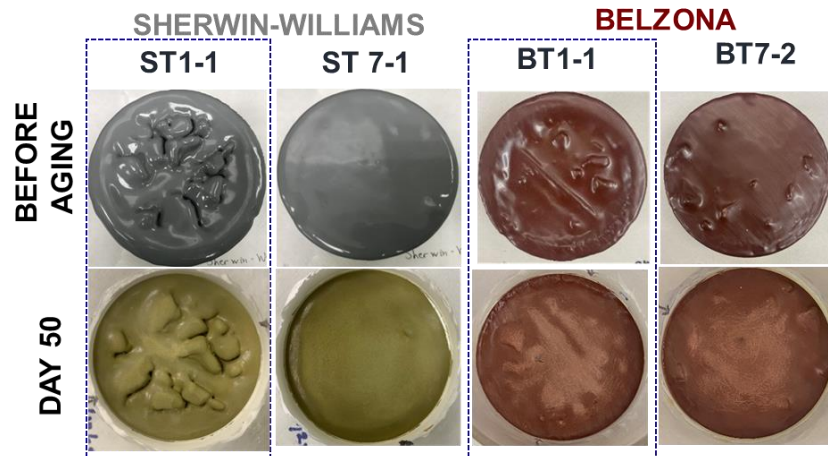


Subtask 20.1: Evaluation of Coatings for the H-Canyon Exhaust Tunnel

FIU Year 3 Research Highlights & Accomplishments:

1. Visual Inspection:

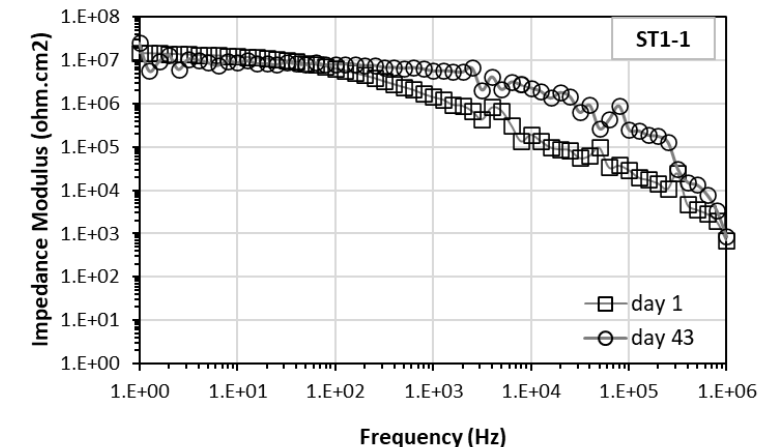
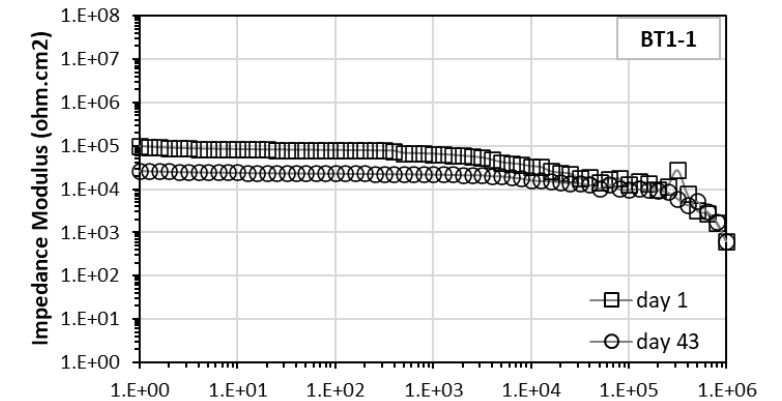
Greatest degradation for aged concrete samples.



Highlighted in blue: samples with surface preparation

2. Impedance measurements:

Greatest degradation observed on Belzona's coated samples. Lowest impedance values.



FIU Year 4 Projected Scope

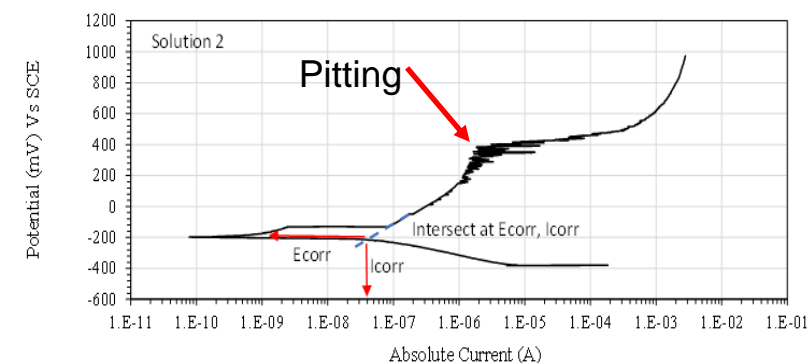
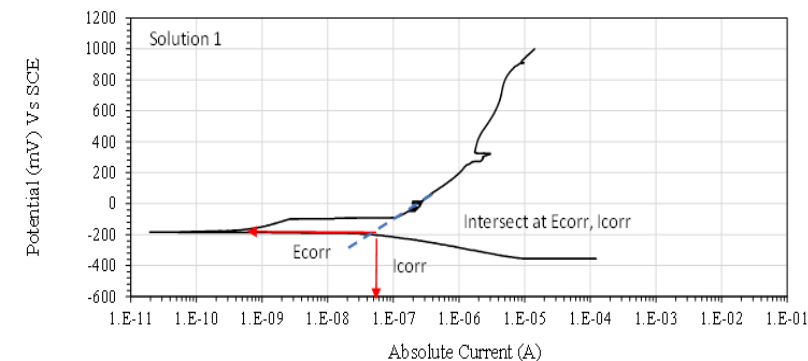
- Continue evaluation of potential coatings through accelerated aging tests.
- Initiate evaluation of Framatome coated samples.
- Study effect of key variables on coating's performance.
- Perform surface characterization on selected coated samples.
- Establish ranking based on coating's behavior to aging condition.

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

FIU Year 3 Research Highlights & Accomplishments:

- Potentiodynamic graphs for 316 SS in Hanford groundwater Solutions 1 and 2

- Corrosion data obtained from Tafel slopes.
- Effect of chloride ions on pitting formation on 316SS in Solution 2 (chloride ions only). Similar behavior on 304SS in Solution 2.



FIU Year 4 Projected Scope

- Continue evaluation of potential canister materials when exposed to simulated Hanford groundwater solutions.
- Evaluate corrosion performance of various canister materials, 304SS, 316SS, etc., exposed to cement waste forms.
- Obtain corrosion data of different low alloy carbon steel (reference material) and compare to corrosion data of 304SS and 316SS.
- Study effect of waste form concentration on corrosion performance of canister materials.

Technology Roadmap

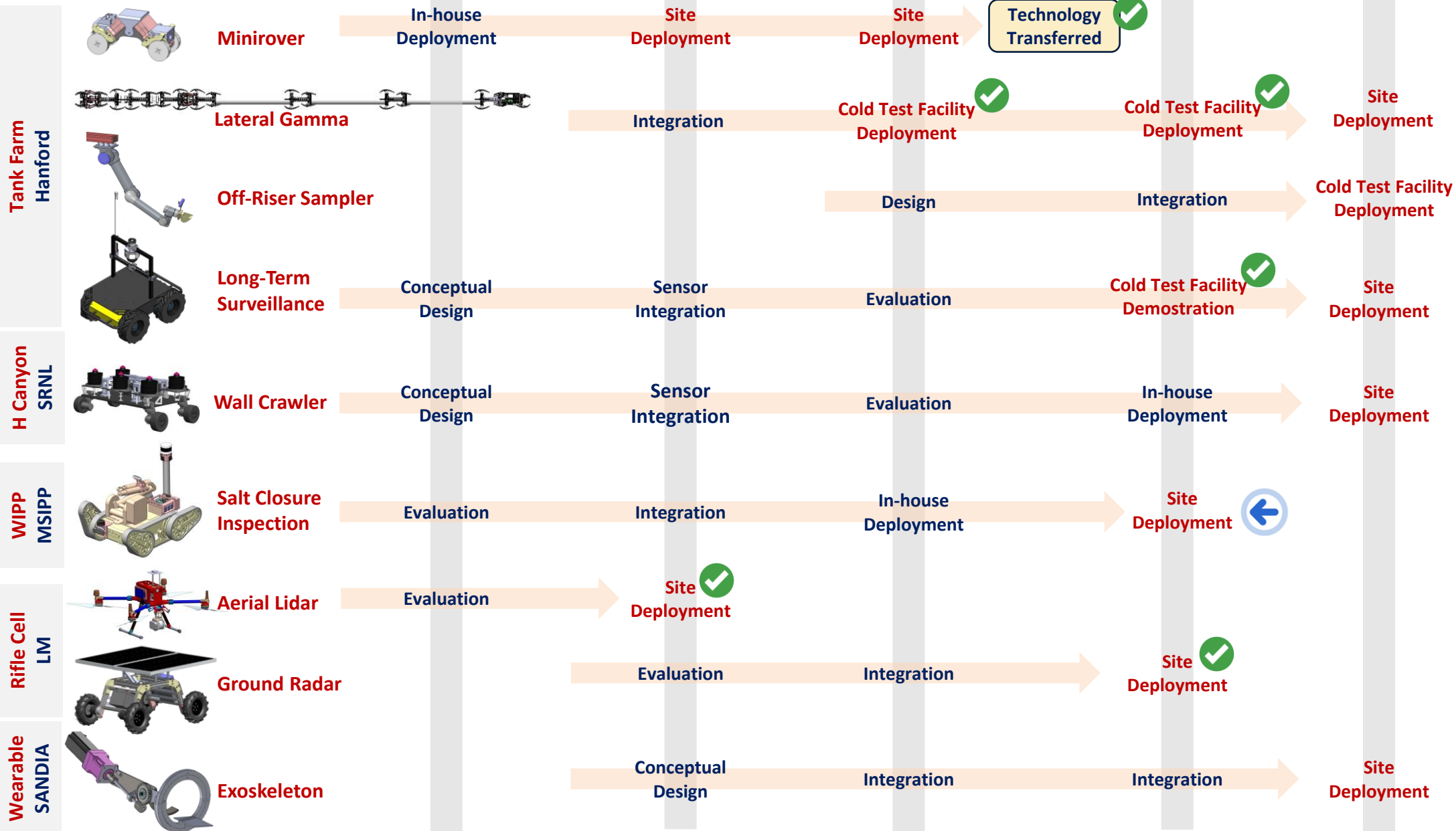
2020

2021

2022

2023

2024





Thank You. Questions?