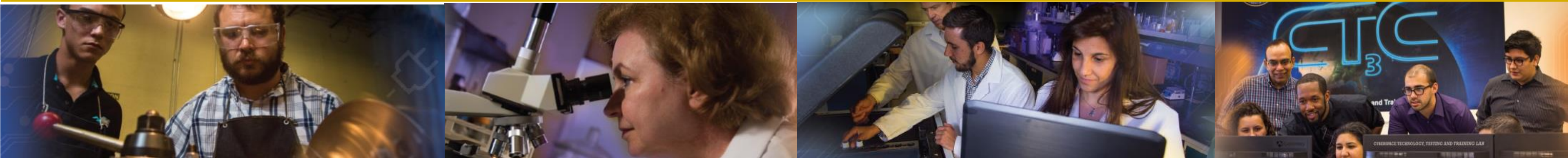
FIU Research Review
DOE-EM Cooperative Agreement

Dr. Leonel Lagos, PhD, PMP® (Principal Investigator)
Applied Research Center
Florida International University

FLORIDA INTERNATIONAL UNIVERSITY



Florida International University

- FIU is among the 10 largest public universities in the U.S. (~56,000 students in 2016)
- Top tier research institution - R1 Carnegie Classification for Highest Research Activity
- ABET accreditation
- **First in nation in awarding bachelor's and master's degrees to Hispanic students.**
- Designated a Minority-Serving Institution.

The Applied Research Center

FIU Applied Research Center

- Founded in 1995
- Executed over $100 million in research with DOE, DoD, other Federal and State agencies and private industry.
- Portal concept provides ease of access to FIU's Colleges and Centers to facilitate collaborative research.
- Multicultural and multilingual staff.
- Project Management Professionals (PMP®) and Professional Engineers (PE).
- Successful STEM Workforce Development Programs (DOE Fellows and Cyber Fellows).

Applied Research Center Facilities

FIU Applied Research Center







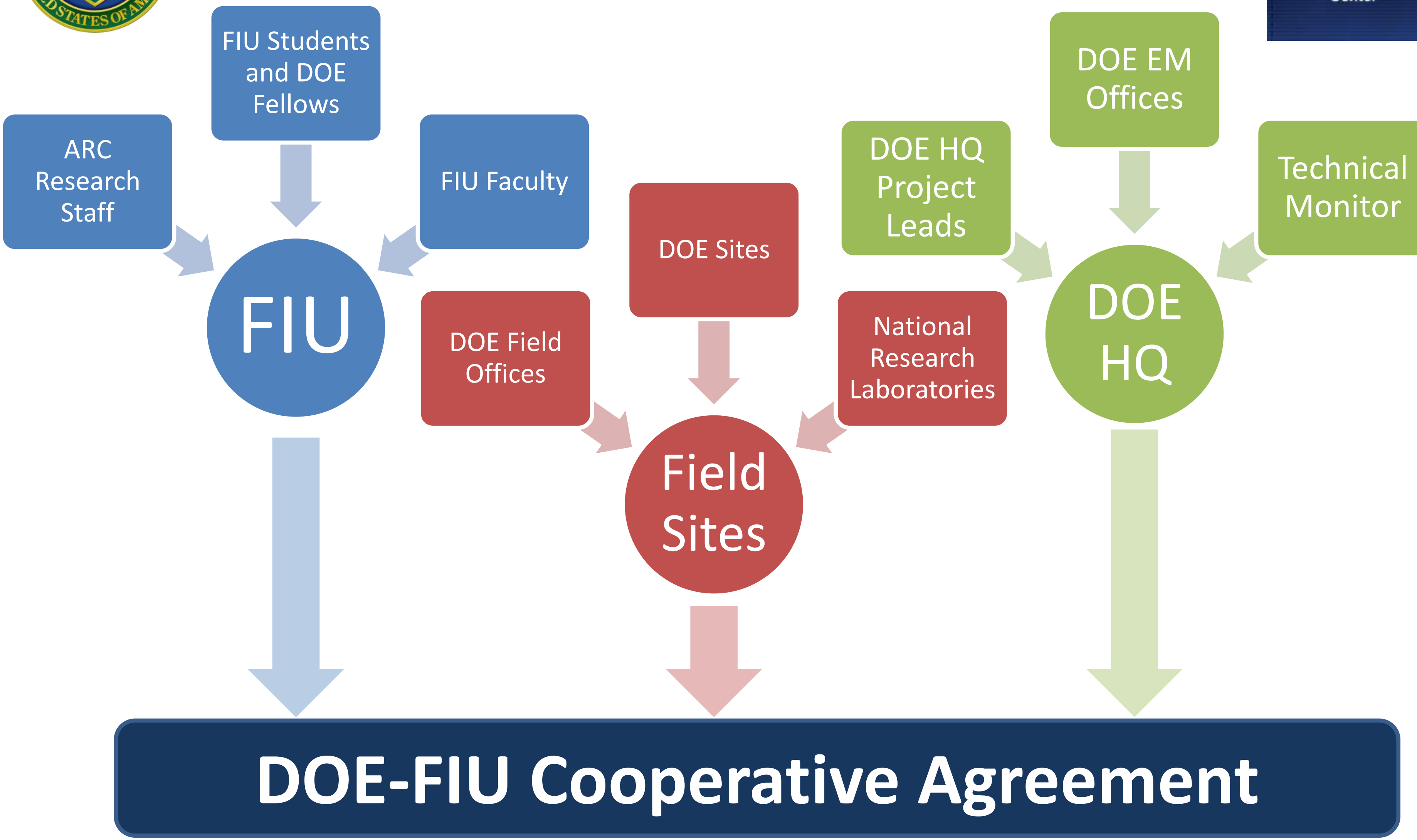

Robotics & Sensors Lab - Technology Testing & Demonstration Facility – Radiological Lab – Analytical Chemistry Lab – Soil & GW Lab – Multi-Function High Bay – GIS Lab – Cybersecurity Lab – Secure Server Room – Engineering Design Center – Machine Shop

Current Cooperative Agreement Research Efforts

FIU is providing continuing support in research areas that support DOE EM's vision and DOE field site priorities:

- Robotics (e.g., applications in HLW, D&D, etc.) for SRNL and PNNL – FIU has special niche in developing remote systems for HLW applications
- Soil & Groundwater R&D (e.g., Tc-99, iodine, co-contaminants) for PNNL, SRNL, and LANL
- High Level Waste for Tank Farm, PNNL, and WRPS
- D&D Technology Testing & Evaluation for SRNL and other sites
- Waste and knowledge management systems for EM (KM-IT and WIMS) for all DOE field sites and HQ
- STEM Student Workforce Development & Training (DOE Fellows) for DOE and contractor future workforce

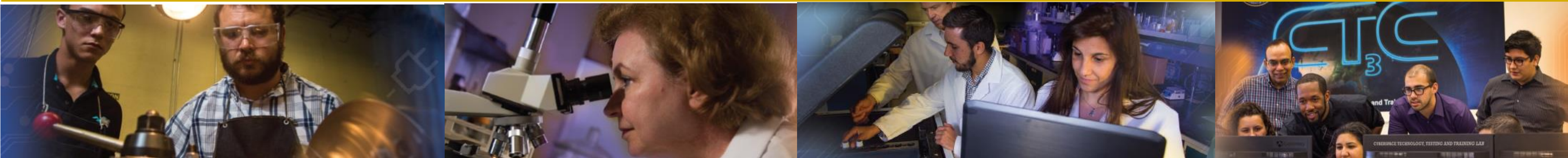
Cooperative Agreement Team



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, Reza Abbasi Bahranchi, William Tan, Jose Rivera

DOE Fellows/Students: John Conley, Maximiliano Edriei, Gene Yllanes, Michael DiBono, Clarice Davila, Sebastian Zanlongo, Joseph Coverston

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

DOE-ORP: Naomi Jaschke, Jeremy Johnson, Isabella Wheeler

WRPS: Dennis Washenfelder, Terry Sams, Ruben Mendoza, Jason Gunter, Kayle Boomer, Jason Vitale, Steven Kelly

SRNL: Michael Poirer, Connie Herman

PNNL: Kayte Denslow, Carl Enderlin, Harold Atkins, Dawn Wellman

Project Tasks and Scope

Task 17: Advanced Topics for Mixing Processes

- computational fluid dynamics modeling of HLW mixing processes in waste tanks
- experimental testing of waste transport

Task 18: Technology Development and Instrumentation Evaluation

- development of inspection tools for DST primary tanks
- evaluation of IR sensors for determining tank temperatures

Task 19: Pipeline Integrity and Analysis

- pipeline corrosion and erosion detection
- nonmetallic materials evaluation

Task 17 - Advanced Topics for Mixing Processes

CFD Modeling of Mixing Processes in Waste Tanks

Site Needs:

Mixing and mobilization of HLW is a complicated process due to the variability of a number of flow characteristics including rheology, chemistry, PSD and percent concentration. Experimentation and development of appropriate simulants can be costly and time consuming. Improving simulation capabilities of these processes can assist in optimizing system/component designs at a significant savings. Currently, the level of fidelity of most CFD simulations does not justify the sole use of CFD packages for system design.

Year 7 Objectives:

Develop computational capability as a prediction tool to:

- Evaluate the performance of mixing mechanisms for high-level waste
- Support critical issues related to HLW retrieval and processing

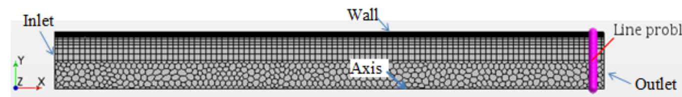
Present Tasks:

- Capabilities of Star-CCM+ code will be improved incrementally to obtain a comprehensive tool that includes the complex flow features of HLW mixing
- Star-CCM+ will be used in order to investigate accuracy of correlations used to predict impacts of the radial jets on LLW mixing

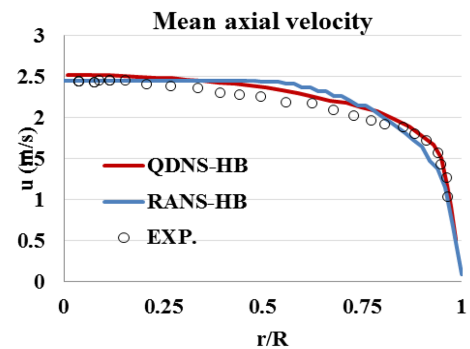
Task 17 - Advanced Topics for Mixing Processes

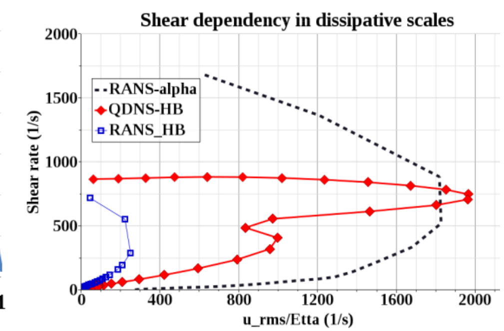
CFD Modeling of Mixing Processes in Waste Tanks

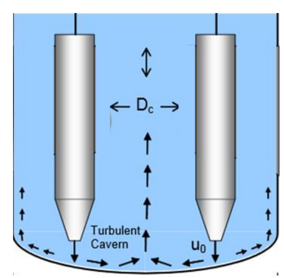
Accomplishments Year 7:

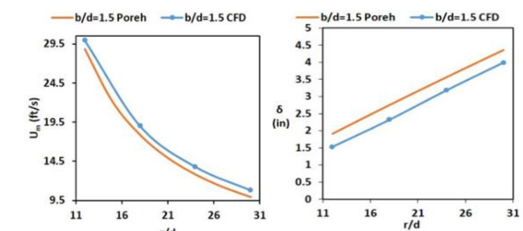


- 3D modeling of non-Newtonian fluids using QDNS and RANS were validated with experimental data. Improved previous efforts to match experimental data.
- Investigated shear dependency to improve RANS modeling – QDNS and RANS were found to be significantly different.
- Our current modified RANS method also was significantly different from the QDNS shear dependency.
- Used Star-CCM+ to validate Poreh's correlations to determine jet thickness and max velocity for various geometric configurations.
- Poreh's formula was fairly accurate for the r/b and b/d ranges of current PJM systems when predicting velocity and jet thickness.

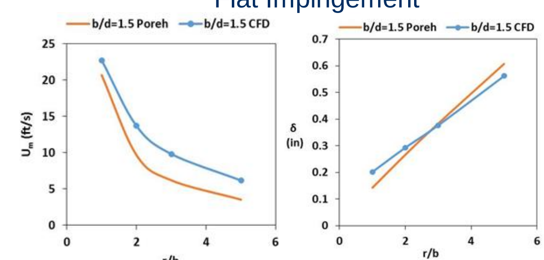








Flat Impingement



Curved Impingement

Task 17- Advanced Topics for Mixing Processes

Experimental Testing of Waste Transport (New)

Proposed Scope for Year 8

Site Needs:

According to the Defense Nuclear Facilities Safety Board, a number of issues still exist regarding the slurry transport and safety strategies at Hanford. Establishing an experimental test facility that can address a variety of technical gaps associated with critical velocities and flushing techniques would be beneficial to both Hanford and Savannah River.

Objective:

- Develop and experimental test loop to bridge technical gaps related to critical velocities, bed formation, and particle re-suspension. Provide additional insight to flushing volumes required.
- Test loop will expand on the current 300 ft system at FIU. The system will have multiple sections with loops ranging from 300 to 1500 ft to increase applicability.

Task 18 - Technology Development and Instrumentation Evaluation

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 7 Objectives:

- 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.
- Develop cost effective tools that can travel through the air supply line (3 and 4 inch diameter lines) leading to the central plenum.
- Demonstrate the use of an IR sensor to approximate the inside wall temperature of DSTs to provide information regarding the conditions within the DSTs.

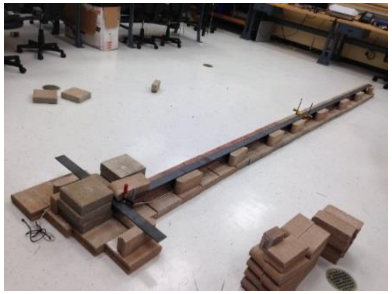
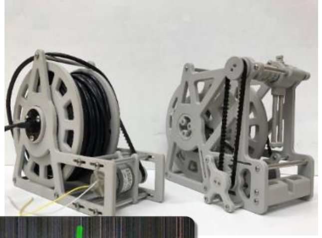
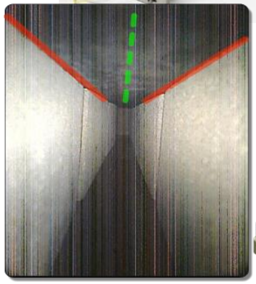
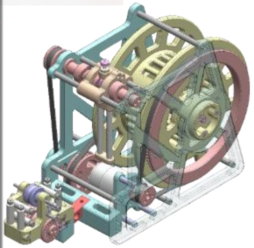
Present Tasks:

- Continue to develop our miniature rover and pneumatic crawler to provide information regarding the health of the primary and secondary liners. This includes optimization of the design, development of a cable management system, sensor integration and demonstration on a full scale mockup.
- Develop a full scale sectional mockup of the a DST that includes the drain lines, refractory channels and primary and secondary liners.
- Conduct bench scale tests using the IR sensor to evaluate its ability to assess inner wall temperatures of the DSTs.

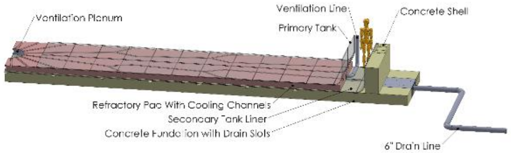
Task 18 - Technology Development and Instrumentation Evaluation

Accomplishments Year 7:

- Conducted tests demonstrating the ability of the miniature rover to navigate a minimum of 17 ft and through 2 90 degree turns.
- Developed a cable management system for both the rover and crawler.
- Developed visual based control for miniature rover.
- Conducted engineering scale tests for the pneumatic crawler to demonstrate its ability to navigate through multiple elbows and 100 ft of pipes.
- Developed conceptual design modifications to both inspection tools for the integration of environmental and NDI sensors.
- Developed a full-scale sectional mockup that is 8 feet wide and 38 feet in length and includes both the refectory slots, drain lines and secondary and primary liners.
- Completed bench scale test bed and executed the test plan for the evaluation of Raytek MI3 IR sensor.

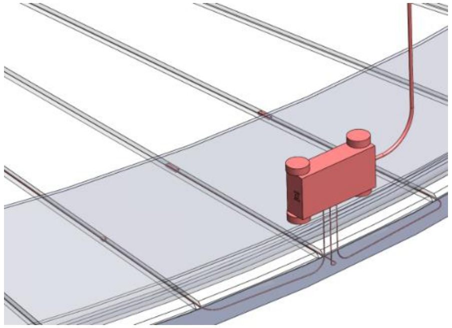




Task 18 - Technology Development and Instrumentation Evaluation

Proposed Scope for Year 8

Miniature Rover



- Integrate environmental sensors and NDI sensors (UT) into the inspection tools.
- Integrate rover into robotic platform.
- Validate system/sensors and cable management system on full scale sectional mockup. Demonstrate its ability to navigate through both the refractory slots and drain line channels.

Pneumatic Crawler

- Integrate environmental sensors and NDI sensors (UT) into the inspection tools.
- Validate system/sensors and cable management system on full scale sectional mockup.
- Develop first prototype of a 6-inch diameter crawler that can navigate through the leak detection lines.

IR Sensor Evaluation

- Determine if any additional testing is needed – based on feedback from site engineers.
- Integrate IR system into our robotic inspection tools and demonstrate on the full-scale sectional mockup.

Task 19 - Pipeline Integrity and Analysis

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.

In addition, nonmetallic materials are used in Hanford's waste transfer system that include inner primary hoses in the HIHTLs, Garlock® gaskets, and EPDM O-rings. These 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.

Year 7 Objectives:

- Investigate the use of remote permanently mounted Ultrasonic Transducer (UT) systems for measuring pipe wall thickness.
- Provide the Hanford 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.

Present Tasks:

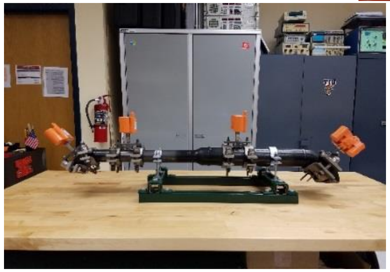
- Evaluate strength of non-metallic materials after aging for 6 and 12 months that have been subjected to elevated temperatures and exposed to caustic fluid. Conduct post failure analysis to assess levels of material degradation.
- Evaluate the long term reliability/accuracy of the Permasense guide wave sensors to provide real time thickness measurements of 2 and 3 inch diameter pipes on a bench scale test loop.

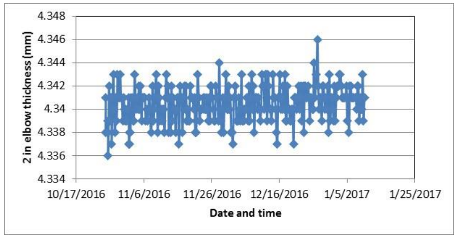
Task 19 - Pipeline Integrity and Analysis

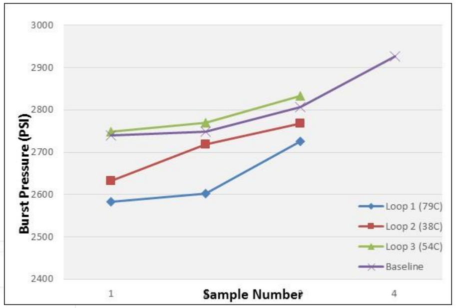
FIU Applied Research Center

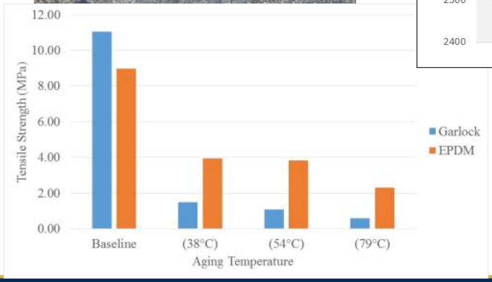
Accomplishments Year 7:

- Down selected sensors to two for evaluation
  - Permasense guided wave sensors – limited to 2 sensors for 2 in diameter pipes
  - Ultran Group – couplant free sensors
- Bench scale testing of wireless Permasense system on a two and three in pipe. Validated data over four months. (Accurate to 0.001mm)
- Designed test loop for accelerated aging of pipes and real-time measurements.
- Completed aging of nonmetallic material for 6 months at elevated temperatures with caustic solution.
- Completed pressure tests on HIHTL coupons and gaskets/O-rings. No significant change was observed in pressure tests.
- Material tests that there is significant changes in elastic modulus and tensile strength.
- Continuing to age coupons for 1 year.









Task 19 - Pipeline Integrity and Analysis

Proposed Scope for Year 8

UT Sensor Evaluation

- Determine optimal simulants to age/erode the pipe loop.
- Initiate erosion/corrosion of 2 and 3 inch pipe in test loop. Validate sensor thickness measurements real-time.
- Investigate the potential integration of the small Ultran sensors into robotic inspection devices.

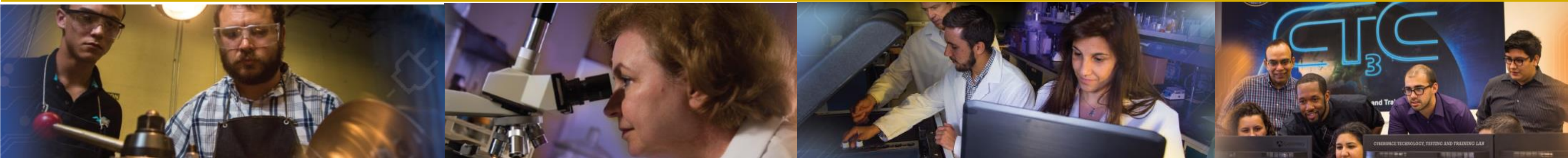
Non-metallic Material aging

- After the 1 year of aging, specimens will be removed and tested to determine the level of degradation in strength and material properties.
- Based on results of testing, additional data points may be needed for evaluation or modifications to the current system may need to be incorporated.
- Additional testing may include evaluation of constituent materials within the HIHTL (EPDM sheets and polyester fabric). Specific testing could include radiation exposure with a point source on small material samples.

FIU PROJECT 2:
YELENA KATSENOVICH

ENVIRONMENTAL REMEDIATION SCIENCE & TECHNOLOGY

FLORIDA INTERNATIONAL UNIVERSITY



FIU Personnel and Collaborators

Principal Investigator: Leonel Lagos

Project Manager: Yelena Katsenovich

Faculty/Staff: Angelique Lawrence, Ravi Gudavalli

Postdoctoral Fellows: Vasileios Anagnostopoulos, Hilary Emerson, Mehrnoosh Mahmoudi

DOE Fellows/Students: Alberto Abarca, Mohammed Albassam, Silvina Di Pietro, Alejandro Garcia, Hansell Gonzalez Raymat, Ron Hariprashad, Alejandro Hernandez, Juan Morales, Awmna Rana, Ripley Raubenolt, Alexis Smoot, Sarah Solomon, Christine Wipfli, Frances Zengotita

DOE-EM: John De Gregory, Kurt Gerdes, Paul Beam, Skip Chamberlain

DOE-SRS: Patrick Jackson

SRNL: Brian Looney, Miles Denham, Carol Eddy-Dilek, Kevin Kostelnik, John Dickson, Elizabeth Hoffman, Mark Amidon, Lisa Oliver, Mike Paller

SREL: John Seaman

PNNL: Timothy Johnson, Brady Lee, Nik Qafoku, Jim Szecsody, Vicky Freedman

LANL: Don Reed, Timothy Dittrich

DOE-CBFO: Russ Patterson, Anderson Ward

Project Tasks and Scope

Task 1: Remediation Research and Technical Support for the Hanford Site

– Laboratory-scale experiments to study impacts of potential *in situ* remediation techniques on the subsurface at Hanford.

Task 2: Remediation Research and Technical Support for Savannah River Site

– Laboratory-scale experiments to study impacts of potential *in situ* remediation techniques on the subsurface at SRS.

Task 3: Surface Water Modeling of Tims Branch

– Development of a hydrological model of Tims Branch watershed at SRS.

Task 5: Research and Technical Support for WIPP

– Laboratory-scale experiments to study the fate of actinides and lanthanides at the WIPP site.

Task 1: Remediation Research and Technical Support for the Hanford Site

Site Needs:

DOE-EM has a critical need to understand the biogeochemical processes influencing the behavior of contaminants (U(VI), Tc-99) in Hanford Site's deep vadose zone that can impact groundwater. Research to address environmental risks and remediation challenges involving Tc-99 is a high-priority activity for the DOE-EM complex. Manipulation of pH via ammonia gas is a potential remediation technology that can lead to incorporation of U(VI) into the sediments. Improving geophysical response for contaminant behavior and remediation performance can assist environmental remediation.

Year 7 Objectives:

- Identify controlling mechanisms that lead to immobilization of U via NH_3(g) injection.
- Evaluate if soil bacteria play a role in the release of U in the aqueous phase by autunite dissolution, secondary mineral formation and potentially U(VI) bio-reduction.
- Investigate spectral induced polarization (SIP) signatures of microbial activity to test if microbial actions are detectible via SIP and analyze the resulting SIP data.
- Investigate if Tc(IV)-carbonate complexes represent an important mechanism for technetium migration in anaerobic environments.

Present (Year 7) Subtasks:

- Compare removal of U following base treatment with NaOH, NH_4OH and NH_3 gas in batch samples in the presence of Hanford relevant minerals
- Investigate microbial-meta-autunite interactions focusing on autunite dissolution in the presence of bicarbonate
- Measure electrical geophysical responses to microbial activity in saturated environments via column experiments
- Determine the partitioning of Tc-99 between aqueous phase and Hanford soil in the presence of bicarbonates under reducing conditions

Task 1: Remediation Research and Technical Support for the Hanford Site

Accomplishments Year 7:

Ammonia Gas for Uranium Remediation

- Modeled speciation of aqueous and solid U(VI) phases in the presence of major pore water constituents and validated results with SEM/EDS and EPMA analysis (DOE Fellow Cardona earned her PhD with this data in May 2017).
- Investigated mineral dissolution/precipitation in the presence of NaOH, NH_4OH, and NH_3 and tracked U partitioning for all minerals. NH_3 gas results in slightly greater removal of U and more reducing conditions.

Microbial Dissolution of Uranyl Phosphate

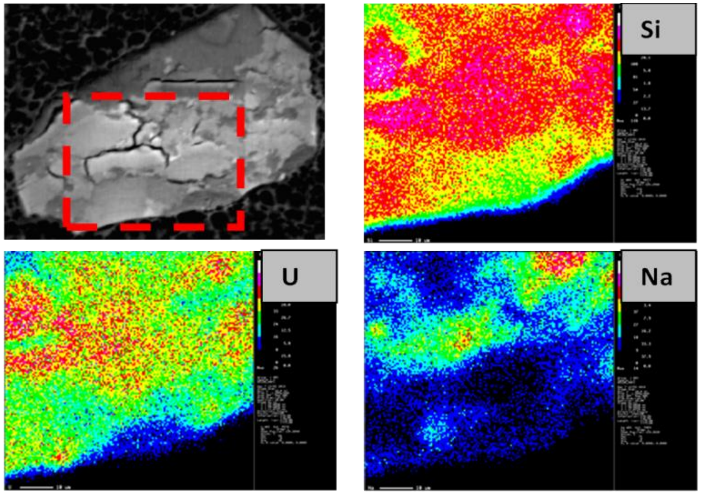
- Investigated microbial dissolution of synthetic uranyl phosphate under conditions simulating micro-oxygen environments in the presence of various concentrations of bicarbonate. No bio-reduction of U was observed within the timeframe of experiments.

Geophysical Response of Microbes

- Analyzed SIP data and changes in pore water parameters via ICP-OES and U(VI) via KPA in the presence and absence of microbial activity.

Technetium Chemistry

- Initiated investigation of Tc-99 aqueous redox chemistry and Tc-99 partitioning between aqueous phase and Hanford soil in the presence of bicarbonates, as well as different reducing agents. Performed identification of Tc^{4+} and Tc^{7+} soluble species through solvent extraction/separation technique.



Distribution of Si and U in precipitate correspond nicely.

Results presented at ACS Fall 2016 & Spring 2017, WM2017.

Results published in *Applied Geochemistry, Journal of Environmental Radioactivity*.

FIU Applied Research Center

Task 1: Remediation Research and Technical Support for the Hanford Site

Proposed Scope for Year 8

Site Needs:

DOE-EM faces a number of environmental challenges that are technically complex and unique to EM with tremendous associated cleanup costs. The goal of the efforts under this project is to conduct basic science to fill knowledge gaps and validate potential remediation technologies to assist with environmental cleanup of Hanford Site's contaminated soil and groundwater. This investigation will assist Hanford Site and other DOE EM sites in their efforts to better understand Tc-99 speciation/chemistry and the fate and transport mechanisms of comingled contaminants including Tc-99, U(VI), Cr, and iodine.

Objectives:

- Continue batch experiments investigating NH_3 and U equilibrium partitioning in synthetic porewater and NaCl solutions in the presence of mica minerals and characterize solids (pending EMSL proposal).
- Investigate electrical geophysical response using unsaturated columns inoculated with microbes filled with Hanford sediment and a layer of autunite. Columns will be monitored over time using geochemical, microbiological, and SIP analyses.
- Perform sorption experiments under reducing conditions using Tc-bearing solutions, Hanford Site soil and relevant pure minerals in the presence of different bicarbonate concentrations and investigate potential remobilization of Tc-99 under a range of bicarbonate concentrations indicative of the site's groundwater and pore water composition.
- Initiate studies on co-contaminant incorporation into calcium carbonate in the presence of silica, and investigate the stability of the incorporated contaminants at pH conditions characteristic of Hanford Site.

Task 2 – Remediation Research and Technical Support for Savannah River Site

Site Needs:

DOE EM's current mission places emphasis on innovative approaches and novel technologies which help to address the significant challenges associated with the remaining cleanup of contaminated sites. Significant data gaps still exist regarding the behavior and chemistry of radionuclides of concern as well as the co-mingling of these contaminants that affect the groundwater remediation strategies at SRS and other DOE EM sites. Evaluation of the role of different environmental factors on the fate and transport of contaminants and co-contaminants in soil and groundwater will assist in the design and validation of novel in situ remediation technologies that support EM test bed demonstrations and benefit SRS cleanup initiatives.

Objectives:

- Investigate SRS F/H Area acidic plume chemistry: the effect of soil's acidification on its physicochemical characteristics (specific surface area, pore distribution) and its sorptive capacity towards U(VI).
- Investigate the synergy between colloidal silica and humic acid that may have an effect on the removal of uranium (U) from contaminated groundwater.
- Perform batch sorption experiments with humic acid as well as column experiments to simulate the creation of a sorbed humate treatment zone in acidic groundwater contaminated with U and study properties of sediments contaminated by acid and their sorption characteristics in the range of relevant concentrations for single and multiple co-contaminants to compare results with clean background sediments. The results will support demonstration of humic acid remediation technology in the field.

Present (Year 7) Subtasks:

- Investigation on the Properties of Acid-Contaminated Sediment and its Effect on Contaminant Mobility
- The Synergistic Effect of Humic Acid and Colloidal Silica on the Removal of Uranium (VI)
- Humic Acid Batch Sorption

Task 2 – Remediation Research and Technical Support for Savannah River Site

FIU Applied Research Center

Accomplishments Year 7:

Acid-Contaminated Sediment

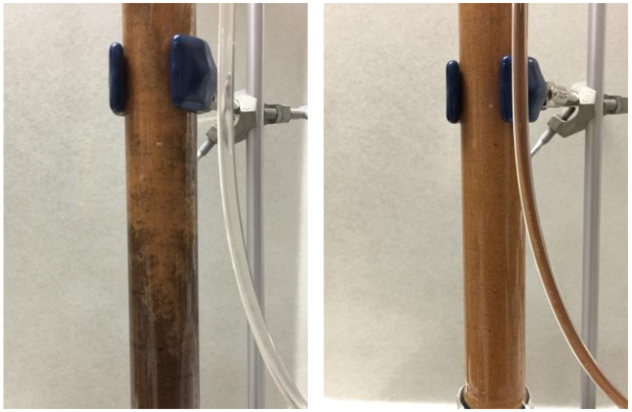
- Performed kinetic studies of SRS soil acidification and identified congruent kaolinite dissolution at pH 3. Characterized soil exposed to acid for different time intervals (specific surface area and pore distribution) and performed sorption experiments at wide pH range.

The Synergistic Effect of Humic Acid and Colloidal Silica

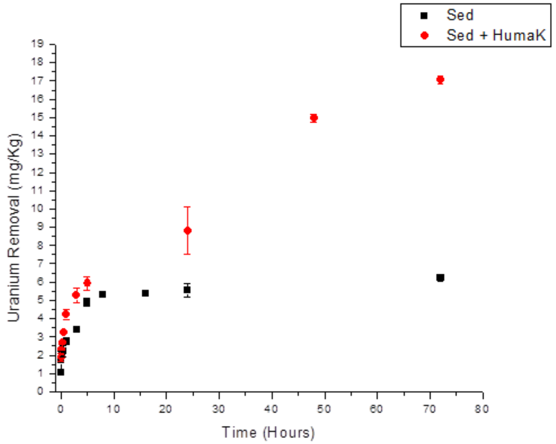
- Studied synergetic interactions between humic acid and colloidal silica on uranium (U) removal at varying U concentrations and varying pH. Completed batch experiments at pH range 3 - 8. Prepared samples for analysis of U(VI) by KPA.
- Optimized Rhenium tracer test for column experiments and performed column experiment with modified humic acid to study the sorption/desorption of modified humic acid and its affinity to immobile U, and to compare data with results from Huma-K experiment.

Batch and Columns Experiments with Huma-K

- Investigated effect of ionic strength on Huma-K sorption via batch sorption experiments. Huma-K sorption increases with increasing ionic strength at pH 4-7.
- Conducted potentiometric titrations of Huma-K, pure humic acid, and modified humic acid to compare their acido-basic properties .
- Submitted manuscript *“Unrefined humic substances as a potential low-cost remediation method for acidic groundwater contamination”* describing sorption properties of Huma-K amendment for contaminated groundwater.
- Investigated kinetics of U(VI) sorption onto SRS sediments with and without Huma-K coating at pH 4.



Humic acid column experiment



Kinetics of U(VI) adsorption onto SRS sediment

Task 2 – Remediation Research and Technical Support for Savannah River Site

Proposed Scope for Year 8

Site Needs:

DOE EM's current mission places emphasis on innovative approaches and novel technologies which help to address the significant challenges associated with the remaining cleanup of DOE contaminated sites. Management of technetium (Tc) and iodine (I) contamination in particular is a high-priority. Significant data gaps still exist regarding the behavior and chemistry of radionuclides of concern such as Tc, I and uranium, as well as the co-mingling of these contaminants that affect the groundwater remediation strategies at SRS and other DOE EM sites. Evaluation of the role of different environmental factors on the fate and transport of contaminants and co-contaminants in soil and groundwater will assist in the design and validation of novel in situ remediation technologies that support EM test bed demonstrations and benefit SRS cleanup initiatives.

Objectives:

- Investigate the interactions of Tc and I with soil from the Four Mile Branch Wetland under aerobic and anaerobic conditions via batch experiments in an effort to understand the fate of contaminants under relevant site's conditions.
- Explore the effect and mechanisms of synergetic interactions between HA and colloidal silica that controls uranium behavior in a range of environmental variables such as pH and soil minerals.
- Evaluate the effect of time, pH, and initial uranium concentrations on U(VI) sorption/ desorption behavior using experimental matrix that includes SRS sediment, U(VI), Huma-K or modified humic substances.
- Study the effect of competitive sorption of uranium with different metals (Ag^{+}, Zn^{2+}, and Ce^{3+}) onto SRS sediment amended with Huma-K.
- Study the long term performance behavior of HA under varied pH levels via column experiments; the results from the laboratory studies can then be correlated with the injection tests previously conducted in the field.

Task 3 – Surface Water Modeling of Tims Branch

Site Needs:

According to DOE EM's Technology Plan to Address the EM Mercury Challenge and the DOE EM Innovation and Technology Program, a number of issues still exist regarding mercury and other heavy metal and radionuclide contamination at SRS and other DOE EM sites. Utilization of Tims Branch as a test bed to develop a numerical modeling tool to evaluate hydrological impacts on the fate and transport of major contaminants of concern (e.g. Hg, U, Ni, radionuclides) will be beneficial to SRS, particularly if the tool developed can be applied to other streams at SRS as well as other DOE EM sites.

Objectives:

- Develop a physically based numerical modeling tool to simulate hydrology (flow depth & velocity) of Tims Branch using open source and commercial software.
- Develop a transport model to simulate the spatiotemporal distribution of tin concentration in Tims Branch and support long-term monitoring of tin (Sn)-based mercury (Hg) remediation in Tims Branch (TB).
- Develop a transferable technology that can be applied to study hydrological impacts on the fate and transport of major contaminants of concern (e.g. Hg, U, Ni, radionuclides) and that is potentially applicable in other Hg-contaminated stream systems at SRS and other DOE EM sites.
- Collect *in-situ* field data such as stream cross-sections and timeseries of flow depth and velocity, suspended particle concentration and other water quality parameters to support model calibration and verification.

Present (Year 7) Subtasks:

- Modeling of Surface Water and Sediment Transport in the Tims Branch Ecosystem
- Application of GIS Technologies for Hydrological Modeling Support
- Biota, Biofilm, Water and Sediment Sampling in Tims Branch Watershed

Task 3 – Surface Water Modeling of Tims Branch

<u>**Accomplishments Year 7:**</u>

2-D Overland Flow (OL) Model

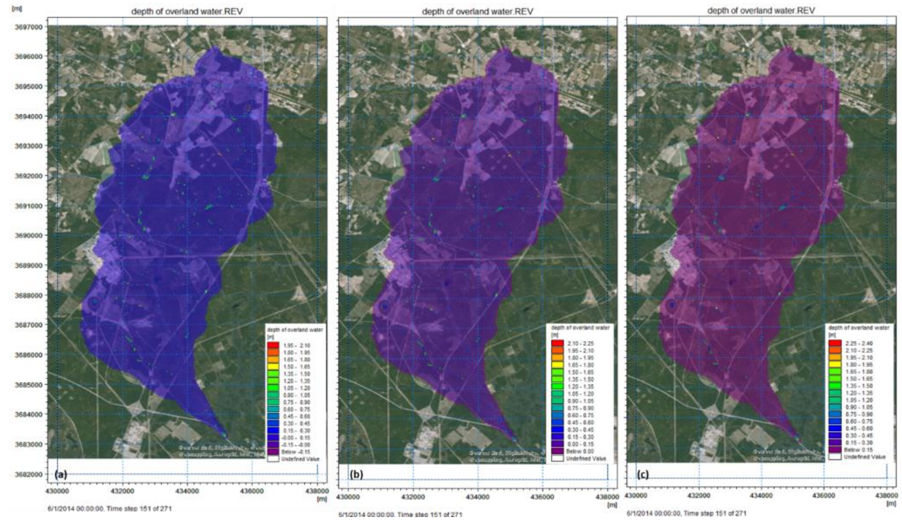
- Developed 2-D OL flow model using MIKE SHE.
- Model calibration in progress (sensitivity & uncertainty analyses).

1-D Stream Flow (SF) Model

- Developed 1-D SF model of A-014 outfall tributary using MIKE 11.
- Field data collected in August 2016 implemented in model.
- Model calibration in progress (sensitivity & uncertainty analyses).

***In-Situ* Data Collection at Tims Branch, SRS**

- Field sampling & *in-situ* data collection incorporated into DOE Fellow summer internship at SREL (in collaboration with SRNL).
- Follow-up field work conducted in June 2017, coordinated with student internship.
- Data supports model development & calibration.



MIKE SHE 2-D OL Flow Model

In-Situ Data Collection at Tims Branch, SRS

Task 3 – Surface Water Modeling of Tims Branch

Proposed Scope for Year 8

Objectives:

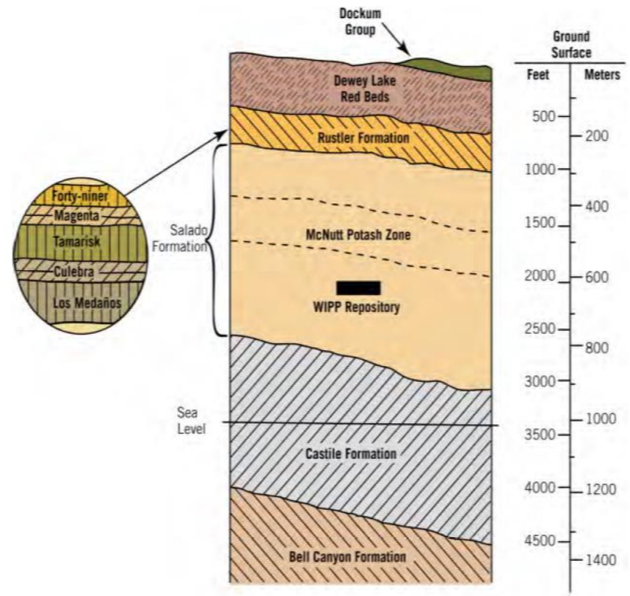
- Model Calibration (completion of MIKE SHE OL flow and MIKE 11 SF models sensitivity and uncertainty analyses) .
- Coupling of stream flow and overland flow models.
- Data analysis & visualization using GIS and statistical tools.
- Field sampling, *in-situ* and remote data collection.
- Begin preliminary development of 1-D stream flow (SF) model of main Tims Branch stream using MIKE 11 (field data and measurements collected in July 2017 to be implemented).
- Preliminary development of solute transport model.

Task 5: WIPP Collaboration

FIU Applied Research Center

Site Needs:

There is a lack of relevant experimental sorption data for trivalent actinide and lanthanide interactions with Culebra dolomite. These data are important for the WIPP performance assessment (PA). The previous PA assumed a K_d of 20-400 mL/g for Pu and Am. However, sorption K_d values have been measured from $10^{3.4}$ to 10^6 mL/g (e.g. Brady *et al*., 1999; Perkins *et al*., 1999; Brush & Storz, 1996). Therefore, there is a need to decrease the uncertainty in these parameters.



Year 7 Objectives:

To update experimental sorption data for actinides under simplified systems to complement LANL ACRSP research for the WIPP 5-year re-certification:

- Evaluate trivalent actinide and lanthanide sorption parameters for dolomiate at variable ionic strength.
- Investigate the sorption capacity of dolomite minerals for trivalent actinides and lanthanides.

Present (Year 7) Tasks:

- Conduct mini column saturation experiments for Nd at 0.1 and 5.0 M NaCl.
- Analyze equilibrium and kinetic sorption parameters for Nd at variable ionic strength (0.01 to 5.0 M).
- Characterize solid phases following interaction with variable ionic strength brines and Nd.

Oxidation State Distribution of Key Actinides in WIPP Performance Assessment

Actinide	Oxidation State				Speciation Data used in Model Predictions
	III	IV	V	VI	
Uranium		50%		50%	Thorium for U(IV), 1 mM fixed value for U(VI)
Plutonium	50%	50%			Am/Nd for Pu(III) and thorium for Pu(IV)
Americium	100%				Americium/neodymium

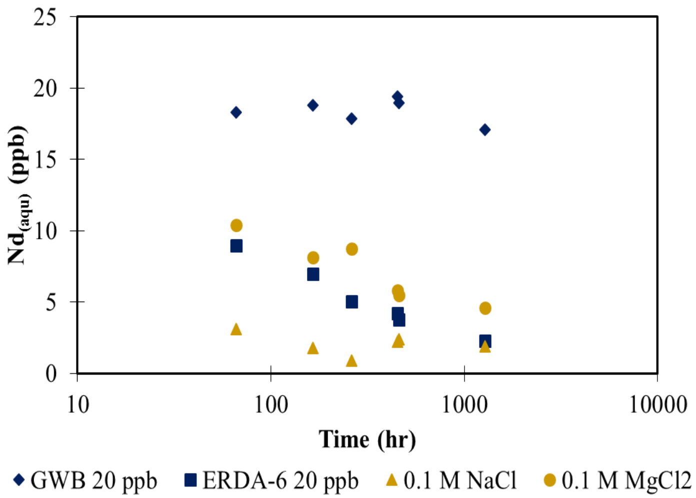
FIU Applied Research Center

Task 5: WIPP Collaboration

Accomplishments Year 7:

- Established a relationship with LANL ACRSP
  - Feb-Apr 2016 deployed ARC postdoc to LANL ACRSP
  - Jun-Aug 2017 deploy DOE Fellow & ARC postdoc to LANL ACRSP
- Conducted batch and mini-column experiments to investigate Nd(III) sorption as an analog for Am/Pu(III)
  - Results highlight conservatism in WIPP PA sorption assumptions
  - Showed that removal of Nd increases with ionic strength in the absence of significant GW flow likely due to sorption and incorporation processes (by comparison of batch versus mini column experiments)
- Presented work at AGU 2016, McNair 2016, LSSF 2017, Waste Management 2017, ABC Salt V 2017, and ACS Fall 2017 (accepted)

Crosscutting research bridges the basic and applied sciences



Experiments with WIPP synthetic brines (blue, LANL) versus simplified salt systems (yellow, FIU) help to understand which parameters and processes control the system.

FIU Applied Research Center

Task 5: WIPP Collaboration

Proposed Scope for Year 8

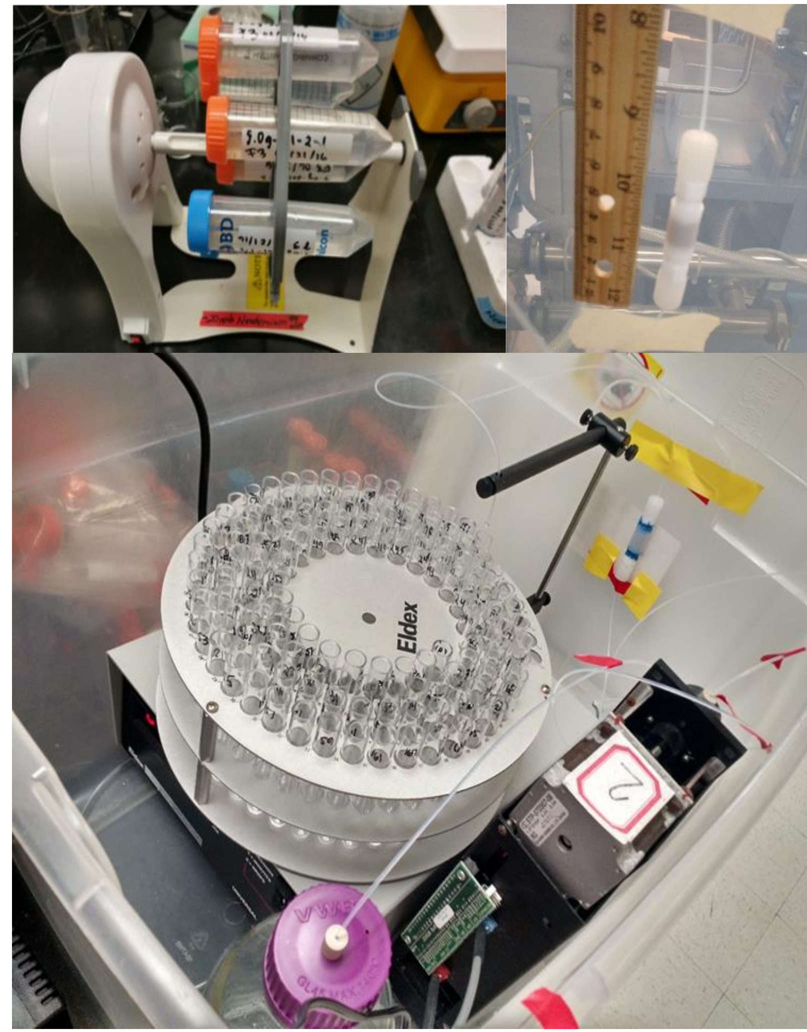
Site Needs:

The effects of ligands in the waste stream (e.g. EDTA and oxalate) on near field mobility of actinides is still unknown (Dunagan, 2007; Brush, 1990). Complexation constants have been measured for most actinides and lanthanides (Thakur *et al*., 2014; 2015; Borkowski *et al*., 2001). However, their long-term stability and sorption are not yet understood.

Interactions of actinides with corrosion products may also affect mobility through sorption and incorporation processes. There is a need to understand how actinides are incorporated into these materials.

Objectives:

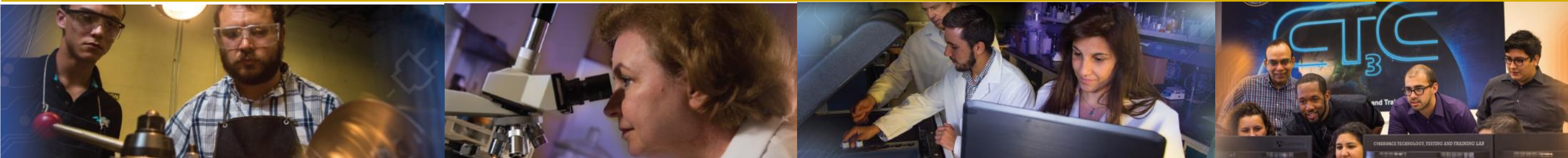
- Develop capabilities for analysis of EDTA (including complexed EDTA) in the aqueous phase.
- Investigate the stability of An-EDTA complexes under relevant conditions.
- Measure sorption parameters for Nd/Am(III), Th(IV), and U(VI) complexed with EDTA at variable ionic strength via batch and mini column experiments.
- Compare mobility of Nd (Year 7 results) versus Nd-EDTA.
- Synthesize iron oxide minerals (as analogs for corrosion products) in the presence of actinides and analogs.



FIU PROJECT 3: WASTE AND D&D ENGINEERING AND TECHNOLOGY DEVELOPMENT

Himanshu Upadhyay
Joseph Sinicrope

Florida International University



FIU Personnel and Collaborators

FIU Applied Research Center

Principal Investigator: Leonel Lagos

Project Manager: Leonel Lagos

Faculty/Staff: Himanshu Upadhyay, Joseph Sinicrope, Peggy Shoffner, Walter Quintero, Clint Miller, David Roelant, Santosh Joshi

DOE Fellows/Students: Jesse Viera, Alex Piedra, Andres Cremisini

DOE-EM: John De Gregory, Andy Szilagyi, Rod Rimando, Genia McKinley, Jonathan Kang

SRNL: Mike Serrato, Aaron Washington, Connor Nicholson

SRS: Jack Musall

Project Tasks and Scope

Task 1 Waste Information Management System (WIMS)

- manage waste forecast information for planned treatment/disposal across the DOE complex
- provide web-based tool to receive, organize, and report DOE waste forecast data from across the complex via a common application

Task 2 D&D Support for Technology Innovation, Development, Evaluation and Deployment

- adaptation and evaluation of intumescent coatings
- uniform testing protocols and performance metrics for D&D
- development of hot cell test bed and technology demonstrations

Task 3 Knowledge Management Information Tool (KM-IT)

- maintain and preserve D&D knowledge base by enhancing communication, information sharing, and distribution to assist future D&D projects and workforce

Task 1 – Waste Information Management System (WIMS)

Site Needs:

Accurate estimates of the quantity and type of present and future radioactive waste streams is critical to the development of tools to integrate the complex-wide management of LLW/MLLW treatment and disposal. A complex-wide LLW and MLLW database and reporting system is needed to communicate this information to local and national stakeholders and governmental groups.

Year 7 Objectives:

- Provide a central web-based location to access waste forecast data for sites across the DOE complex
- Provide easy-to-use tools to view the data in various formats
- Update data on an annual basis

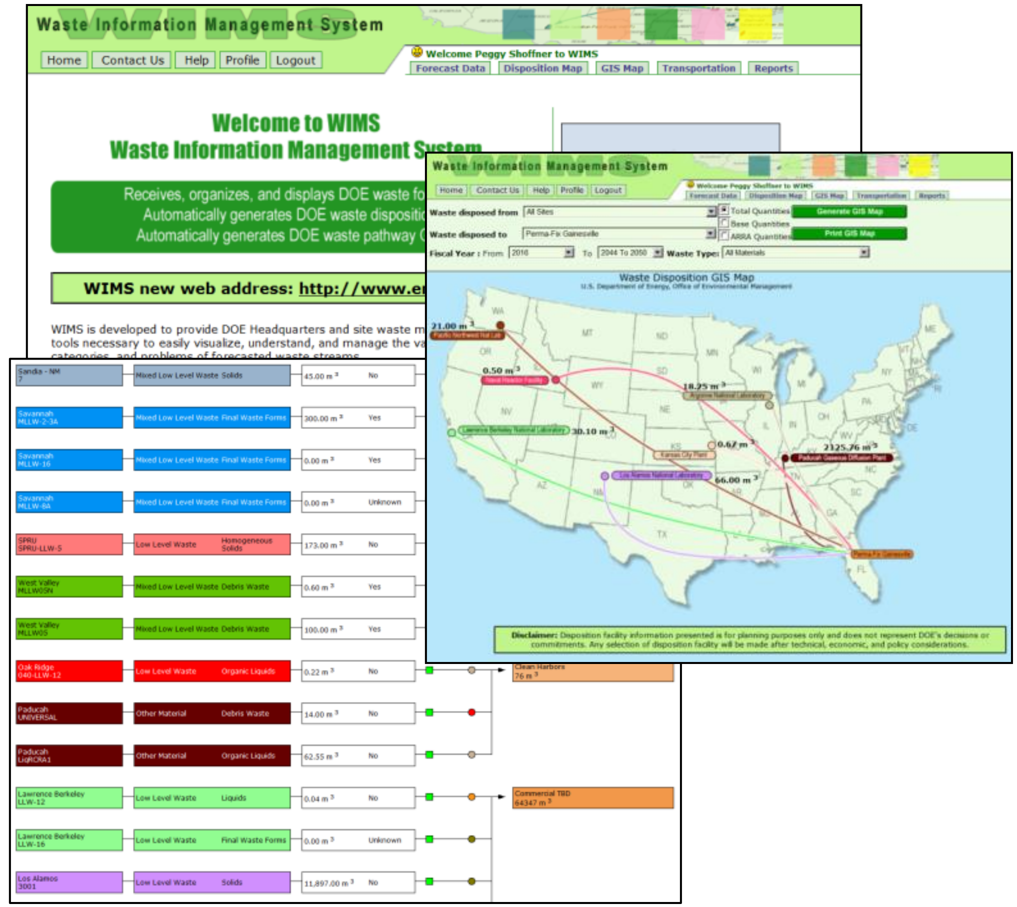
Present Tasks:

- Maintain existing system via database management, application maintenance, and performance tuning
- Incorporate new data files into WIMS on an annual basis

Task 1 – Waste Information Management System

Accomplishments Year 7:

- WIMS is successfully deployed http://www.emwims.org
- Easy-to-use tool to visualize and understand the forecasted DOE waste streams.
- Completed integration of 2017 waste forecast and transportation data into WIMS.
- New 2017 dataset launched on public website on May 10.



Task 1 – Waste Information Management System

Proposed Scope for Year 8

- Integrate annual update of waste forecast and transportation data into WIMS.
- Deploy a secure socket layer for the WIMS application to improve security protocols.

Task 2 – D&D Support for Technology Innovation, Development, Evaluation and Deployment

Site Needs:

Sites across the DOE Complex are facing an increased need to deactivate and decommission aging facilities that have reached the end of their operating life. The challenges include completing the D&D of active, excess, and abandoned facilities to a final disposition end state in a timely and safe manner.

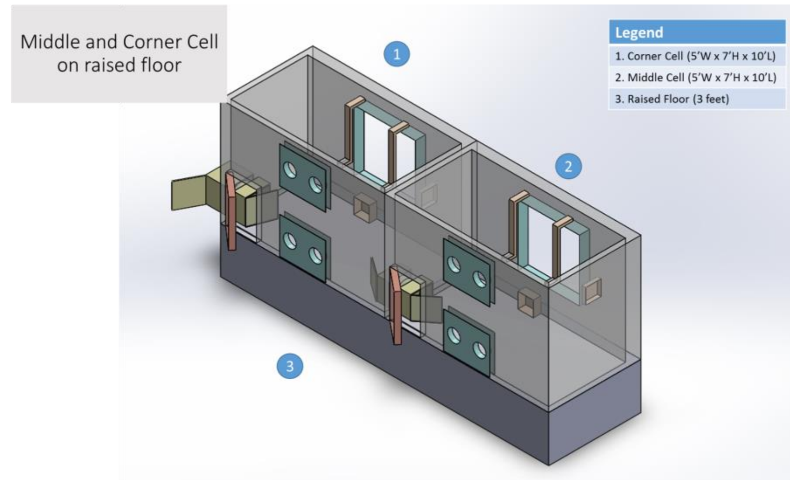
Year 7 Objectives:

- Provide D&D technology innovation, development, and evaluation results and information needed to complete challenging D&D safely and effectively

Present Tasks:

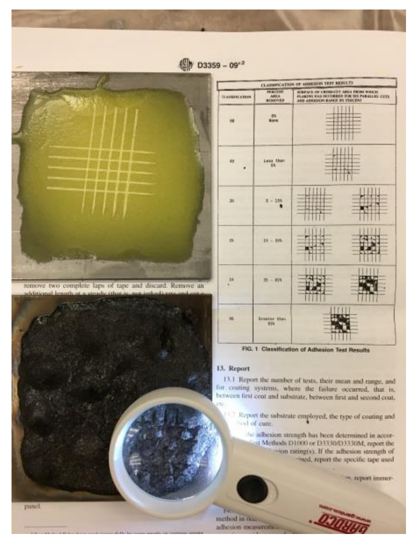
- Adaptation as incombustible fixatives and testing of intumescent coatings
- Development of uniform testing protocols and performance metrics
- Construction of a hot cell test bed and conducting a cold demonstration / test and evaluation of applying intumescent coatings

Task 2 – D&D Support for Technology Innovation, Development, Evaluation and Deployment



<u>Accomplishments Year 7:</u>

1. Constructed SRS 235-F Hot Cell Test Bed
   a) Support to adapting intumescent coatings task
   b) Future test/evaluate of other technologies (e.g. robotics) intended to support D&D of hot cells
2. Developed two (2) standards for fixative technologies with ASTM International
   a) ASTM E3104-17: Specification For Strippable & Removable Coatings to Mitigate Spread of Radioactive Contamination
   b) ASTM E3105-17: Specification For Permanent Coatings Used to Mitigate Spread of Radioactive Contamination
   c) Collaborated to inform the D&D community & publicize these new standards: KM-IT, DOE EM Updates and news releases, and ASTM via industry articles
3. Completed initial series of adhesion tests under thermal stressors for intumescent coatings
4. Executed test plan for application of intumescent coatings to hot cell test bed



Task 2 – D&D Support for Technology Innovation, Development, Evaluation and Deployment

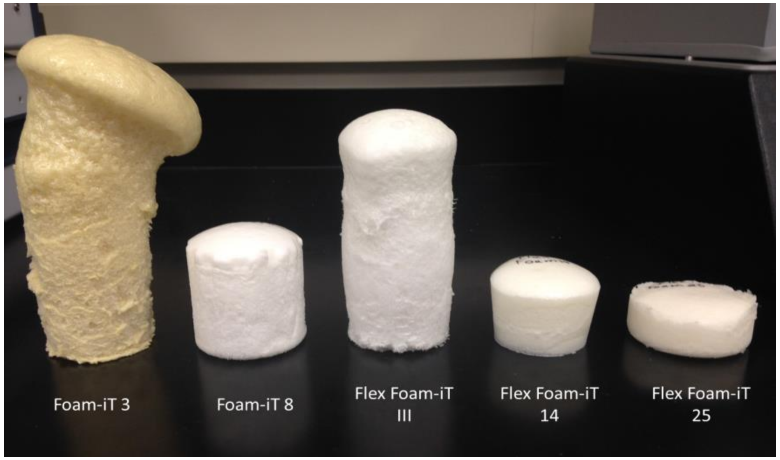
Proposed Scope for Year 8

1. Test and evaluation of radiation hardened polyurethane foams for D&D activities
   a) In support of SRNL
   b) Emphasis is on fire resistant testing

2. Continue ASTM international standards development for fixatives in support of D&D activities

3. Initiate development of testing protocols to quantify impacts of fixative technologies on Airborne Release Fractions and Respirable Fractions to Source Term Formula under thermal and impact stressors
   a) In support of potential updates to DOE-HDBK-3010

4. Identify additional applications of intumescent coating technology to satisfy other challenge areas related to fire risks outlined in Basis for Interim Operations across the DOE EM complex



Goals of DOE-HDBK-3010

- Systematically compile airborne release and respirable fraction experimental data for non-reactor nuclear facilities
- Assess available data
- Provide values derived from data assessment that may be used in accident analysis

Requirement for Fire Resistant Fixatives Across DOE EM Complex

Table [illegible]. Types of Accidents (and Frequencies) Summarized

DOE Site/Facility	Fire Events	Explosion Events	Loss of Confinement (Spill) Events	Natural Phenomena Hazards	Other Events
RFETS Bldg 440	• ***1,200 Drum Fire (EU)*** • ***15 Crate Fire (U)*** • Truck Fire (EU)		• LLW Repack Spill (U) • Drum Spill (A)	• ***Earthquake Collapse (U)***	• ***Aircraft Crash (EU)***
RFETS Bldg 664	• ***3 Drum Fire (U)*** • ***15 Crate Fire (U)*** • *336 Drums + 72 Crates Fire (EU)* • Truck Fire (EU)		• *Multi-Container Drop*	• ***Earthquake Collapse (U)***	• ***Aircraft Crash (worst-case) (EU)*** • ***Aircraft Crash (realistic case) (EU)***
SRS APSF	• *Accountability Msmt. Room Fire (U)*	• *Explosion in Repackaging Area (A)*		• *Seismic Induced Full Facility Fire (U)*	
SRS HB-Line	• Full Facility Fire (EU) • Full Facility Fire & Secondary Events (EU) • ***Intermediate Fire (U)*** • ***Intermediate Facility Fire & Secondary Events (EU)***		• Spill (A)	• Earthquake with Secondary Events (EU)	
SRS Bldg 235-F	• Fire – Best Case (U) • Fire – Worst Case (U)			• Design Basis Earthquake (EU)	
SRS SWMF	• ***TRU Pads - Internal Culvert Drum Fire (U)***	• ***TRU Pads - Culvert Explosion (U)***	• TRU Pads - High Energy Vehicle Impact (EU) • ***TRU Pads - Dropped Steel Box (A)***	• TRU Pads -Tornado (EU)	• 634-7E Buried Waste Helicopter Crash (EU)
Hanford WRAP Facility	• *4 Drum Fire (U)* • *Single Drum Fire in Glovebox (U)*	• ***Drum Explosion with 4 Drum Fire (U)*** • *Single Drum Explosion in Glovebox (U)*	• Solid Waste Box Failure (A)	• ***Design Basis Earthquake (U)*** • Beyond DBE (EU)	
INEEL RWMC	• ***Vehicle Fire (U)***	• *Drum Explosion (A)*	• *Box Spill (A)*	• Design Basis Earthquake (U)	
LANL RAMROD Facility	• Small Fire (A) • Medium Fire (EU) • Large Fire (EU)	• Small Natural Gas Explosion (A) • Large Natural Gas Explosion (EU)	• Coring Glovebox Spill (A)	• Design Basis Earthquake (U)	• Aircraft Crash (EU)

Note: Scenarios in *Italics* are risk dominant events, based on Risk Class I or II for the collocated worker. ***Bold Italics*** denotes that it is also risk dominant for the public.

Task 3 – D&D Knowledge Management Information Tool (D&D KM-IT)

Site Needs:

To prevent the loss of the collective knowledge from the aging workforce, the need to collect, retain and disseminate knowledge in an organized and structured way through the development and maintenance of a universally available and usable knowledge management system was identified by EM.

Year 7 Objectives:

To attain the long-term active use, operation, and continued growth of the D&D knowledge from across the D&D global community and capture within the D&D KM-IT system resulting in enhanced worker safety, improved operational efficiencies, improved communication & knowledge among stakeholders, and the cross-generational transfer of D&D knowledge to the future workforce.

Present Tasks:

- System development and enhancement
- Addition of current and relevant data and management of existing content
- Outreach and marketing

Task 3 – D&D Knowledge Management Information Tool (D&D KM-IT)

Accomplishments Year 7:

- Addition of current and relevant data to the D&D KM-IT system, including news items, additional vendors, and technologies.
- Performance of website analytics and reporting to track usage metrics.
- Oral presentation and live demonstrations at WM17
- Development of newsletters and infographics relevant to the D&D community
- Deployment of a pilot native mobile application for the D&D Fixatives Module

www.dndkm.org

Task 3 – Knowledge Management Information Tool (D&D KM-IT)

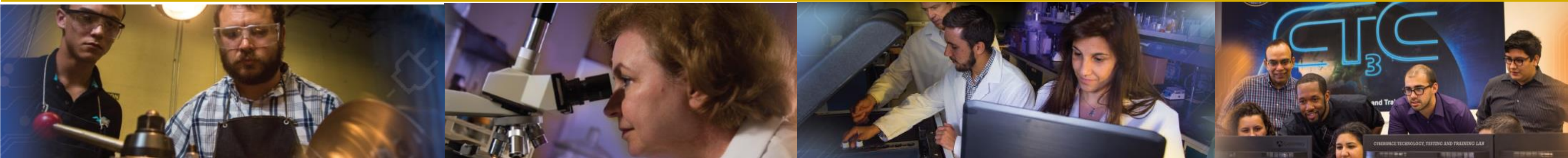
Proposed Scope for Year 8

- Outreach and Marketing
  - Participation in industry conferences and workshops
  - Newsletters and mass communications (e.g., online promotion)
  - Social media integration and support
  - User support, including requested ad hoc specialized reporting
- KM-IT Development and Enhancement
  - Expand KM-IT to additional knowledge areas of high interest to programmatic areas of EM
  - Develop pilot modules for the new knowledge area(s) using existing platform
- Mobile Native Application Development
  - Expand on the pilot mobile native application for android platforms performed in FIU Performance Year 7 (fixatives module) to other platforms (e.g., Windows, Apple)
- Content Management
  - Publish additional technologies and vendors on the KM-IT platform
  - Update News, Training, Document Library and other sections of KM-IT
- Data Analytics
  - Google analytics, visualization, server log analysis, and metrics reporting
  - Text data mining research

FIU PROJECT 4: DOE-FIU SCIENCE AND TECHNOLOGY WORKFORCE DEVELOPMENT PROGRAM

Leonel Lagos

Florida International University



FIU Personnel and Collaborators

Principal Investigator: Leonel Lagos

Program Manager: Leonel Lagos

Faculty/Staff: Ravi Gudavalli, Walter Quintero, Clint Miller, Peggy Shoffner

DOE Fellows/Students: Max Edrei, Sebastian Zanlongo, Clarice Davila, Michael DiBono, Alejandro Garcia, Alejandro Hernandez, Alexis Smoot, Awmna Kalsoom Rana, Christine Wipfli, Hansell Gonzalez, Silvina Di Pietro, Sarah Solomon, Mohammed Albassam, Frances Zengotita, Juan Morales, Ripley Raubenolt, Ron Hariprashad, Jesse Viera, Alexander Piedra, Andres Cremisini

DOE-EM: Mary Ann Maloney, Junita Turner, Andre Fordham, Andy Szilagyi, John De Gregory, Rod Rimando, Genia McKinley

DOE National Laboratories

Program Description

FIU's Applied Research Center (ARC) and the US Department of Energy's Office of Environmental Management have established a workforce development program for the training of FIU STEM, minority students in an effort to create a "*pipeline*" of scientists and engineers that will enter DOE's workforce upon completing their degrees and research at FIU.

Workforce Development Program

Site Needs:

A significant portion of the EM workforce, including DOE as well as contractors, is at or nearing retirement age, contributing to a shortage of a well-trained technical workforce to continue EM's mission.

Year 7 Objectives:

Providing a pipeline of FIU STEM minority students trained and mentored to enter the DOE workforce in technical areas of need - the DOE Fellows traineeship program.

Present Tasks:

- Recruitment of qualified talented FIU minority STEM students as new DOE Fellows
- Engagement in DOE EM research (Projects 1, 2, 3)
- Poster exhibition & competition
- Annual DOE Fellows induction ceremony
- Summer internship program and summer internship technical reports
- Conference participation & presentations
- DOE Fellows lecture series forum
- Promote career opportunities

FIU Applied Research Center

Workforce Development Program

Accomplishments Year 7:

- Provided hands-on research at FIU
- Started 12 internships for summer 2017 for a total of 120 internships
- DOE Fellow completed a one year internship with IAEA
- Conducted the 10th induction ceremony for a total of 131 inducted as DOE Fellows
- Fellows participated in WM17 and several other conferences and events. Have presented over 205 papers and posters at national/international conferences
- Held the 10th DOE Fellow Poster Exhibition at FIU at which 157 research posters have been presented.

FIU Applied Research Center

Merlin Ngachin

Former DOE Fellow, **Mr. Merlin Ngachin (DOE Fellow Class of 2007)**, accepted a position at the Department of Energy's Argonne National Lab as Sr. Health Physicist. Merlin previously held a Sr. Health Physicist position at Waste Control Specialists (WCS), a facility in Andrews County, Texas, that ensures safe and permanent disposal of radioactive waste.

Duriem Calderin

Former DOE Fellow, **Mr. Duriem Calderin (DOE Fellow Class of 2008)**, accepted a position at the Department of Energy's Pacific Northwest National Lab as a Sr. Nuclear Risk Specialist as part of the Risk and Decisions Science Group. Prior to PNNL, Duriem worked for Bechtel, AREVA, and Columbia Energy in Richland, WA.

Workforce Development Program

Proposed Scope for Year 8

Active hands-on research assisting ARC scientists/engineers during the execution of DOE-EM research - integrating education with practical experience in the DOE EM problem areas.

- Recruitment of qualified talented FIU minority STEM students
- Engage in DOE EM research (Projects 1, 2, 3)
- Poster exhibition & competition (October 2017)
- Annual DOE Fellows induction ceremony (November 2017)
- Summer internship program
- Summer internship technical reports
- Conference participation & presentations, including WM Symposia 2018
- DOE Fellows lecture series forum
- DOE EM HBCU collaboration/interactions
- Extend recruitment to include HBCU/MSI students interested in PhD at FIU
- Work closely with DOE nat. labs to identify opportunities for PhD students
- Identify extended work assignments for FIU graduate students at DOE nat. labs that can lead to post-doctoral positions