YEAR END TECHNICAL REPORT
August 29, 2016 to September 28, 2017

Waste and D&D Engineering and Technology Development

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FIU | Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

Addendum:

This document represents one (1) of four (4) reports that comprise the Year End Reports for the period of August 29, 2016 to September 28, 2017 prepared by the Applied Research Center at Florida International University for the U.S. Department of Energy Office of Environmental Management (DOE-EM) under Cooperative Agreement No. DE-EM0000598.

The complete set of FIU's Year End Reports for this reporting period includes the following documents:

Project 1: Chemical Process Alternatives for Radioactive Waste
Document number: FIU-ARC-2017-800006470-04b-255

Project 2: Environmental Remediation Science and Technology
Document number: FIU-ARC-2017-800006471-04b-254

Project 3: Waste and D&D Engineering and Technology Development
Document number: FIU-ARC-2017-800006472-04b-245

Project 4: DOE-FIU Science & Technology Workforce Development Initiative
Document number: FIU-ARC-2017-800006473-04b-253

Each document will be submitted to OSTI separately under the respective project title and document number as shown above. In addition, the documents are available at the DOE Research website for the Cooperative Agreement between the U.S. Department of Energy Office of Environmental Management and the Applied Research Center at Florida International University: http://doeresearch.fiu.edu

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PROJECT 3 OVERVIEW

The Waste and D&D Engineering and Technology Development Project (Project 3) focuses on delivering solutions under the waste, D&D and IT areas for the DOE Office of Environmental Management. This work is also relevant to D&D activities being carried out at other DOE sites such as Oak Ridge, Savannah River, Hanford, Idaho and Portsmouth and international efforts being conducted by EM with the Nuclear Decommissioning Authority (NDA) in England and the International Atomic Energy Agency (IAEA). This project included the following tasks during the August 29, 2016 to September 28, 2017 period of performance:

Task 1: Waste Information Management System (WIMS)

This task provides direct support to DOE EM for the management, development, and maintenance of a Waste Information Management System (WIMS). WIMS was developed to receive and organize the DOE waste forecast data from across the DOE complex and to automatically generate waste forecast data tables, disposition maps, GIS maps, transportation details, and other custom reports. WIMS is successfully deployed and can be accessed from the web address http://www.emwims.org. The waste forecast information is updated annually. WIMS has been designed to be extremely flexible for future additions and is being enhanced on a regular basis.

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

This task provides direct support to DOE EM for D&D technology innovation, development, evaluation and deployment. FIU focused on assisting DOE EM in meeting the D&D needs and technical challenges around the DOE complex. FIU concentrated its efforts during FIU Performance Year 7 on working with the Savannah River Site to identify and evaluate innovative technologies in support of the SRS 235-F project. FIU further supported the EM international program and the EM Infrastructure and D&D program by participating in D&D workshops, conferences, and serving as subject matter experts.

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

The D&D Knowledge Management Information Tool (KM-IT) is a web-based system developed to maintain and preserve the D&D knowledge base. The system was developed by Florida International University's Applied Research Center (FIU-ARC) with the support of the D&D community, including DOE EM, the former ALARA centers at Hanford and Savannah River, and DOE's Energy Facility Contractors Group (EFCOG). The D&D KM-IT is a D&D community driven system tailored to serve the technical issues faced by the D&D workforce across the DOE Complex. D&D KM-IT can be securely accessed from web address https://www.dndkm.org. The mobile version of the system can be accessed from https://m.dndkm.org.

TASK 1.
DOE'S WASTE INFORMATION MANAGEMENT SYSTEM

TASK 1: EXECUTIVE SUMMARY

For Task 1, FIU has developed a Waste Information Management System (WIMS) to receive and organize the DOE waste forecast data from across the DOE complex and to automatically generate waste forecast data tables, disposition maps, and other displayed reports.

TASK 1: INTRODUCTION

The Applied Research Center (ARC) at Florida International University (FIU) in Miami, Florida, has completed the deployment of a fully operational, web-based forecast system: the Waste Information Management System (WIMS). WIMS is designed to receive and organize the DOE waste forecast data from across the DOE complex and to automatically generate waste forecast data tables, disposition maps, and other displayed reports. This system offers a single information source to allow interested parties to easily visualize, understand, and manage the vast volumes of the various categories of forecasted waste streams in the DOE complex. The successful web deployment of WIMS with waste information from an initial 24 DOE sites occurred in May 2006. Annual waste forecast data updates are added to ensure the long-term viability and value of this system. Individuals may visit the web site at http://www.emwims.org/.

TASK 1: EXPERIMENTAL

The initial requirement from DOE Headquarters was to consolidate waste forecast information from separate DOE sites and build forecast data tables, disposition maps and GIS maps on the web. An integrated system was needed to receive and consolidate waste forecast information from all DOE sites and facilities and to make this information available to all stakeholders and to the public. As there was no off-the-shelf computer application or solution available for creating disposition maps and forecast data, FIU built a DOE complex-wide, high performance, n-tier web-based system for generating waste forecast information, disposition maps, GIS Maps, successor stream relationships, summary information and custom reports based on DOE requirements. This system was built on Microsoft.net framework1.1 and SQL server 2005. Visual Studio 2003, SQL server reporting services, Dream Weaver and Photoshop were also used as development tools to construct the system. Since the initial requirements were met, additional features have been developed and deployed on WIMS.

TASK 1: RESULTS AND DISCUSSION

FIU regularly performed database management, application maintenance, and performance tuning of queries and indexes of WIMS in order to ensure a consistent high level of database and web application performance. New waste forecast and transportation forecast data is imported into WIMS on an annual basis.

The 2017 waste forecast and transportation data was collected, reviewed, and transmitted from DOE to FIU on March 18, 2017. The revised waste forecast data was received as formatted data files and, to incorporate these new files, FIU built a data interface to allow the files to be

received by the WIMS application and import it into SQL Server, the database server where the actual WIMS data is maintained. FIU then modified the WIMS modules (Forecast, Disposition Map, GIS, and Transportation) to incorporate the new data set. FIU completed the data import and deployed it onto the test server for DOE testing and review on April 27, 2017. FIU received approval from the DOE data review and deployed the new data on the public server on May 10, 2017. The 2017 data set included low-level and mixed low-level radioactive waste forecast data and transportation information supplied by all DOE programs.

The data in WIMS can be viewed by site managers, stakeholders, and interested members of the public. Anyone with internet access may register and use WIMS (http://www.emwims.org).

Figure 1 provides a screenshot of the GIS map displaying the 2017 data update and Figure 2 provides a screenshot of the waste disposition map displaying the 2017 data update.

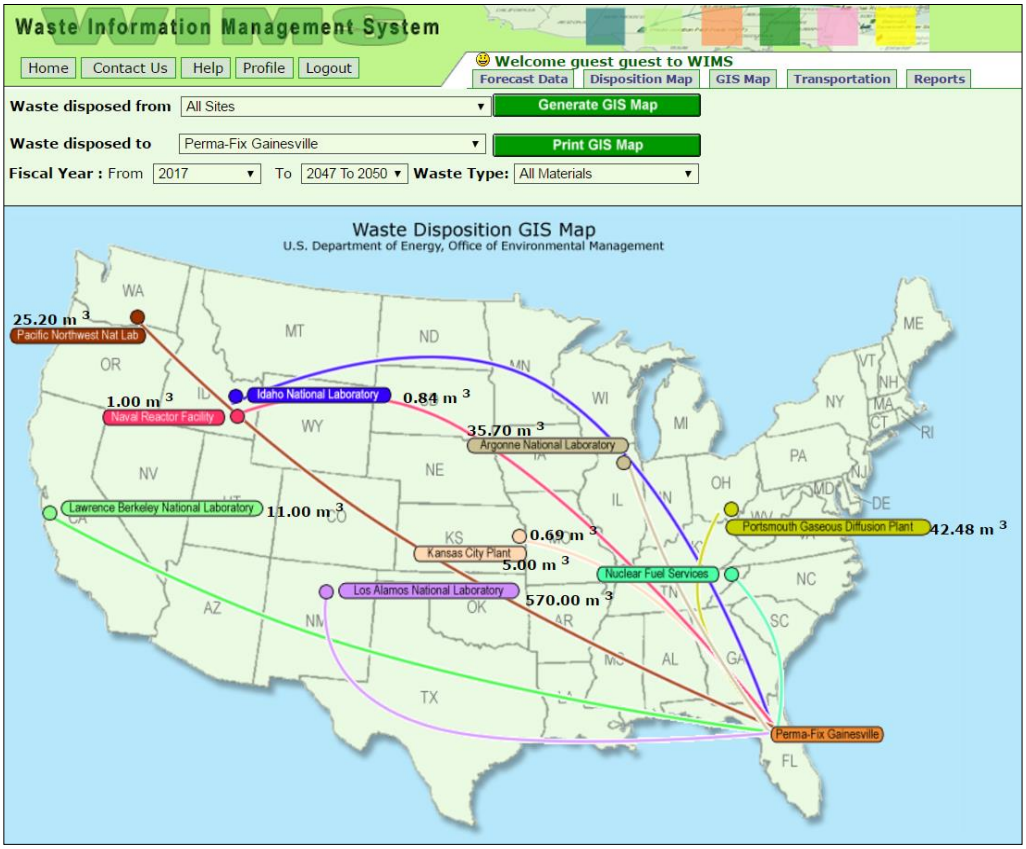

Figure 1. WIMS screenshot displaying new 2017 data set as GIS map.

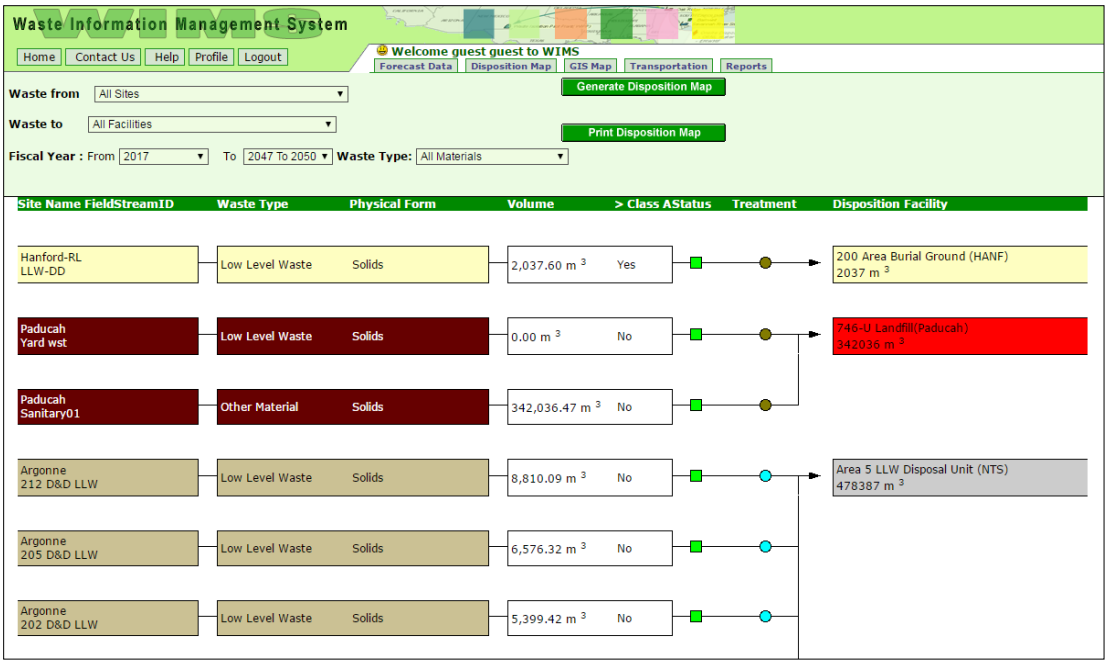

Figure 2. WIMS screenshot displaying new 2017 data as a waste disposition map.

WIMS Picklists for Querying Forecast Data

Upon entrance into WIMS, the information for display as a forecast data table, a disposition map, or a GIS map can be filtered in many ways through the provided drop-down menus. The updated filtration choices for each field of data are shown in the following lists. The fiscal year ranges are adjusted forward one year with each annual data update.

Waste type:

- All Materials
- Unknown
- Low Level Waste
- Mixed Low Level Waste
- 11e.(2) Byproduct Material
- Other Material

Fiscal Year:

- 2017
- 2018
- 2019
- 2020
- 2021
- 2022-2026
- 2027-2031
- 2032-2036
- 2037-2041
- 2042-2046
- 2047-2050

Waste from:

- All Sites
- Ames Laboratory
- Argonne National Laboratory
- Bettis Atomic Power Laboratory
- Brookhaven National Laboratory
- Energy Technology Engineering Center
- Fermi National Accelerator Lab
- Hanford Site – RL

- Hanford Site – RP
- Idaho National Laboratory
- Kansas City Plant
- Knolls Atomic Power Laboratory – Kesselring
- Knolls Atomic Power Laboratory – Schenectady
- Lawrence Berkeley National Lab
- Lawrence Livermore National Lab
- Los Alamos National Laboratory
- Naval Reactor Facility
- Nevada Test Site
- NG Newport News
- Norfolk Naval Shipyard
- Nuclear Fuel Services, Inc.
- Oak Ridge Reservation
- Pacific Northwest National Laboratory
- Paducah Gaseous Diffusion Plant
- Pantex Plant
- Pearl Harbor Naval Shipyard
- Portsmouth Gaseous Diffusion Plant
- Portsmouth Naval Shipyard
- Princeton Plasma Physics Laboratory
- Puget Sound Naval Shipyard
- Sandia National Laboratories – NM
- Savannah River Site
- Separations Process Research Unit
- Stanford Linear Accelerator Center
- Thomas Jefferson National Accelerator Facility
- Waste Isolation Pilot Plant
- West Valley Demonstration Project

Waste to:

- All Facilities
- 200 Area Burial Ground (HANF)
- 746-U Landfill (Paducah)
- Area 5 LLW Disposal Unit (NTS)
- Area 5 MLLW Disposal Cell (NTS)
- Clean Harbors
- Commercial TBD
- E-Area Disposal (SRS)
- EMWMF Disposal Cell (ORR)
- Energy Solutions-Clive (formerly Envirocare)
- Energy Solutions-TN (formerly GTS Duratek)
- ERDF (HANF)
- Impact Services - TN
- INL CERCLA Cell (INL)
- Integrated Disposal Facility (HANF)
- New RH LLW Vaults (INL)
- ORNL Liquid LLW System
- OSWDF (Portsmouth)
- Paducah CERCLA
- Paducah WW Trt
- Perma-Fix Gainesville
- Perma-Fix-Diversified Scientific Services, Inc.
- Perma-Fix-Northwest (formerly PEcoS)
- Perma-Fix-Materials & Energy Corp
- River Metals
- RMW Trenches (MLLW/LLW)(HANF)
- RMW Trenches/IDF (HANF)
- RWMC (LLW disposal) (INL)
- Siemens
- Smokey Mountain Solutions
- Studsvik/RACE, LLC
- TA 54/Area G (LLW disposal) (LANL)
- To Be Determined
- Waste Control Specialists

Waste Management Conference

FIU also participated in relevant meetings and conferences in support of this project. FIU completed an abstract in August 2016 and a technical paper in November 2016 for WIMS and submitted these to the Waste Management Symposium 2017 (WM17). WM17 accepted the

technical paper and FIU prepared and made a professional technical presentation on "Waste Information Management System with 2016-17 Waste Streams" during session 72: Decisionmaking Tools and Frameworks that Enhance Communication for ER Cleanup Programs, at the Waste Management Symposium on March 7, 2017, to communicate to the D&D community new updates to the system during the last year.

TASK 1: CONCLUSIONS

WIMS continues to successfully accomplish the goals and objectives set forth by DOE for this project. WIMS has replaced the historic process of each DOE site gathering, organizing, and reporting their waste forecast information utilizing different database and display technologies. In addition, WIMS meets DOE's objective to have the complex-wide waste forecast information available to all stakeholders and the public in one easy-to-navigate system. The data includes low-level and mixed low-level radioactive waste forecast data supplied by all DOE programs in addition transportation information.

TASK 1: REFERENCES

Office of Environmental Management (DOE-EM), http://www.em.doe.gov, U.S. Department of Energy.

Waste Information Management System (WIMS), http://www.emwims.org, Applied Research Center, Florida International University.

Upadhyay, H., W. Quintero, P. Shoffner, L. Lagos, *Waste Information Management System with 2016-17 Waste Streams*, Waste Management 2017 Conference, Phoenix, AZ, March 2017.

TASK 2. D&D SUPPORT FOR DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT

TASK 2: EXECUTIVE SUMMARY

This task provides direct support to DOE EM for D&D technology innovation, development, evaluation and deployment. FIU focused on assisting the DOE Office of Infrastructure and D&D (EM-4.11) in meeting the D&D needs and technical challenges around the DOE complex. FIU concentrated its efforts during FIU Performance Year 7 on working with the Savannah River Site to identify and evaluate innovative technologies in support of the SRS 235-F project. FIU further supported the EM International Program and the EM Infrastructure and D&D Program by participating in D&D workshops, conferences, and serving as subject matter experts.

TASK 2: INTRODUCTION

FIU directly supports DOE-EM's Office of Infrastructure and D&D as well as affiliated DOE sites, national laboratories, and institutions contributing to the development of innovation in D&D. This task also collaborates with DOE-EM's international partnerships and agreements, when appropriate, by providing D&D expertise, knowledge and support. The technical approach for this task is to identify, test and evaluate new technologies, methodologies, and approaches to support the D&D of facilities across the globe. In this report, FIU will present the accomplishments achieved during FIU Performance Year 7 in support of technology innovation, development, evaluation and deployment.

TASK 2: EXPERIMENTAL

For FIU Performance Year 7**,** FIU expanded its research in technology development, demonstration and evaluation in the following key areas: 1) performing testing and evaluation of intumescent coatings technologies with the objective of enhancing the stabilization of radioactive contamination and fire resiliency and protection for fixatives and facilities in support of D&D activities at SRS 235-F and across the DOE EM complex; 2) implementing a phased approach for the standards development, testing, evaluation, and deployment of D&D technologies, with an emphasis working with ASTM International E10 Committee on Nuclear Technologies and Applications to develop testing protocols and performance metrics for testing and evaluating D&D technologies; and 3) investigating cross-cutting applications of robotic technologies from FIU's high-level waste research area (Project 1) in support of D&D activities. FIU also participated in workshops and conferences and served as subject matter experts.

TASK 2: RESULTS AND DISCUSSION

Adaptation of Intumescent Coatings

The objective of this research task is to improve the operational performance of fixatives to mitigate the release of radioisotopes during fire and/or extreme heat conditions. During FIU

Performance Year 5, FIU worked closely with SRNL to define the technical requirements for achieving this objective, identified a select list of contamination control products for testing, and baselined the selected products. The results indicated that the commercially available fixatives tested see significant degradation at heat conditions starting between 200-400ºF, at which time radioisotopes could potentially be released into the environment. Based on these results, FIU continued to collaborate with SRNL during FIU Performance Year 6 to expand the research into other commercial products being used by other agencies and industries to maximize fire resiliency. Intumescent coatings (ICs) were identified as a promising area for research. FIU procured the selected IC products and performed testing and evaluation with the following main objectives: 1) to determine the fire resiliency of each selected product; and 2) to perform basic proof-of-concept testing for layering a contamination control product with a fire retardant product to improve performance during fire resiliency tests. This testing showed that the initial hypothesis was correct, specifically that the fire resiliency of fixatives can be enhanced through the layering/combining of an intumescent coating. Additionally and equally promising, the results helped identify the possibility of some commercial-off-the-shelf ICs to function as standalone fixatives, in and of themselves, that could assist with managing the safety basis at SRS 235-F.

For FIU Performance Year 7, FIU continued the research and development associated with the adaptation of intumescent coatings to enhance fire resiliency and protection for fixatives and facilities in support of D&D activities at SRS 235-F. FIU performed a series of tests to subject test coupons of intumescent coatings (IC) to increasing temperatures using a muffle furnace along with adhesion and impact testing of these test coupons on various types of substrates, both before and after exposure to extreme heat conditions.

There is no specific adhesion test designed to evaluate fixative technologies, particularly those with characteristics similar to the FD intumescent coating (an elastomeric coating). To accommodate the gap, FIU ARC explored the feasibility of two “best fit” protocols: 1) *ASTM D3359: Standard Test Methods for Rating Adhesion by Tape Test*, and; 2) *ASTM D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*.

Utilizing the testing protocols outlined in ASTM D3359, FIU first conducted a series of adhesion tests on 4"x4" stainless steel coupons prepared under environmentally controlled conditions at 72ºF and 43% humidity. Adhesion tests were conducted before and after subjecting the test coupons to extreme heat conditions in a muffle furnace at temperatures between 600-800ºF for 15 minute periods.

The intumescent coating (FX) exhibited superior initial results both before and after exposure to extreme heat. FX demonstrated exceptional adhesion properties to the stainless steel coupons, yielding little to no adhesion loss from the substrate (0-5%) both before and after exposure.

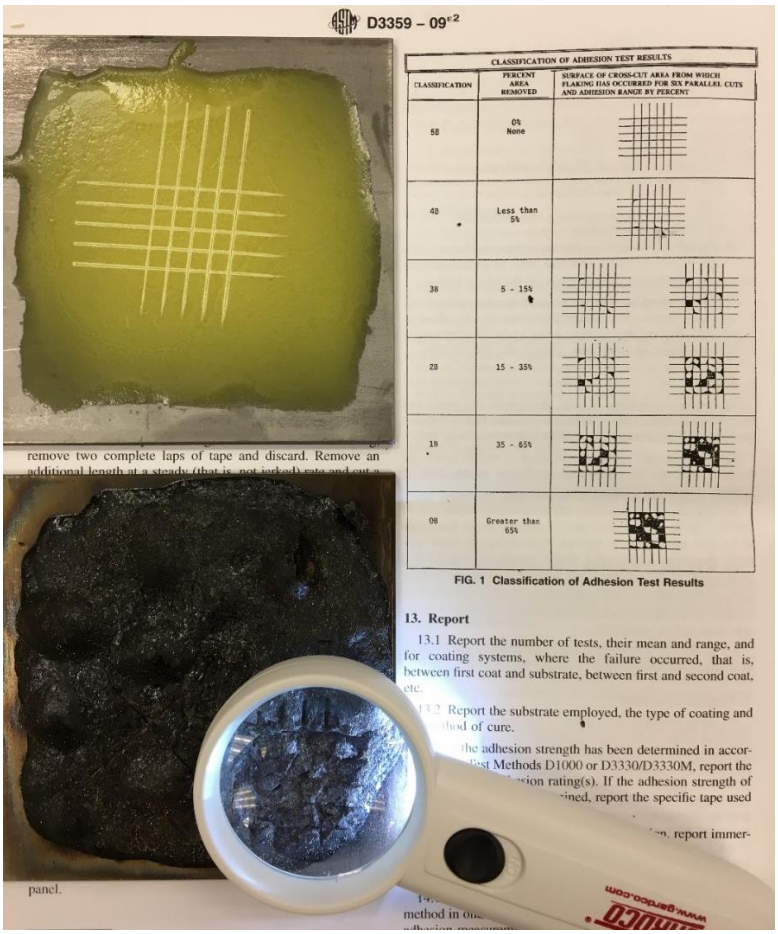

Figure 3. FIU is using ASTM standard testing protocols to measure the adhesion of an intumescent coating on test coupons before (top) and after (bottom) extreme heat conditions.

FIU then expanded the testing to stainless steel coupons that were prepared and cured under adverse environmental conditions with temperatures greater than 90ºF and humidity ranging from 60-90%. The stainless steel substrates were placed outdoors in ARC's hot cell test bed for 1-week to acclimatize them to the environmental conditions. Temperatures during this period averaged approximately 94ºF and 78% humidity. The two selected intumescent coatings were then applied to the stainless steel coupons in the hot cell, to the manufacturer's thickness specifications, under the same environmental conditions (no primer was applied) and allowed to cure. The coupons remained outdoors under these conditions for a period of two months, at which time they were collected from the hot cell test bed and ASTM D3359 adhesion tests were conducted.

As noted in the figures below, the first IC (identified as FX) exhibited no noticeable degradation in terms of adhesion to the stainless steel substrate with 0% removal from the substrate during the adhesion stress test. These results mirror those encountered when testing was executed under ideal laboratory conditions. However, some discoloration was noted. The adhesion stress tests on the second IC (identified as FD) coupons resulted in approximate 55% removal of the coating from the substrate (see figures below). This result is almost identical to the results received under ideal, laboratory conditions. No discoloration was noted. However, after 6 months of exposure to

the adverse environmental conditions outlined above, the FX intumescent coating began to delaminate from the stainless steel coupons, while the FD intumescent coating remained intact. Thus, the longer exposure to the same adverse environmental conditions yielded completely different results than the short-term exposure observations.

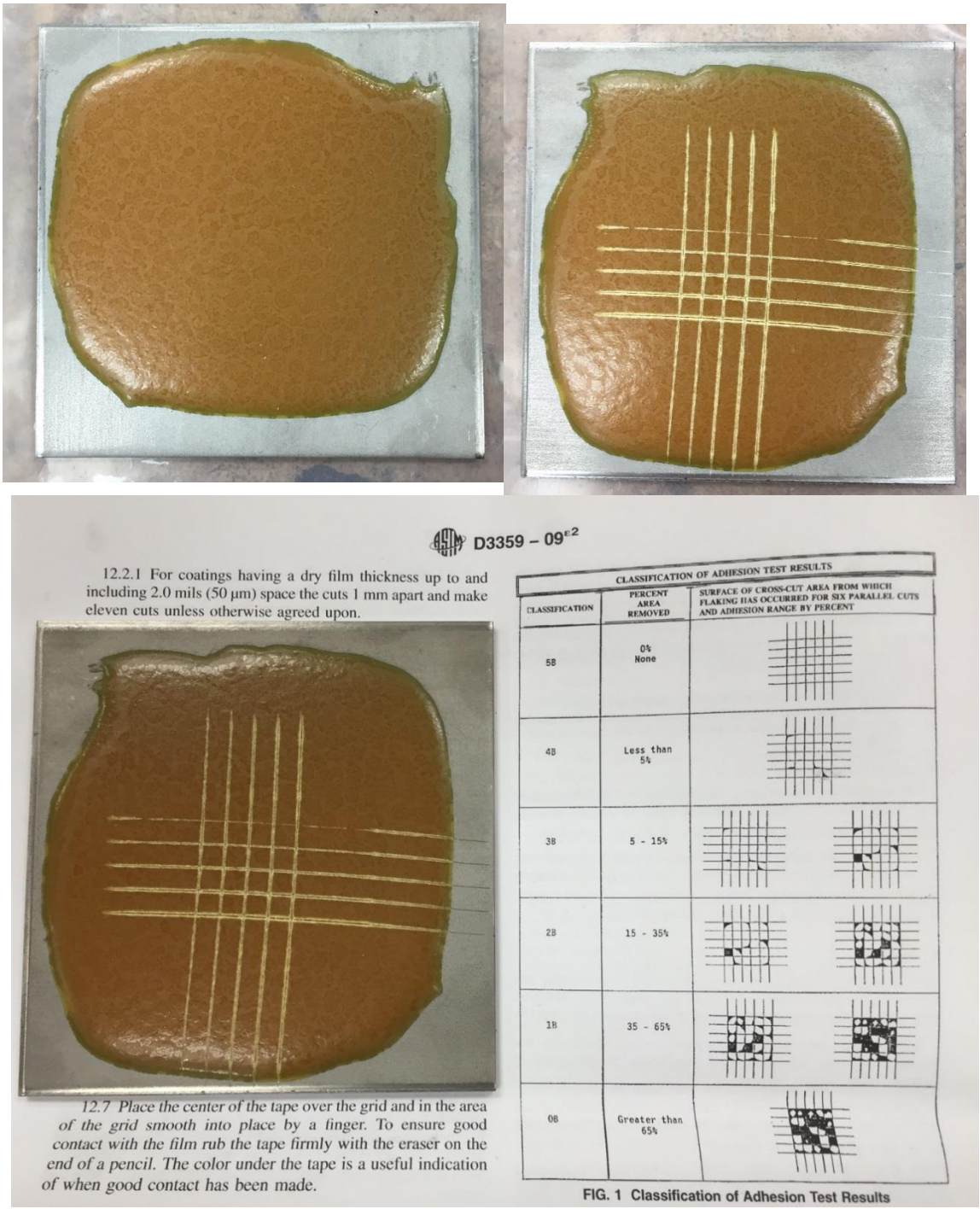

Figure 4. FX intumescent coating test coupon (top left), cross-cuts into IC (top right), classifying the adhesion test results per ASTM D3359 (bottom).

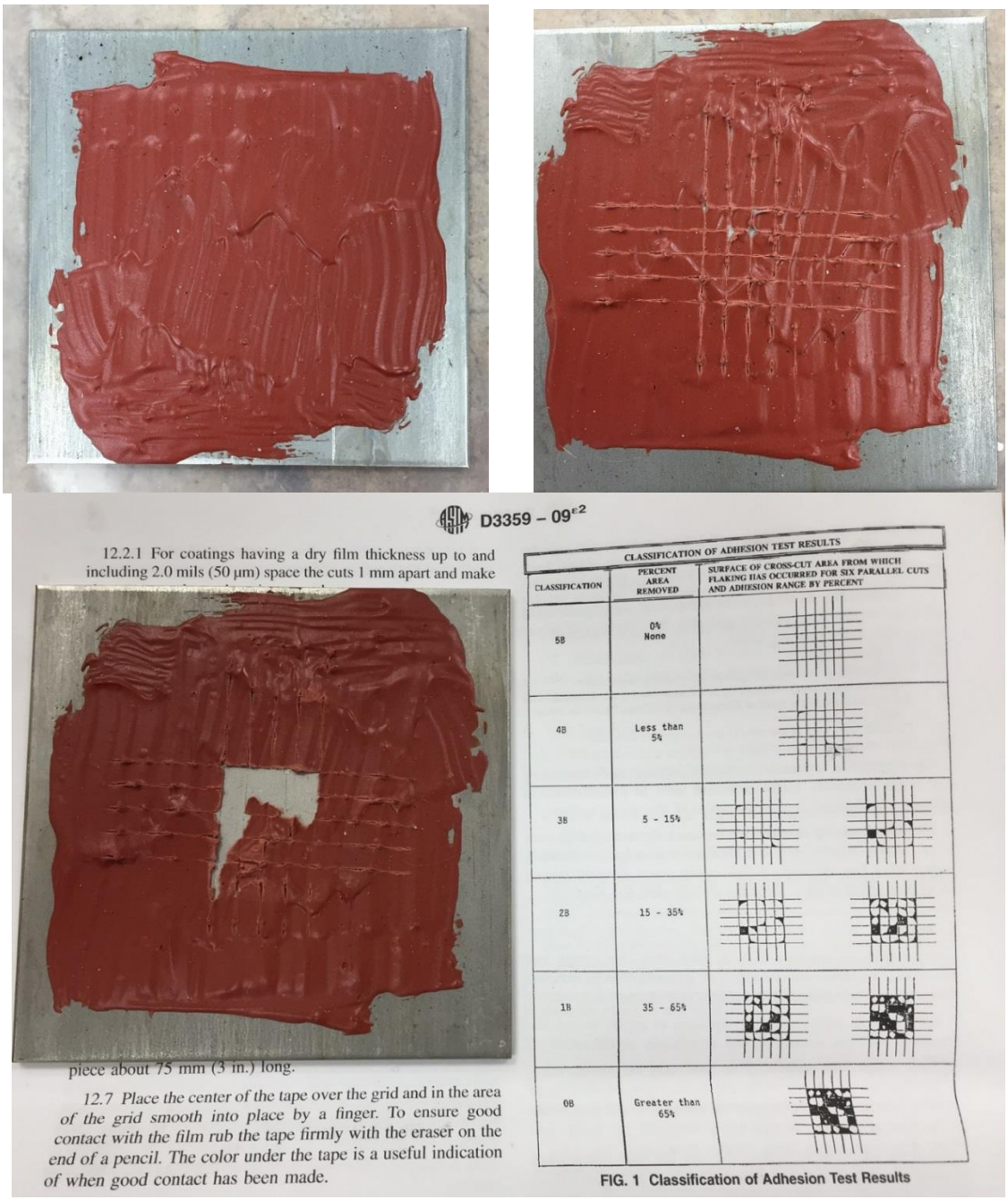

Figure 5. FD intumescent coating test coupon (top left), cross-cuts into IC (top right), classifying the adhesion test results per ASTM D3359 (bottom).

These results were discussed extensively with SRNL researchers and others across the DOE EM complex, and the general consensus was that specifically designed protocols for testing adhesion properties of fixatives and intumescent coatings intended to support D&D activities was needed. This research effort also highlighted the fact that even "best fit" testing protocols have limitations and reinforces the need to continue to press forward with the development of uniform standards and testing protocols through international standards organizations (ASTM, NIST, ANS, ISO, etc.).

Robotic Technologies for D&D Applications

The SRS 235-F facility has a need to identify a remote system that can make one-time entry to highly contaminated areas. The one-time-entry requirement indicates that the technology will not be retrieved at the end of the work but would remain inside the facility due to the high levels of contamination. As part of this subtask during FIU Performance Year 6, FIU performed research to identify robotic technology systems applicable to the challenges and needs of the SRS 235-F Facility. Research utilized the Robotic Database in D&D KM-IT to search and identify potential robotic technologies and compiled a spreadsheet of all of the available robotic technologies in the database.

During FIU Performance Year 7, FIU leveraged the research already completed to begin identifying cross-cutting applications of robotic technologies being developed at FIU in the high-level waste research area that could potentially be used in support of D&D activities. On December 1, FIU conducted a teleconference with the research collaborators at SRNL to begin identifying the potential requirements for robotic applications in support of D&D activities at SRS 235-F. FIU briefly presented the robotic technologies currently being developed under the high level waste activities (Project 1) and opened the discussion to ways in which one or more of these technologies could be used in support of D&D activities at the site.

During the May visit from the Project Engineer for the SRS 235-F facility as well as our research collaborators from SRNL, FIU conducted a detailed discussion concerning potential cross-cutting applications of ARC's robotic efforts for D&D activities in support of the SRS 235-F hot cell project. While no specific requirements / applications were identified from this discussion, a potential requirement for a remote dry film thickness gauge capability was later identified based on initial observations and findings during the execution of the Incombustible Fixatives Test Plan. Determining the precise thickness of fixatives applied in restricted spaces and confirming they are within specified parameters throughout the area has proven exceptionally challenging. It is possible that one of ARC's remote / robotic platforms could be modified and paired with a dry film thickness gauge to validate the thickness of the fixative application throughout the radioactive space.

ARC continued investigating this concept via a literature/industry search on the sensor technologies currently available for determining fixative coating thickness and explored the potential for integrating a sensor into the small wall crawler being developed at ARC. A conceptual CAD design for the integrated technology with the objective of measuring coating thickness on the hot cell wall and floor is being developed as well as available coating thickness sensors are being evaluated.

FIU has briefly investigated different communication methods between microcontrollers and sensors, searching for a better alternative for tether construction. For this task, FIU is planning to use a controller area network (CAN bus) in the tether design. The conceptual design is based on an existing wall climbing platform currently being developed at FIU. The existing technology, shown in the following figure, has the potential to be successfully deployed to measure thickness of fixative coatings.

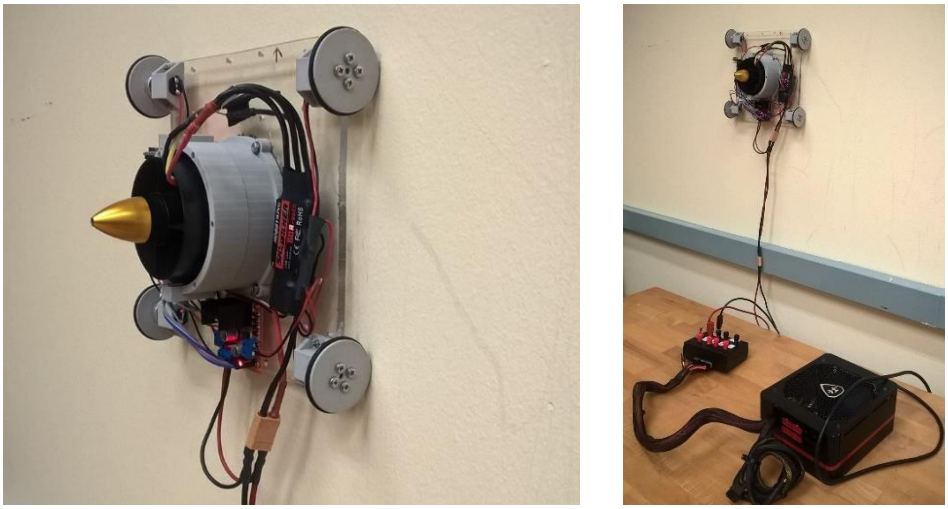

Figure 6. FIU wall crawler technology.

The conceptual design shown in the figure below is an articulate wall crawler developed to climb walls and ceilings as well as transition between floor-and-wall, wall-and-wall, and wall-and-ceiling. The tool will also be capable of mapping the inside of the hot cell, overcoming obstacles, and potentially carrying additional instrumentation.

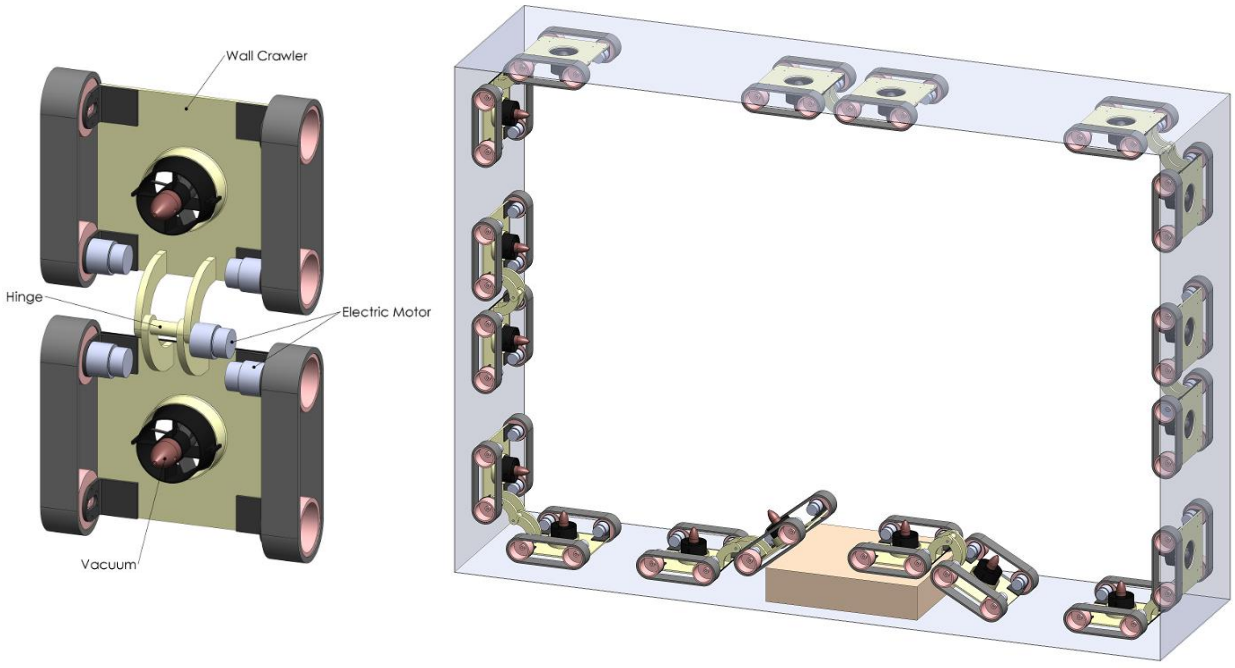

Figure 7. Wall crawler conceptual design.

The next figure shows the sensor currently being used at FIU to measure coating thickness. The device is a fully electronic coating thickness gauge that uses magnetic and eddy current principles on both ferrous and non-ferrous metals.

Figure 8. PosiTector 6000 coating thickness gage.

The current electronic coating thickness gauge is accurate and versatile. However, in the current package and size, it will be difficult to deploy. The typical fixative thickness is around 1/8th of an inch, and the team is researching alternative sensors suitable for integration and deployment. The conceptual design will be completed as part of the carryover scope in FIU Performance Year 8.

Technology Demonstration and Evaluation

The primary objective of this task is to standardize and implement proven processes to refine and better synchronize DOE-EM technology needs, requirements, testing, evaluation, and acquisition by implementing a three-phased technology test and evaluation model. The development of uniformly accepted testing protocols and performance metrics is an essential component for testing and evaluating D&D technologies.

Uniform Testing Protocols and Performance Metrics for D&D

The development of uniformly accepted testing protocols and performance metrics is an essential component for testing and evaluating D&D technologies. As highlighted in the section above on adhesion testing, the "best fit" testing protocols have limitations, and reinforces that the requirement to develop uniform standards and testing protocols for D&D technologies through international standards organizations (ASTM, NIST, ANS, ISO, etc.) is critical.

During FIU Performance Year 6, an FIU representative obtained official membership on ASTM International's E10 Committee on Nuclear Technologies and Applications and was selected to lead the ASTM International E10.03 Subcommittee. In this position, FIU oversaw the development of two (2) new draft standard specifications for removable/strippable coatings and permanent coatings/fixatives.

During FIU Performance Year 7, FIU continued to work with the Subcommittee membership to develop uniformly accepted testing protocols and performance metrics as an essential component for testing and evaluating D&D technologies. These efforts will help to ensure that the FIU three-phased Technology Test and Evaluation Model is uniform in its application and defensible in its findings and results.

FIU performed detailed planning, developed the meeting agenda, and chaired the ASTM International E10.03 Subcommittee on Radiological Protection for Decontamination and Decommissioning for Nuclear Facilities and Components, on January 29 to February 1, 2017 in Norfolk, VA. During this meeting, both of the draft standard specifications were modified based on comments from the various sites to better align the requirements with the source term formula, particularly in the technical areas related to measuring a fixative's impact on the airborne release fraction (ARF) and respirable fraction (RF) before and after being subjected to thermal and seismic stressors.

The Subcommittee then submitted the two (2) draft standard specifications which were released for a formal Subcommittee ballot on February 23, 2017. The voting period for the E10.03 Subcommittee concluded on March 23, 2017. The 71% return rate surpassed the requirement to have at least 60% of the Subcommittee membership return a ballot. Both standards were unanimously approved by the Subcommittee members, with only minor editorial comments suggested for the revision.

Figure 9. Photo shows Joseph Sinicrope (FIU ARC) and Dr. Connor Nicholson (SRNL) at the ASTM International Conference.

The first full ASTM International E10 Committee balloting for the two (2) standard specifications on fixative technologies ended on May 1, 2017. FIU attended the ASTM International Conference on June 19-22, 2017, and chaired the E10.03 Subcommittee. All comments received from the full ASTM International E10 Committee in May for the two (2) standard specifications on fixative technologies were successfully adjudicated and incorporated where deemed appropriate. The final revisions were further approved by the ASTM International Staff Manager and Editorial Board.

On July 24, 2017, ASTM International's E10 Committee on Nuclear Technology and Applications published the two new international standard specifications for fixative technologies that aim to immobilize radioactive contamination, minimize worker exposure, and protect uncontaminated areas against the spread of radioactive contamination during the decommissioning of nuclear facilities.

The first specification, Specification for Strippable & Removable Coatings to Mitigate Spread of Radioactive Contamination (E 3104-17), establishes performance specifications for a coating that is intended to be removable during subsequent decontamination operations. The second specification, Specification for Permanent Coatings Used to Mitigate Spread of Radioactive Contamination (E 3105-17) is for coatings that are intended to be permanent, non-removable, long-term material for fixing contamination in place during decommissioning.

The E10 Committee, through the E10.03 Subcommittee on Radiological Protection for Decontamination and Decommissioning of Nuclear Facilities and Components, has moved forward with creating consensus based standards for D&D technologies that are not only aligned with technical specifications, but also account for the safety, regulatory, and operational requirements encountered during D&D activities. The intent is to promulgate relevant, uniform testing protocols that can be leveraged across the nuclear environmental management community, and support decision makers and end users with common references in the selection and employment of those standards and associated technologies.

Figure 10. From left: Joseph Sinicrope (FIU ARC / Chairman, E10.03 Subcommittee), Connor Nicholson (SRNL), Brent Peters (SRNL), Ed Walker (Chairman, E10 Committee on Nuclear Technology and Applications).

FIU and ASTM have widely publicized the availability of the two new international standard specifications for fixative technologies. ASTM issued an online news release and the new standards were publicized in the September/October issue (both online and print copy) of the ASTM Standardization News publication and is available at: https://www.astm.org/standardization-news/?q=update/coatings-help-prevent-radioactive-contamination-decommissioning. In addition, FIU published an article on this topic on D&D KM-IT and the ARC website, and issued announcements on ARC's Facebook, Twitter, and

LinkedIn social media. FIU also supported the development and revision of an article for publication in the EM Update newsletter.

FIU initiated planning for the next ASTM International E10.03 Subcommittee meeting scheduled for January 21-23, 2018, in New Orleans, LA. The focus of this meeting will be on initiating the development of standardized testing protocols for: 1) Determining the Decontamination Factor (DF) of strippable coatings on various substrates; 2) Determining a fixative's ability to immobilize radioactive contamination and measuring its impacts on airborne release fractions (ARF) and respirable fractions (RF) in the source term formula. Both of these objectives are directly aligned with the incombustible fixatives initiative, and address SRNL's and FIU's collaborative research efforts on providing empirical data to support updating the DOE-HDBK-3010. It is also an excellent venue for capturing and archiving lessons learned / best practices in a systematic manner.

News / Magazines & Newsletters

ASTM Standardization News

Coatings Help Prevent Radioactive Contamination in Decommissioning

ASTM International's committee on nuclear technology and applications (E10) has created new specifications for coatings that help prevent the release of radioactive particles when nuclear facilities are being decommissioned.

The specifications aim to immobilize radioactive contamination, minimize worker exposure, and protect uncontaminated areas against the spread of radioactive contamination.

The first specification is for a coating intended to be removed during subsequent decontamination operations: Specification for Strippable and Removable Coatings to Mitigate Spread of Radioactive Contamination (E3104).

The second specification is for a coating intended to be a permanent, non-removable, long-term material for fixing contamination in place during decommissioning: Specification for Permanent Coatings Used to Mitigate Spread of Radioactive Contamination (E3105).

The coatings are applied to surfaces commonly found in nuclear facilities and aim to reduce:

- Migration of the contamination into or along buildings, equipment, and other surfaces;
- Resuspension of contamination in the air; and,
- The spread of contamination as a result of external forces such as pedestrian traffic and fire.

"These standards, and the subsequent testing protocols being developed by our committee, can potentially assist in updating directives and guidance documents, such as U.S. Department of Energy handbooks on airborne release fractions and respirable fractions for nonreactor nuclear facilities," says Joseph Sinicrope of Florida International University's Applied Research Center. Sinicrope also serves as chairman of ASTM International's subcommittee on radiological protection for decontamination and decommissioning of nuclear facilities and components (E10.03).

Figure 11. ASTM News publication on new fixative standards (Sept/Oct 2017 edition).

Technology Demonstration under Nonradioactive Conditions at FIU

Leveraging the research being performed on intumescent coatings and including close coordination with DOE EM, SRNL, and SRS, FIU conducted a cold demonstration / test and evaluation of applying intumescent coatings in a full-scale SRS 235-F hot cell mock-up at the FIU Hot Cell Test Bed during FIU Performance Year 7.

SRNL research scientists conducted a meeting with SRS 235-F site personnel and captured the desired dimensions to be replicated at the FIU Hot Cell Test Bed. Based on these discussions, FIU completed two design options to be considered for the scheduled test and evaluation: 1) a middle cell at SRS 235-F, and 2) a corner cell. The primary difference between the two designs was the potential entry points, with the corner cell affording two additional options via glove ports on a separate exposed wall.

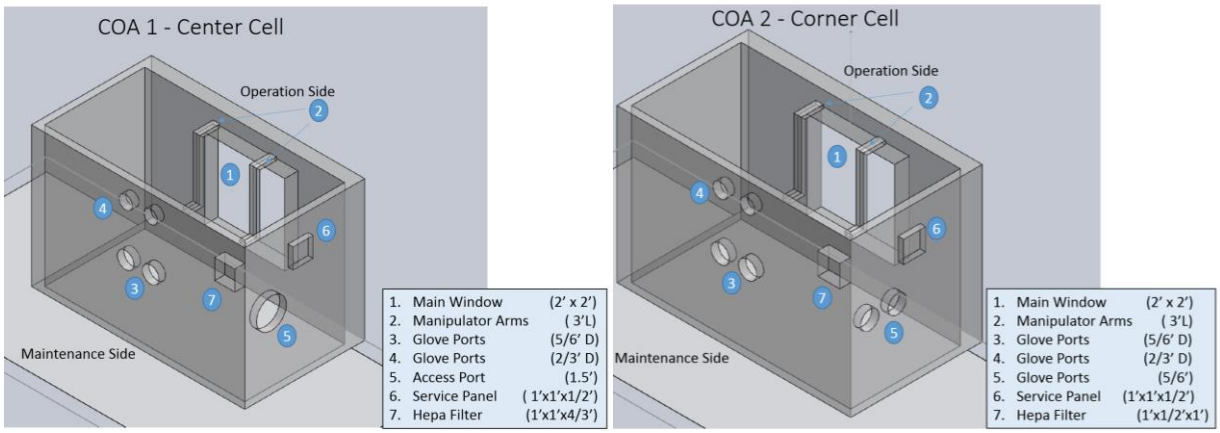

Figure 12. Proposed designs to replicate SRS 235-F hot cells: center cell (left) and corner cell (right).

FIU revised the design options for consideration based on discussions with SRS 235-F site personnel. The revised options included: 1) a single corner cell; 2) a single middle cell; 3) a consolidated corner and middle cell design; and 4) all 3 designs with the incorporation of a 3' raised floor. These design options were briefed to SRNL representatives and a final design was selected. The design phase for the full-scale SRS 235-F hot cell mock-up testbed was completed, reviewed, and approved by the project task stakeholders (SRS 235-F site personnel, SRNL, and ARC). The decision was made to pursue a combination middle and corner cell design (figures below) using the actual hot cell dimensions from the site's schematics. A raised floor was also incorporated to best mirror the operational conditions experienced at the site. Detailed blue prints were developed for approval by the ARC Senior Engineer.

Based on the stakeholder approval received on October 28, 2017, as well as a follow-on site visit and phone conversation on November 15 with SRS 235-F site personnel and SRNL research scientists, the SRS 235-F Hot Cell Test Bed design was reaffirmed and construction began in December 2016 at FIU ARC's outdoor test facility.

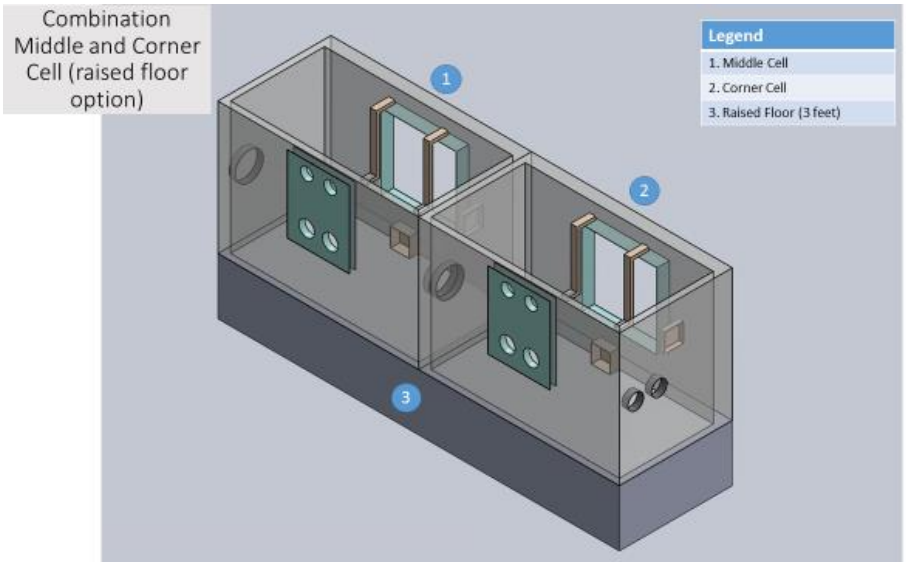

Figure 13. Selected design for the hot cell mock-up testbed showing the combination of a middle and corner hot cell with a raised floor.

Figure 14. Construction began on the selected hot cell mockup design.

The draft test plan, titled *"Adapting Intumescent Coatings as Fire Resilient Fixatives ISO SRS 235-F D&D Activities Phase II: Construction of SRS 235-F Hot Cell Test Bed and Application Demonstration"* was completed on January 6, 2017 and forwarded to SRNL for review/comment. The final document received concurrence and was signed by all stakeholders at FIU and SRNL on February 6, 2017.

The test objectives outlined in the document were developed through extensive coordination with SRS 235-F site personnel (i.e., project managers, safety and fire representatives, etc.) and Savannah River National Laboratory (SRNL) research scientists. They are specifically designed to advance the testing, evaluation, and possible deployment of intumescent coating (IC) technologies as fire resilient fixatives to mitigate the potential release of radioisotopes during postulated fire scenarios highlighted in the Basis for Interim Operations (BIO) and contingency planning documents in support of D&D activities at SRS 235-F, with a particular emphasis on the 235-F PuFF Facility Cells 6-9.

This test plan addressed Phase II of the overall research effort, with the first main objective centered on constructing a to-scale SRS 235-F Hot Cell Test Bed on-site at ARC that mirrors the operating environment encountered in an adjoining corner and middle hot cell configuration at the SRS 235-F facility. The second main objective was an evaluation of the mechanics and processes associated with applying the selected intumescent coatings in the hot cell configurations using: 1) the approved tools as identified in the 235-F Risk Reduction Tooling List, Rev 0, dated January 26, 2015; and 2) alternative application methods, such as airless sprayers, recommended by the IC manufacturer.

Phase I of the test plan was completed on May 25, 2017 with the final construction of the SRS 235-F Hot Cell Test Bed as shown in the figures below.

Figure 15. Completed construction of Hot Cell Test Bed at ARC.

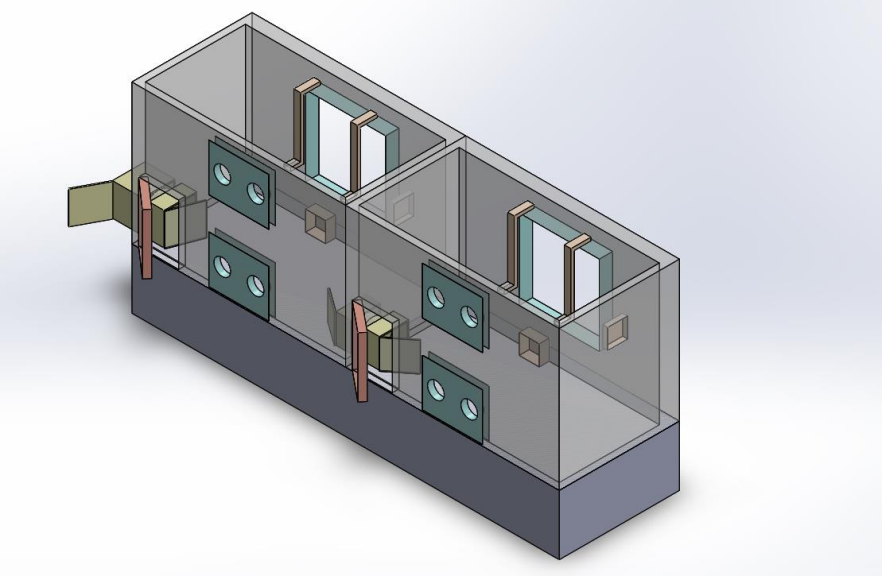

Figure 16. As-built design of the middle and corner hot cells with raised floor.

FIU supported a visit from Rod Rimando (Director of EM's Office of Technology Development) Mike Serrato (SRNL), and other representatives from across the DOE complex, who had the opportunity to tour the ARC Hot Cell Test Bed during the week of May 1, 2017. In addition, scientists from SRNL (Dr. Aaron Washington and Dr. Connor Nicholson) and the Project Engineer for the D&D of the hot cells at SRS 235-F (Jack Musall) visited FIU on May 17-19, 2017. During the SRS/SRNL visit to FIU, the following activities were conducted:

- Overview / presentation on FIU ARC support to DOE EM Cooperative Agreement, with a particular emphasis on D&D support to SRNL/SRS
- Review of incombustible fixatives (adapting intumescent coatings) efforts to date, and detailed discussion on proposed way ahead for FIU Performance Year 8
- Overview of significant D&D problem sets at SRS
- ARC facility tours (e.g., Robotics Lab and Radiation Lab)
- Detailed review and tour of completed SRS 235-F Hot Cell Test Bed
- Intumescent coating demonstrations
- Tour to highlight FIU's radiochemistry efforts

During June, FIU developed an ARC Fact Sheet supporting Phase I of the test plan, highlighting the hot cell test bed's key components. This deliverable was reviewed by the SRNL collaborators and then submitted to DOE on June 28, 2017.

Phase II of the test plan commenced on May 31, 2017 and was completed in early October. Testing included:

- Application of the intumescent coating using the site approved tools, specifically the extension pole and a roller brush.
- Monitoring of curing time.

- Observation and recording of ability of all required tools and materials to fit through the bag in/bag out port and pass-through port.
- Evaluation of volume/surface area of intumescent coating required to cover all surfaces to minimum thickness needed.
- A small scale test to evaluate the effectiveness of using a simple slow-pour method of applying an intumescent coating to the floor of the hot cell test bed.
- A larger scale (5'x5') test to further evaluate the effectiveness of using a simple slow-pour method of applying an intumescent coating to the floor of the hot cell test bed.
- Fire testing on a test coupon (18"x18") after using the slow pour method of applying the intumescent coating.
- Testing a handheld sprayer as a possible option for applying the IC fixative to vertical / wall surfaces.

Figure 17. Testing ability of reaching all hot cell surfaces from lower glove ports using a manual long-reach tool outfitted with a roller for applying intumescent coatings.

With 95% of the assayed contamination residing on the floor of the SRS 235F facility hot cells, and given the composition and characteristics of the intumescent coatings, FIU performed a small scale test of slowly pouring the IC onto a 1' x 1' area within the hot cell testbed. This method showed significant promise in reducing worker time and potential for disturbing residual contamination during the application of intumescent coating on horizontal / floor surfaces in hot cells. The IC cured within 24-hours of application with a heat index of around 100ºF. Consequently, FIU is moving forward with preparations for a full-scale test and evaluation of the technique.

Figure 18. Small scale test of a slow pour technique using intumescent coatings (left) and preparing for full-scale demo of slow pour application method for horizontal / floor surfaces in hot cell (right).

FIU used the following tools to support the slow pour application method of the IC onto a horizontal surface (i.e., floor of hot cell mockup):

- Container – 2.5-quart-size plastic bucket to hold/transport the IC
- Gripper - used to maneuver a 2.5-quart-size plastic container of IC
- Custom wooden T-shaped extension tool - used to spread the IC. To develop this tool, FIU connected a 13" wooden head to the approved extension handle on the SRS tooling list.

Figure 19. Tools used for slow pour method to apply IC to hot cell floor.

FIU poured the IC into a 2.5 quart plastic container outside the hot cell, filling the container with 1 to 1.25 quarts of IC to keep the weight between 2 to 3 pounds to minimize worker fatigue. The container and tools were then passed through the bag in/bag out port. Maneuvering the 2.5-qt container to various locations within the hot cell by manipulating the gripper from the glove-ports was relatively easy and allowed for targeted pouring of the IC. After marking the hot cell border at 1/8" above the floor, FIU poured the IC from the container at a height of about 1 to 3" above the floor to minimize any potential for splatter or disturbance of any residual contamination that may be present in a radioactive environment. FIU then spread and smoothed the IC across the floor area using the wooden T-shaped tool, using the 1/8" markings along the perimeter of the hot cell as a thickness guide. The custom wooden T-shaped extension tool allowed access to all locations within the hot cell test bed from the glove-ports and easily reached the corners. An area of 5' x 5' was coated to 1/8" thickness in approximately 15 minutes once the tools and IC were in the hot cell. Total curing time after the slow pour application was 48 hours under hot and humid weather conditions (temperatures 75°-97° F and humidity 45%-93%).

The slow pour method for the floor/horizontal surfaces proved very effective during application, significantly reducing time and effort while greatly facilitating application to the requisite thickness level. With an estimated 95% of the contamination residing on the hot cell floors at the SRS 235-F facility and given the composition and characteristics of the IC being tested, the slow pour method may be a viable application method for horizontal surfaces that would expedite application and minimize disturbance of any residual contamination.

Figure 20. Slow pour method to apply IC to hot cell floor.

After the small-scale slow pour application on a 18”x18” test coupon and subsequent curing, FIU performed fire testing on the coupon. This testing yielded positive results with minimal to no flame propagation or smoke and demonstrated excellent thermal insulation from the IC.

Figure 21. Fire testing a 18”x18” wooden test coupon after applying IC to 1/8” thickness using a slow pour method.

Testing of the handheld sprayer showed some initial success as a possible option for applying the IC fixative to vertical/wall surfaces. The sprayer is self-contained, relatively lightweight, battery operated, easily fits through the bag in/bag out and pass-through ports, and appears to be compatible with the viscosity of the FD intumescent coating. FIU conducted a series of comparison tests between roller vs sprayer application. The roller method of application averaged less than 14 mils of thickness per application on a vertical surface and approximately 12 total applications are needed to reach the requisite 1/8” coating thickness. With a 24-48 hour curing period between applications, this option does not appear like a viable for field deployment. On the other hand, the results with the hand held sprayer were much more promising in terms of labor, time, and number of applications.

FIU used a cordless GRAYCO UltraMax Handheld Airless Paint Sprayer at a setting 10 to apply the IC to a 36” x 40” vertical (wall) surface of the hot cell test bed to a 1/8” coating thickness. Approximately 2 quarts of product were consumed. Including time needed to refill the sprayer, the total application time with the sprayer was 5 minutes.

FIU summarized the preliminary results and lessons learned from this testing and discussed with the research collaborators at SRNL on August 30, 2017. The full technical report was subsequently developed to present the final results and analysis.

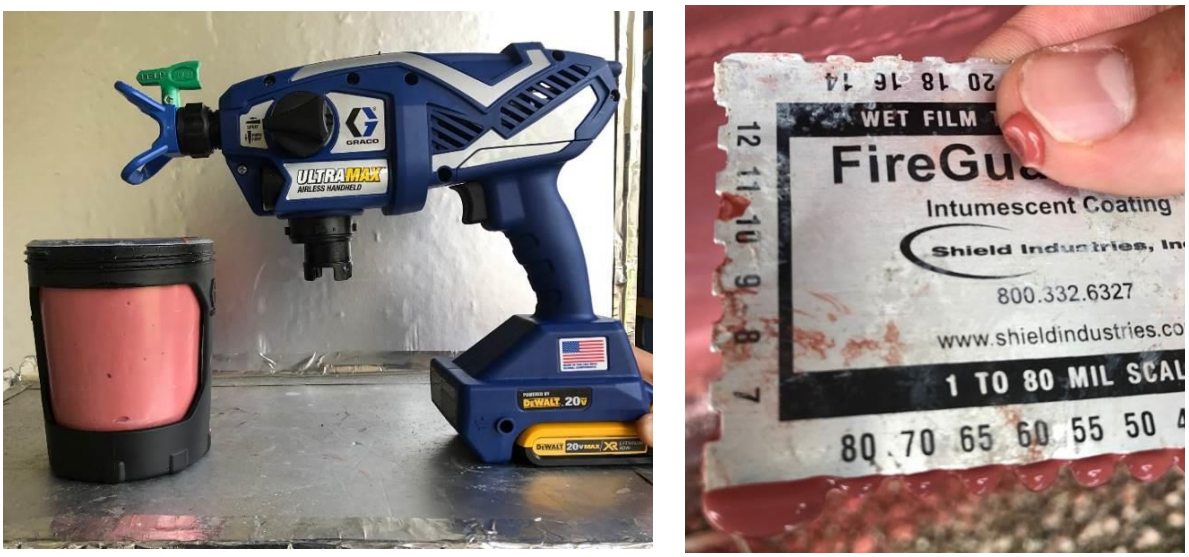

Figure 22. Airless sprayer (left) and manual film thickness gauge (right).

Presentations, Meetings and Conferences

FIU also participated in relevant meetings and conferences in support of this task. On July 18-19, 2017, a research review via videoteleconferencing was conducted between DOE EM, the DOE sites and national laboratories, and FIU ARC as part of the DOE Cooperative Agreement. The presentations included one on the D&D and IT for Environmental Management applied research. All presentations are available for downloading on FIU's DOE Research webpage at http://doeresearch.fiu.edu.

FIU participated in two meetings for the ASTM International's E10 Committee on Nuclear Technologies and Applications, working with the ASTM International E10.03 Subcommittee on Radiological Protection for Decontamination and Decommissioning for Nuclear Facilities and Components to develop uniformly accepted testing protocols and performance metrics for testing and evaluating D&D technologies. These meetings were held from January 29 to February 1, 2017 in Norfolk, VA and from June 19 to June 22, 2017, in West Conshohocken, PA.

FIU also prepared and presented a professional paper titled, "Application of Robotics Technology to D&D," during session 132: Robotics and Remote Systems-Nuclear Environments: International Applied D&D Operations at the Waste Management 2017 (WM17) conference from March 5-9, 2017, in Phoenix. An additional presentation based on the research being performed in collaboration between FIU and SRNL was also presented by SRNL at this conference titled, "Environmental and Radiological Response of Fixatives and Intumescent Coatings for D&D Applications."

In addition, two DOE Fellows prepared and presented student posters based on research related to this project at WM17. Alexander Piedra presented a student poster titled, "Baseline Adhesion Testing of Intumescent Coatings" and Sebastian Zanlongo presented a student poster titled, "Low-Cost Robotic Platform for D&D Activities."

FIU prepared and presented a professional paper titled, "D&D Technology Innovation,

Knowledge Management, and Student Training" during the EPRI International Low-Level Waste Conference on June 19-21, 2017 in Charlotte, NC.

Figure 23. Baseline Adhesion Testing of Intumescent Coatings – DOE Fellow Alexander Piedra.

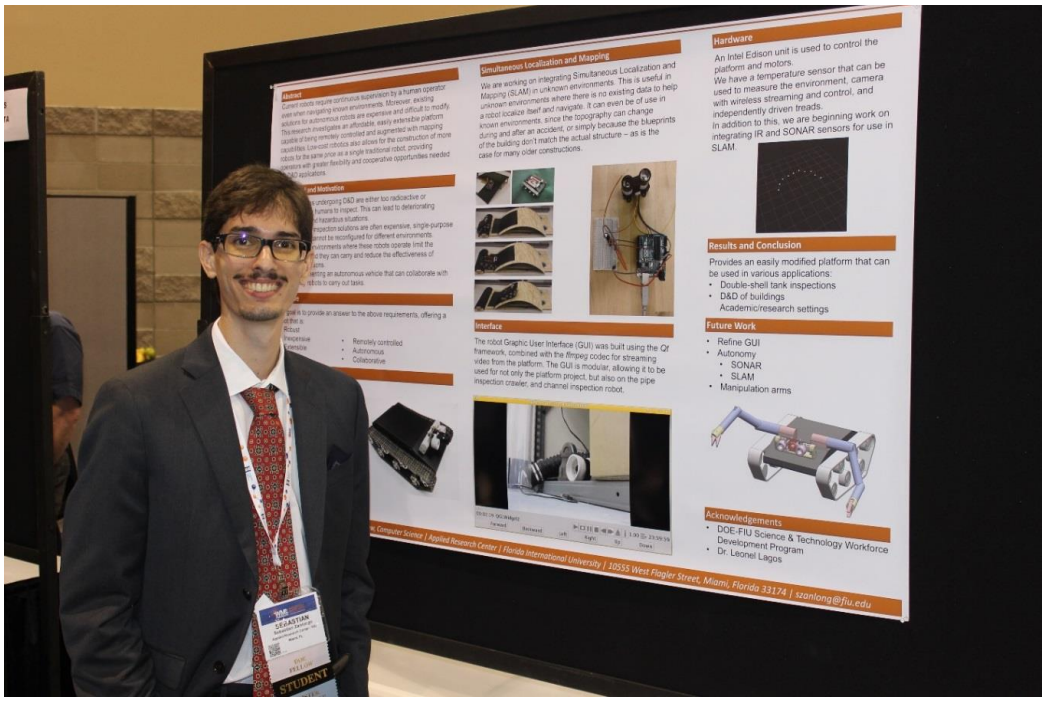

Figure 24. Low-Cost Robotic Platform for D&D Activities – DOE Fellow Sebastian Zanlongo.

TASK 2: CONCLUSIONS

Planning for the D&D of facilities across the DOE complex is a tremendous undertaking, especially considering that a significant number of the facilities contain hazards to human health and the environment: seriously deteriorated structural integrity, very high dose rates, high levels of fixed and removable contamination on/in facility surfaces and equipment, and chemically hazardous materials. Providing support for technology innovation, development, evaluation, and deployment is critical to the safe and efficient completion of facility D&D. In addition, the development of uniformly accepted testing protocols and performance metrics is an essential component for testing and evaluating D&D technologies. As highlighted in this report, using the best-fit testing protocols has signficant limitations, and reinforces the requirement to develop uniform standards and testing protocols for D&D technologies through international standards organizations (ASTM, NIST, ANS, ISO, etc.).

TASK 2: REFERENCES

Florida International University, *Enhancing Operational Performance of Fixatives and Coatings for D&D Activities: Baselining and Proof of Concept*, Test Plan, June 2015.

Florida International University, *Incombustible Fixatives – Adapting Intumescent Coatings as Fire Retardant Fixatives to Support D&D Activities,* Technical Progress Report, June 2016.

Florida International University, *Adapting Intumescent Coating as Fire Resilient Fixatives ISO SRS 235-F D&D Activities – Phase II: Construction of SRS 235-F Hot Cell Test Bed and Application Demonstration,* Test Plan, January 2017.

Florida International University, *Incombustible Fixatives – Adapting Intumescent Coatings as Fire Retardant Fixatives to Support D&D Activities,* Technical Report, October 2017.

Lagos, L., P. Shoffner, J. Sinicrope. *D&D Technology Innovation, Knowledge Management, and Student Training*, EPRI International Low-Level Waste Conference, June 19-21, 2017.

Nicholson, J., A. Washington, M. Serrato, P.Shoffner, L. Lagos, J. Sinicrope. *Environmental and Radiological Response of Fixatives and Intumescent Coatings for D&D Applications*, Waste Management Symposia, Phoenix, AZ, March 5-9, 2017.

Sinicrope, J., P. Shoffner, E. Walker, L. Lagos. *The Expanding Nuclear Niche: Meeting the Growing Need for Standardized Testing and Performance Metrics for the Deactivation and Decommissioning of Nuclear Facilities*. ASTM International Standardization News, March 2016.

Upadhyay, H., L. Lagos, W. Quintero, P.Shoffner. *Application of Robotics Technology to D&D, Waste Management Symposia*, Phoenix, AZ, March 5-9, 2017.

TASK 3.
D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL

TASK 3: EXECUTIVE SUMMARY

FIU has developed a D&D Knowledge Management Information Tool (D&D KM-IT) to maintain and preserve the D&D knowledge base and to provide a focused web-based tool to assist the DOE D&D community in identifying potential solutions to their problem areas by using the vast resources and knowledge-base tools available through the web. During FIU Performance Year 7, FIU performed several subtasks, including community outreach and training, application development, system/database/network administration, and data mining.

TASK 3: INTRODUCTION

Planning for the D&D of facilities across the DOE complex is a tremendous undertaking. Capturing the knowledge, experience, and lessons learned from historic D&D activities at DOE sites is imperative to the successful and safe management of future D&D projects. The D&D Knowledge Management Information Tool is a central initiative to accomplish these goals.

The D&D KM-IT is a web-based system developed to maintain and preserve the D&D knowledge base. The system was developed by FIU-ARC with the support of the D&D community, including DOE EM, the former ALARA centers at Hanford and Savannah River, and the DOE's Energy Facility Contractors Group (EFCOG). The D&D KM-IT is a D&D community driven system tailored to serve the technical issues faced by the D&D workforce across the DOE Complex. D&D KM-IT can be securely accessed from web address https://www.dndkm.org. as well as via mobile devices at https://m.dndkm.org.

TASK 3: EXPERIMENTAL

The D&D KM-IT is a web-based knowledge management information tool custom built for the D&D user community by FIU. The objective of the D&D KM-IT is to provide a focused web-based tool to assist the DOE D&D community in identifying potential solutions to their problem areas by using the vast resources and knowledge-base tools available through the web. One such knowledge-base tool includes solutions provided by subject matter specialists who respond to specific questions. The D&D KM-IT archives, in a retrievable module within the system, information collected from the subject matter specialists, thereby building a knowledge repository for future reference. The primary subtasks for FIU Performance Year 7 included community outreach and training, application development, system/database/network administration, and data mining.

TASK 3: RESULTS AND DISCUSSION

Outreach and Training

Significant effort was made towards community outreach in support of the D&D KM-IT system during FIU Performance Year 7. FIU participated in meetings and conferences, hosted conference exhibitor booths, contributed D&D information to Wikipedia, and disseminated newsletters on D&D KM-IT to registered users, subject matter specialists, and conference attendees.

Metrics

FIU completed the development of a metrics progress report for outreach and training activities for D&D KM-IT and submitted this to DOE on March 31, 2017. This document reported on the progress being made towards accomplishing the outreach and training goals and objectives set forth in the document titled, "Metric Definition for D&D KM-IT Outreach and Training," which was developed during FIU Performance Year 5 and expanded on the outreach and training activities for D&D KM-IT as described in the annual PTP by defining specific metrics and capturing the tools and techniques that will be applied to track and report the results. Outreach and training is a critical element towards the long-term sustainability of knowledge and essential for the long-term strategic vision of D&D KM-IT: it will continue to grow and mature into a self-sustaining system through the active participation of the D&D community it was designed to serve.

Conferences and Workshops

FIU participated in relevant meetings and conferences in support of this project, including the EPRI International Low-Level Waste Conference, June 19-21, 2017, in Charlotte, NC, and the Waste Management Symposium 2017 in Phoenix, AZ.

FIU prepared and presented a professional paper titled, "D&D Technology Innovation, Knowledge Management, and Student Training" during the EPRI International Low-Level Waste Conference on June 19-21, 2017 in Charlotte, NC.

In addition, FIU prepared and presented a professional paper titled, "Application of Robotics Technology to D&D," during the March 5-9 Waste Management 2017 (WM17) conference in Phoenix, AZ. At this same conference, a poster titled, "Cross-Platform Mobile App for KM-IT Fixatives Module," was presented by DOE Fellow Andres Cremisini during the student poster session.

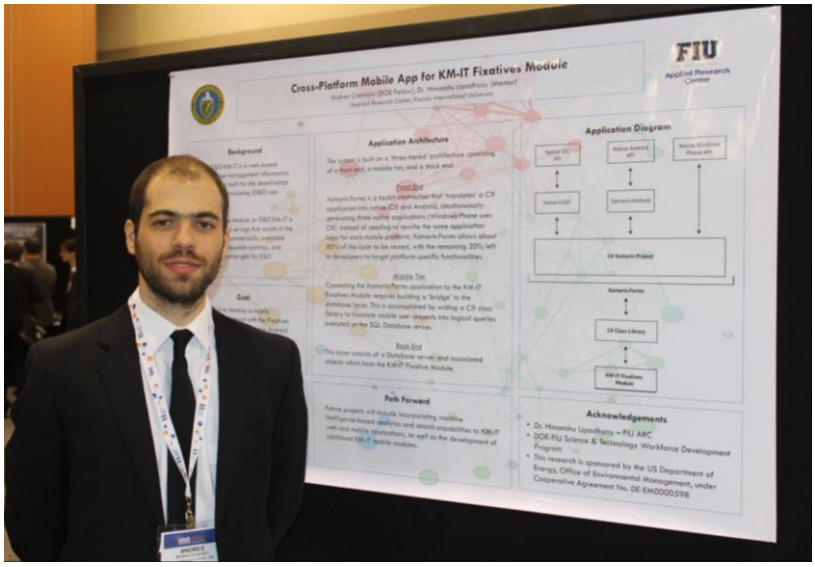

Figure 25. Cross-Platform Mobile App for KM-IT Fixatives Module – DOE Fellow Andres Cremisini.

D&D KM-IT was also showcased at WM17 at the FIU booth in the conference exhibition hall. FIU staff used the opportunity to demonstrate the system to conference attendees. Significant

interest was shown in the knowledge management of D&D as reflected by the increase in user registrations during the conference; there was an increase of 43 registered users during WM17. To date, conferences have proven to be the most effective marketing tool for D&D KM-IT.

Figure 26. DOE Fellows and ARC staff at FIU booth during WM17 Exhibit Hall.

Website Analytics

FIU developed a D&D KM-IT Website Analytics Performance Report on a quarterly basis and summarized the information is graphically-rich annual web analytics reports. These reports included information from Google Analytic and Google Web Master tools and provide multiple graphics and a narrative to explain the results. FIU completed the development of an annual Google Web Analytic report for D&D KM-IT for calendar year 2016 (January to December) and submitted it to DOE on June 30, 2017. During this period, the top five states that visited D&D KM-IT were Florida, California, Texas, Massachusetts, and the District of Columbia. D&D KM-IT was also visited from 122 countries with the top five being the United States, United Kingdom, Canada, India and South Korea, with a combined 8,371 unique visitors.

An infographic was provided for visual representation of key information in this report. It is intended to present information quickly and clearly (Figure 28).

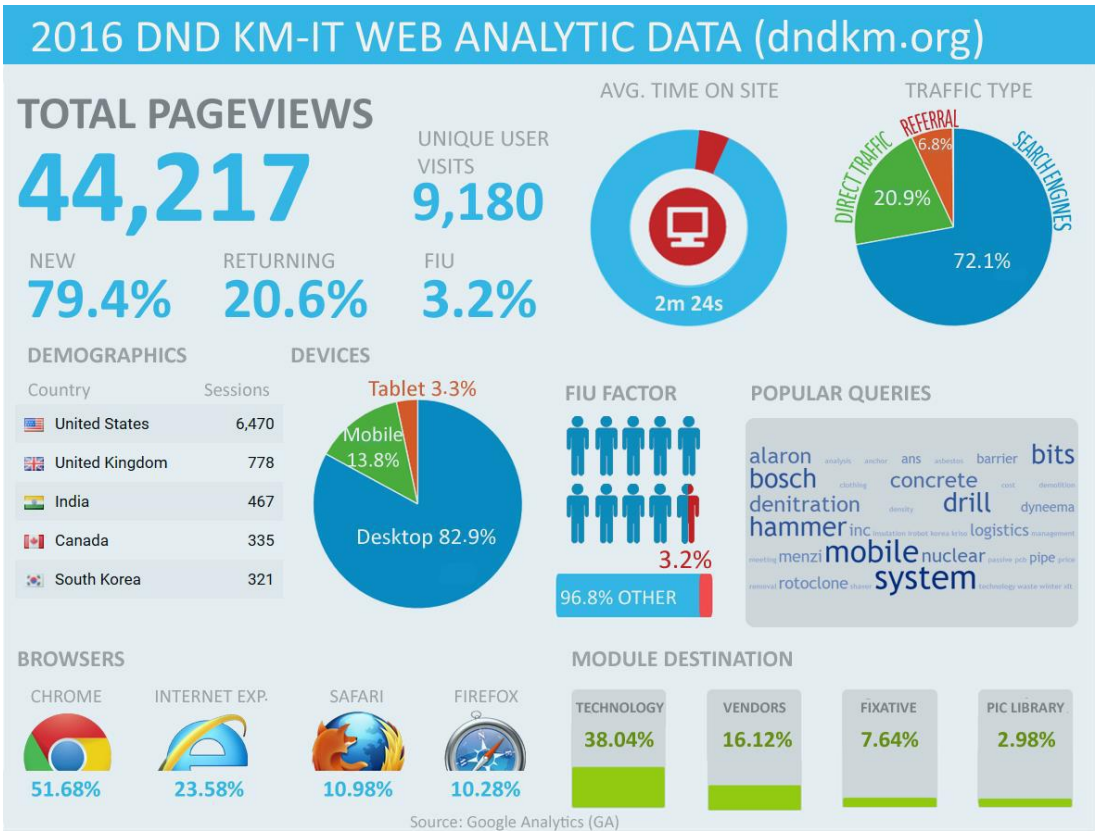

Figure 27. Web analytics infographic for calendar year 2016.

FIU also completed the development of Google Web Analytic reports for D&D KM-IT for the second, third, and fourth quarters of 2016 as well as the first quarter of 2017 (Figure 30). These reports included information from Google Analytics and Google Web Master tools and a narrative to explain the results. A few of the highlights from these reports include:

- While there is significant traffic to the site from other countries, more than half of the visits are from the U.S.
- The most popular modules include Technology, Vendors, Picture Library, and Training.
- Innovative Technology Summary Reports (ITSRs) were the most visited documents on D&D KM-IT.
- Combining cellphone and tablet categories, mobile devices make up over 20% of the site traffic.
- "Mobile Systems" is top query impression for D&D KM-IT.

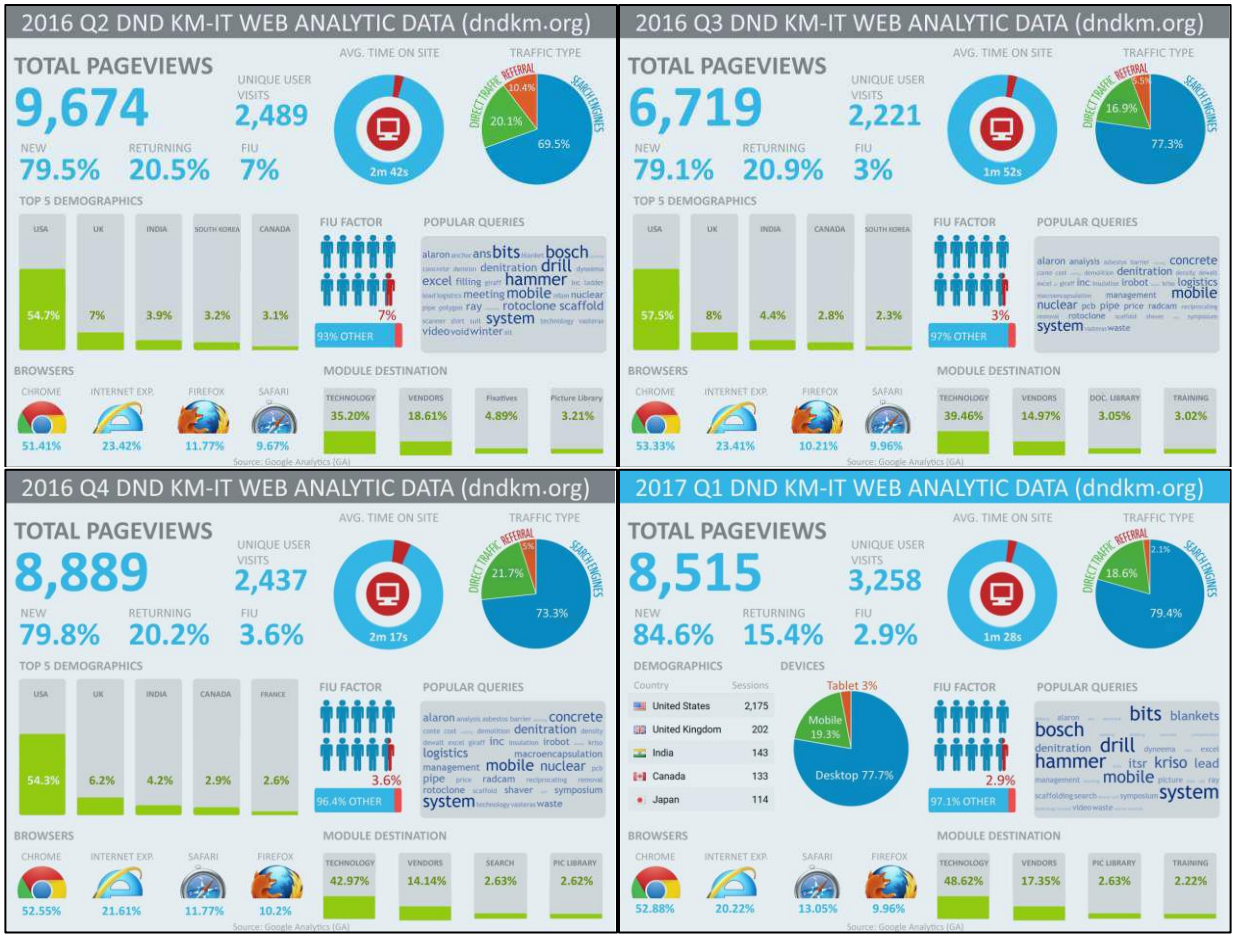

Figure 28. Infographics based on web analytic data for D&D KM-IT.

Strategic Plan

A strategic plan document for D&D KM-IT titled, *D&D Knowledge Management Information Tool – A Strategic Approach for the Long-Term Sustainability of Knowledge*, offers a strategic vision for the long-term sustainability of knowledge through the D&D KM-IT by applying the system's assets together with good web practices; thereby, promoting and enhancing the collaborative sharing of knowledge and work experiences across the D&D community.

FIU developed a quarterly update document for the *D&D KM-IT Strategic Approach for the Long-Term Sustainability of Knowledge* document. The strategic plan for D&D KM-IT is a living document and the projected schedule and status evolve over time as the recommended strategic approaches are implemented. The update document, developed on a quarterly basis, provides an update to the table of recommended actions contained in the original document.

Newsletters

Also as part of the outreach effort, FIU created targeted newsletters to send electronically to D&D KM-IT registered uses, subject matter specialists, and Waste Management Conference attendees. These newsletters informed the recipients of current and newly added features of D&D KM-IT and provided quick links to the system website so that they could immediately try out the enhancements. Newsletters are a digital medium of communication and are a great

outreach technique to bring waves of traffic to the website. By using the registered users as recipients, KM-IT can keep the users up to date on new features and content. FIU is employing an expanded use of infographics and interactive newsletters (e.g., embedded video, graphics and short simulations) to present graphically interesting information. Partial screenshots of the newsletters developed during the performance year are included below. One newsletter was developed to announce ARC's activities related to the D&D KM-IT during the Waste Management 2017 Symposia on March 5-9, 2017. This newsletter was distributed to the WM17 attendee list. The second newsletter announced the ASTM International development for 2 new standards related to D&D fixatives.

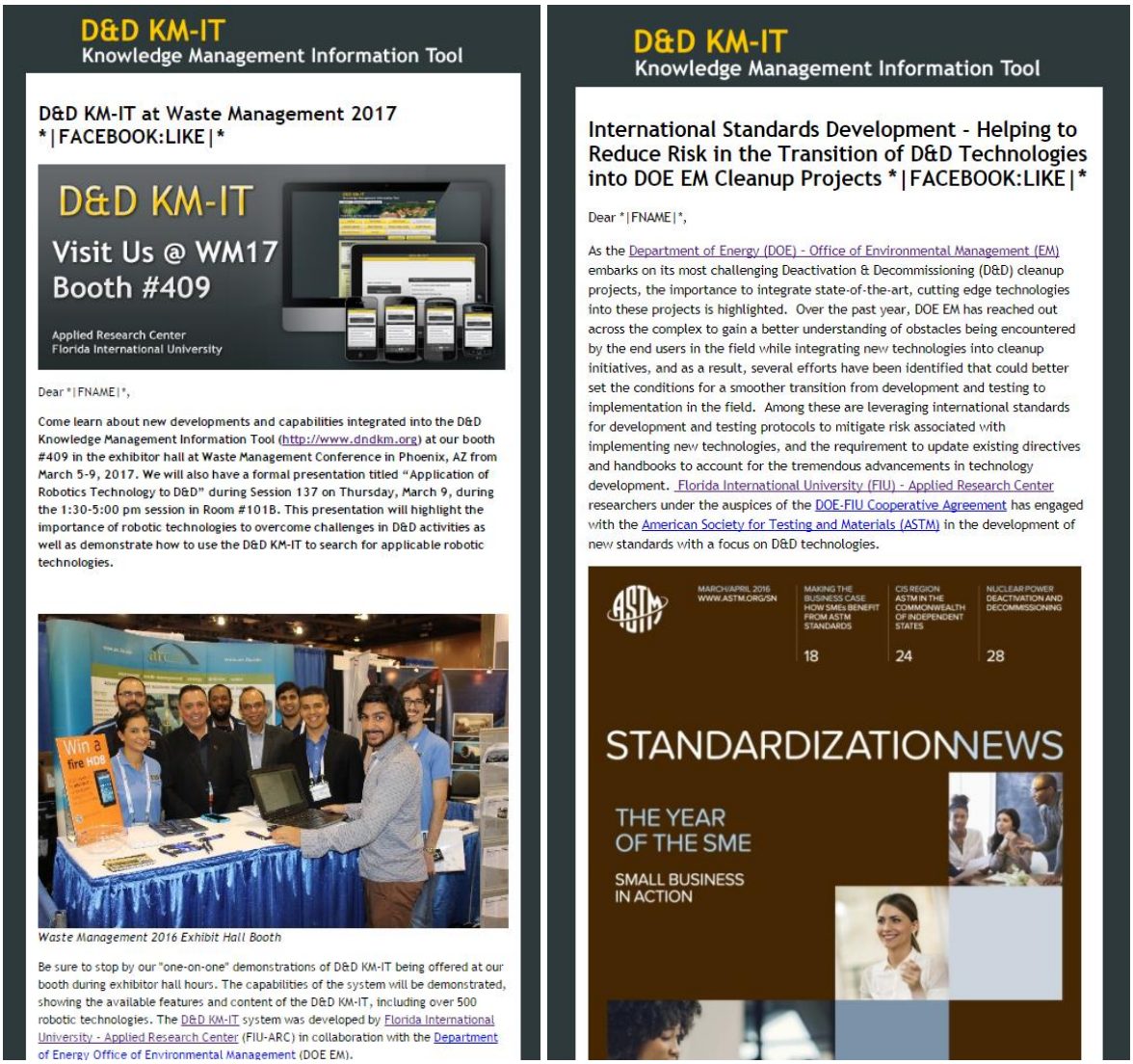

Figure 29. Newsletters from D&D KM-IT.

Wikipedia

D&D knowledge management through contributions in Wikipedia was a part of the outreach and training (D&D community support) subtask. FIU completed and sent a draft summary report to DOE on June 28, 2017. The general D&D knowledge which has been gained through this project offers an opportunity to expand access to a broad audience via Wikipedia, which has a significant presence on the web, thereby offering greater opportunities for collaboration on D&D knowledge. FIU researched and targeted D&D information on Wikipedia where D&D KM-IT could provide additional relevant information while citing the source of the original information on D&D KM-IT. The following Wikipedia articles were added or edited. It is important to note that the information available on wikis is continually evolving and may be further edited by other participants at any time.

1. **Fixative**
   The following text was added to the existing "Fixative" article with a hyperlink to the new Radioactivity Fixatives article.

   Radioactivity Fixatives - specialized polymer coatings used to contain or "fix" radionuclides to surfaces of equipment and buildings thereby preventing exposure to humans.

2. **Radioactivity Fixatives**
   This was submitted and accepted as a new article:

   Radioactivity or radionuclide fixatives are specialized polymer coatings used to "fix" radioactive isotopes or radioactive material to surfaces. These fixatives, also known as permanent coatings in the radioactive contamination control field, have been used for many decades in facilities processing radioactive material to control radioactive contamination. There has been increased interest in these fixatives or coatings recently due to the growing concern of contamination from a radioactivity dispersal device (RDD also known as a dirty bomb) and because radioactivity fixatives in use today lose the ability to contain the radioactivity to the surface during a fire.

   Radioactivity fixatives reduce or eliminate the movement of radionuclides from surfaces thereby lowering the health risk of inhalation or other exposure to radioactive isotopes. There are many articles on the use of radioactive fixatives with a review article from 1983 often used as a reference. A more recent review article looks at the use of these radioactive fixatives for use after the detonation of a RDD. Current research is investigating new coatings that are effective at containing radioactive material to the surface during and after fires.

3. **Radioactivity**
   The following text was submitted as a new article for consideration to the Wikipedia editors.

   The local presence of nuclear radiation arising from the radioactive decay of radionuclides. The unit of radioactivity from the System International of units (SI system) is the becquerel (Bq) defined as the radioactive decay or disintegration of one radionuclide per second. Radioactivity is a measure of the total, local rate of radionuclides decaying per unit time and is dependent upon the total number of atoms, decay constants, and all decay branching pathways for each radionuclide. See sections under radioactive decay entitled, "units of radioactivity" and "radioactive decay rates." For the origin and levels of radioactivity seen in all earth-bound measurements arising from cosmic and terrestrial radionuclides see background radiation.

4. **Strippable Coatings for Surface Decontamination**
   The following text was submitted as a new article for consideration to the Wikipedia editors.

   Strippable coatings for surface decontamination are used for removing contamination from building and equipment surfaces. These coatings are typically used to remove radioactive material from surfaces in buildings being prepared for demolition as well as from buildings with ongoing operations involving radioactive material. A variety of different polymer coatings are used containing chemicals to mobilize the radioactive material in order to move it to the surface and into the coating material as it solidifies. These coatings are then pulled or stripped off the surface, thereby removing the radioactive contaminants that were mobilized into the coating. The process of stripping the coating from the surface does not mar or negatively impact the surface. The coatings when dried or cured binds with the radioactive material physically or chemically or by both processes. The coatings when dried have greater internal cohesion than adhesion to the surface allowing them to be peeled off in sheets though some are scrubbed off. The composition of these coatings when dried contain no hazardous materials. They may be used to remove radioactive and hazardous materials. The application of the coatings is accomplished via brushes, rollers, foggers, foam or sprayers. The application of strippable coatings removes radioactive material thereby preventing the release of radioactive material from typical industrial surfaces such as: concrete, asphalt, brick, granite, limestone, aluminum, stainless steel, painted and steel, glass, painted wood, and unpainted wood, and plastic.

Application Development

During FIU Performance Year 7, FIU added features to the D&D KM-IT application and maintained the system for the D&D community.

D&D Fixative Module

FIU completed the initial development of a pilot native mobile application using the D&D Fixatives Module for the Android platform. A native application is an app that is developed for

use on a specific platform and which is downloaded onto a mobile device in order to be accessed. As such, the native app does not need an internet connection to be used. The pilot native mobile app is being designed and developed to run on Android 7.1 (Nougat). From the welcome screen for the app, the user can choose to perform a keyword search or a criteria search. The keyword search will search for fixative products according to the search word entered. If no keyword is entered and the search button is clicked, it will return all fixative products. The criteria search allows the user to build a multi-tier criteria search by adding the desired criteria and sub-criteria allowing for targeted results.

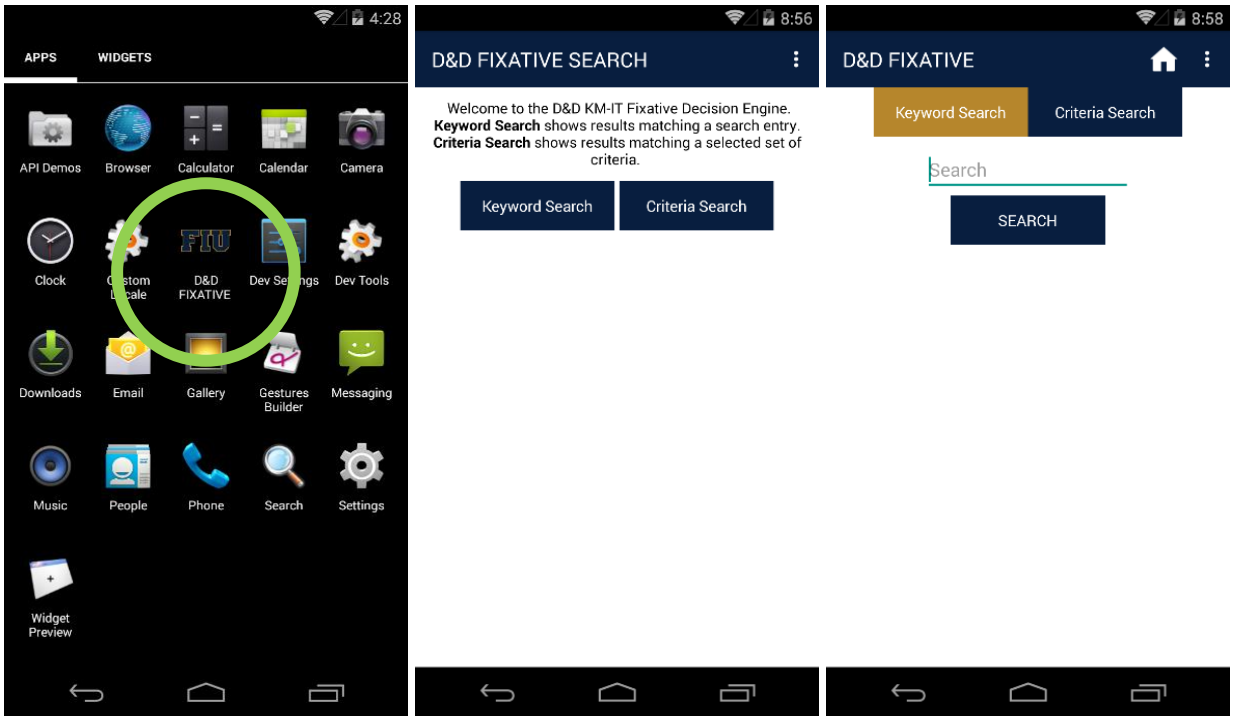

Figure 30. D&D fixative module mobile app on Android, search main page, and keyword search.

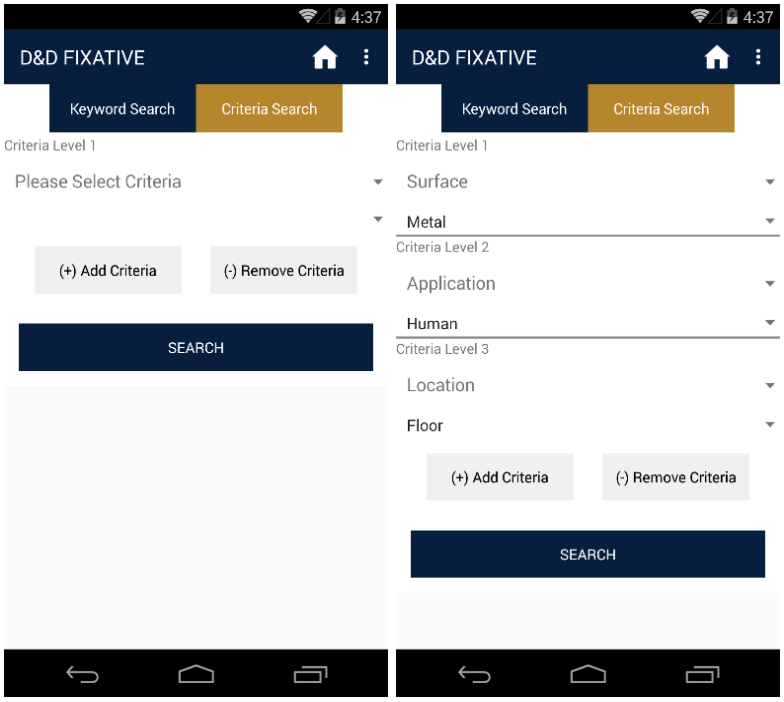

Figure 31. D&D fixative module mobile app criteria search pages.

The search results view displays the names of the fixative products that meet the search query. The user can click on any of the product names to view the details of the fixative product. The user can get further product or vendor data by clicking on the corresponding buttons on the fixative product detail view. Throughout the mobile app, the user can click on a phone number to dial it or launch their phone browser by clicking on an URL.

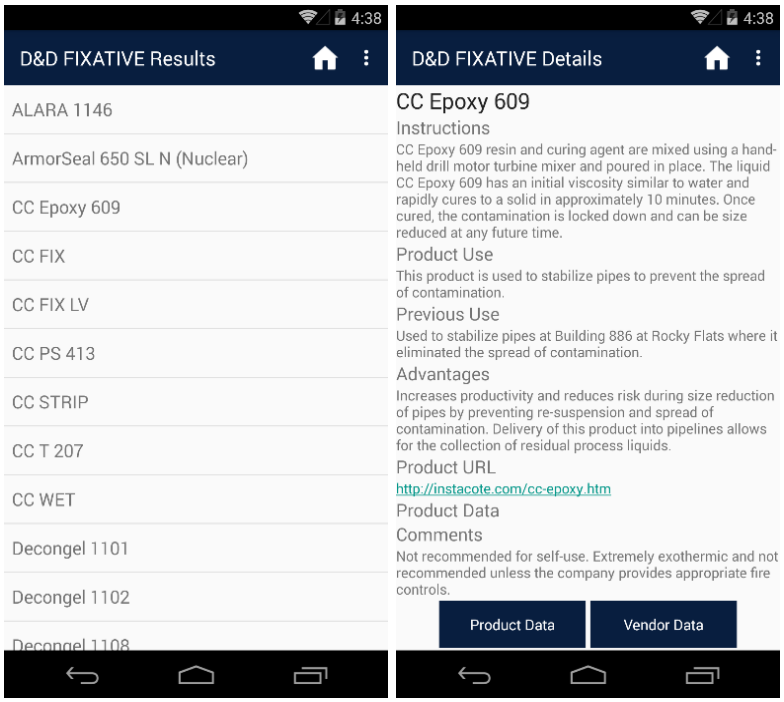

Figure 32. D&D fixative module mobile app search results and fixative details.

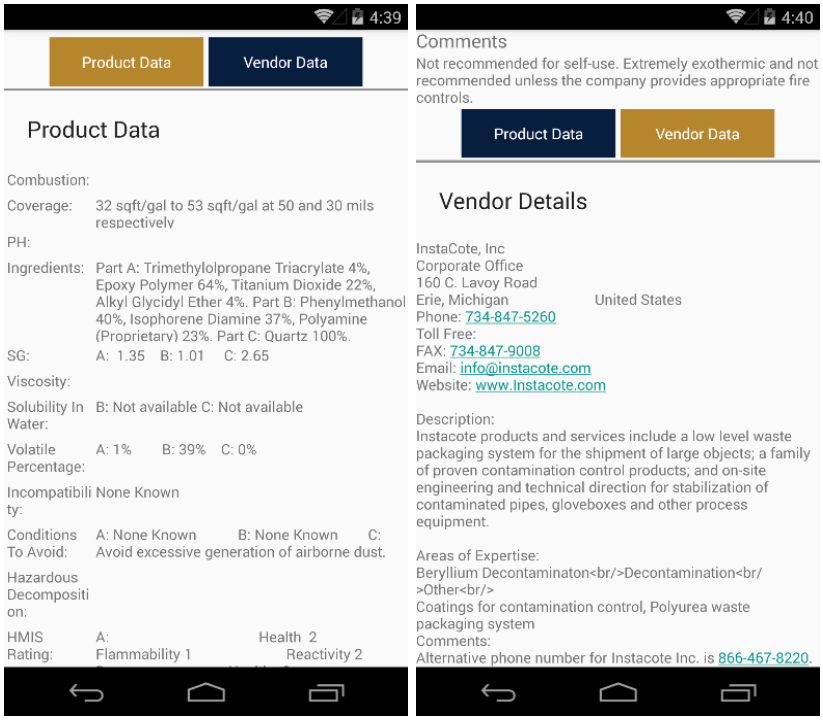

Figure 33. D&D fixative module mobile app product data and vendor details.

The mobile app also includes a description of D&D KM-IT and contact information for FIU ARC as well as a help page and disclaimer page.

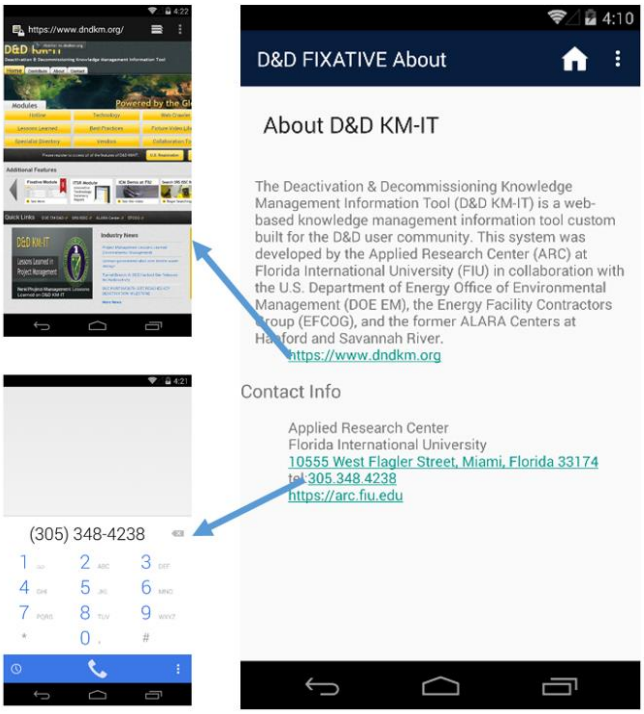

Figure 34. D&D fixative module mobile app about D&D KM-IT page.

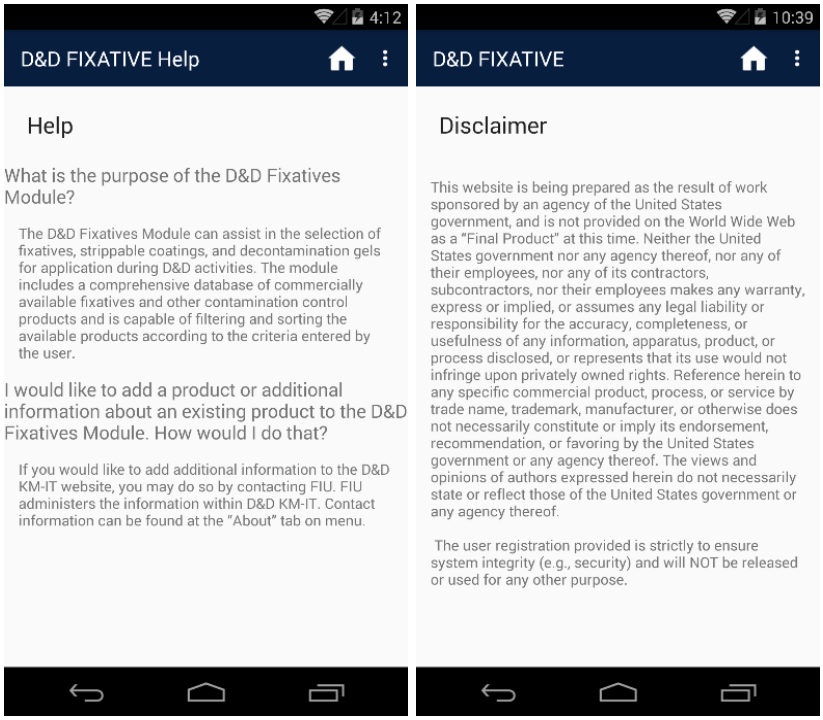

Figure 35. D&D fixative module mobile app help and disclaimer pages.

A Representational State Transfer (REST) web service was built to support the Android mobile app. REST is an architectural style that specifies constraints, such as the uniform interface, that is applied to a web service**.** It provides desirable properties, such as performance, scalability, and modifiability. REST relies heavily on JSON (JavaScript Object Notation), a minimal, readable format for structuring data. It is used primarily to transmit data between a server and web application, as an alternative to XML.

The following technologies were used in the development of the D&D KM-IT Fixative Android Native Mobile App:

- Microsoft Visual Studio 2015
- Xamarin
- REST Web Services
- JSON
- Microsoft SQL Server
- Android
- Postman

FIU provided a demonstration of the pilot native mobile app on the fixative module to DOE on August 10, 2017 via Adobe Connect and then provided a broader presentation on the potential for applying native mobile apps to a wide variety of DOE EM challenges on August 24, 2017.

FIU also worked on developing additional security features to protect all of the systems against possible cyberattacks and infections once the mobile applications are made available to the public. In a computer network, a de-militarized zone (DMZ) is a special local network configuration designed to improve security by segregating computers on each side of a firewall.

A DMZ divides or splits such a network into at least two parts by taking one or more devices inside the firewall and moving them to the outside, or to a separate subnet network, that does not allow a compromised or hacked server into a local area network (LAN). This configuration better protects the inside servers and domains from possible attacks by the outside and vice versa. These DMZs help to manage and protect systems from hackers and malware that an outfacing public or web server could be exposed to but not allow the local corporate servers to be directly in the line of fire of cyber threats. To further describe a network DMZ, it establishes a new subnet from the firewall where certain computer services run one or more computers or network devices. That DMZ system on the outside subnet adds an extra layer of protection for computers behind the firewall of the main LAN as all incoming requests are routed away from the corporate computers. True DMZs also restrict computers behind the firewall from communicating directly with the DMZ devices. Multi-level DMZs with several layers of firewall support can be set up to support larger corporate networks for more in depth cyber protection. A typical setup for a DMZ is shown in the following figure.

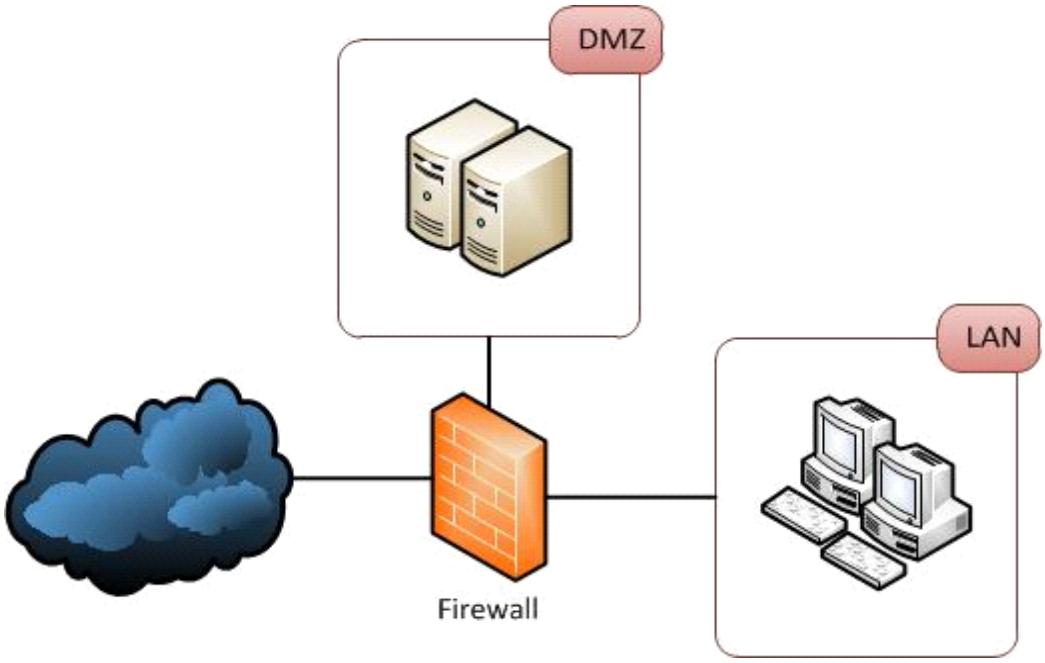

Figure 36. Typical de-militarized zone (DMZ) computer network setup.

ARC has developed the Fixative Rest Service that will be consumed by the native mobile android application once deployed onto the Google Marketplace. This communication will occur over HTTPS and will need to be secured in a DMZ zone. FIU has designed the DMZ network to host the Fixative Rest Service such that it can be accessed from outside the FIU network. A mobile server to host the Fixative Rest Service and the fixative database is under procurement. Deployment of the fixative mobile server in a DMZ will increase the security of the Rest API and the host along with the database used to store the fixative information.

Social Media Integration

FIU has engaged in several discussions with DOE related to social media integration on D&D KM-IT for the purpose of outreach and marketing. Social media has been identified as a platform that should be targeted to increase visibility of D&D KM-IT among the community and other

EM related areas. FIU-ARC is approaching this integration using DOE's *social media policy and best practices* as a guideline to provide social integration on KM-IT to allow Like/Share/Pin to Facebook, Twitter, LinkedIn, and Pinterest as well as to utilize YouTube as platform for D&D KM-IT Videos. FIU developed a white paper to describe the planned social media integration activities for D&D KM-IT in FIU Performance Year 7 in comparison with the guidelines provided in DOE's *social media policy and best practices.*

During Performance Year 7, FIU completed deployment of two pilot videos onto the YouTube platform, including "Robotic Climber H-1 Model" and "Remotely-Operated Advanced Segmentation Process (RASP)." FIU proceeded to coordinate with DOE EM, including the IT group, to determine the best path forward to stream all of the videos (legacy and non-legacy) from the YouTube platform to make them assessable to the EM community. In support of this effort, FIU also compiled an inventory of the legacy videos provided to FIU on VHS format and subsequently digitized by FIU. Video titles, durations, and conversion information was provided to DOE.

Based on the discussions with DOE, FIU worked to transfer the series of legacy technology video files to DOE for posting to the DOE EM YouTube channel. FIU completed uploading 25 video files, a total of approximately 860 MB, to the established "EM Videos" folder on Kiteworks for DOE review prior to posting to YouTube. In addition, FIU received confirmation of approval from DOE EM that FIU can proceed with the strategy for leveraging social media via adding Like/Share/Pin style buttons on KM-IT.

Administration

System, database, and network administration are ongoing activities that FIU undertakes to maintain servers and applications to ensure a consistent high level of performance. FIU continued these efforts during this reporting period. System administration included the day-to-day maintenance and administration of the D&D KM-IT application, network, and database servers. Major tasks involved load balancing, active directory accounts, security patches, operating system updates, system optimization, server monitoring, and emergency problem resolution. Database administration included database backup, optimization, performance tuning, system security, controlling and monitoring user access to the database, and maintaining the database cluster. Finally, the network administration involved monitoring the network and server traffic, installing and maintaining the network hardware/software, assigning addresses to computers and devices on the network, troubleshooting network activities and performance tuning.

Data Mining

Vendors and Technologies

DOE Fellows and FIU graduate students performed data management activities in order to add current and relevant data to the D&D KM-IT System. Their efforts included identifying and adding additional D&D vendors and technologies from industry journals, conference publications, and news announcements as well as researching additional relevant D&D technologies offered by existing vendors. As of the end of September 2017, the Vendor module included a total of 954 vendors and the Technology module included a total of 1337

technologies, including 521 robotic technologies. The figure below shows a couple of the robotic technologies recently added.

Figure 37. Technologies recently added to D&D KM-IT: 510 Packbot (Endeavor Robotics) on left and Spotmini (Boston Dynamics) on right.

Over the last year, the number of registered users increased by 69 to a total of 988 while the number of subject matter specialists is 103. The top ten areas of expertise for registered subject matter specialists is shown below.

Table 3-1. Top Ten Areas of Expertise for Registered Subject Matter Specialists in D&D KM-IT

Expertise Area	SMS Registered
Decontamination	47
Characterization	42
Dismantlement	39
Demolition	35
Deactivation Planning	31
Radiation Controls	30
Large Scale Decon & Demolition	27
ALARA Controls	24
Computer Modeling	24
Sampling	24

News

FIU explored potential sources of information for D&D related news and is gathering and updating D&D KM-IT with D&D related news around the globe from multiple news sources. Figure 42 shows a screen shot of the industry news displayed on the homepage of D&D KM-IT.

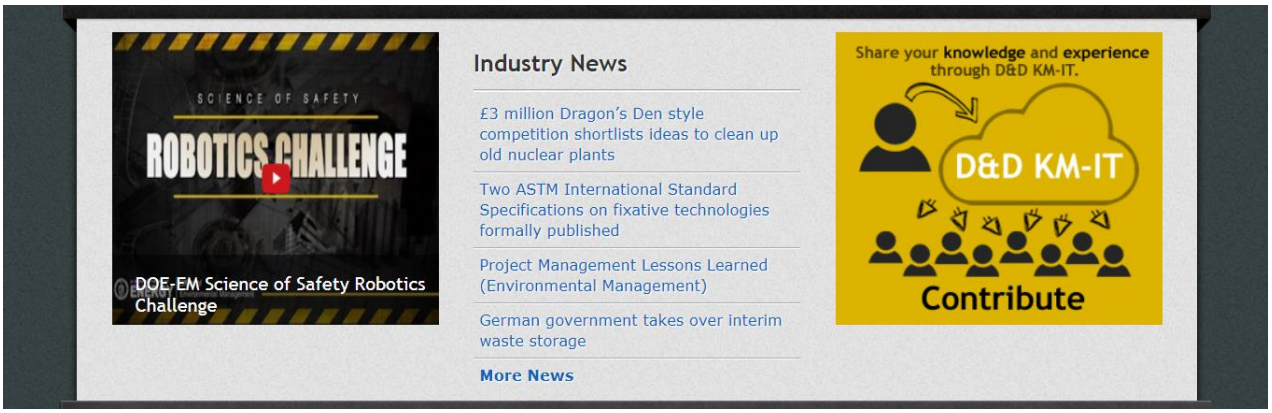

Figure 38. Industry news links displayed on homepage of D&D KM-IT.

TASK 3: CONCLUSIONS

Planning for the D&D of facilities across the DOE complex is a tremendous undertaking, especially considering that a significant number of the facilities contain hazards to human health and the environment: seriously deteriorated structural integrity, very high dose rates, high levels of fixed and removable contamination on/in facility surfaces and equipment, and chemically hazardous materials. Capturing the knowledge, experience, and lessons learned from historic D&D activities at DOE sites is imperative to the successful and safe management of future D&D projects. The D&D Knowledge Management and Information Tool is a central initiative to accomplish these goals.

TASK 3: REFERENCES

D&D Knowledge Management Information Tool (D&D KM-IT), www.dndkm.org, Applied Research Center, Florida International University.

Florida International University, *D&D Knowledge Management through Contributions in Wikipedia*, Summary Report, June 2017.

Lagos, L., P. Shoffner, J. Sinicrope. *D&D Technology Innovation, Knowledge Management, and Student Training*, EPRI International Low-Level Waste Conference, June 19-21, 2017.

Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Second Quarter 2016 (April 1 to June 30, 2016)*, Applied Research Center, Florida International University.

Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Third Quarter 2016 (July 1 to Sept 30, 2016)*, Applied Research Center, Florida International University.

Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Fourth Quarter 2016 (Oct 1 to Dec 31, 2016)*, Applied Research Center, Florida International University.

Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: First Quarter 2017 (Jan 1 to March 31, 2017)*, Applied Research Center, Florida International University.

Quintero, W., *Web Analytics for D&D KM-IT for Calendar Year 2016*, Applied Research Center, Florida International University.

Upadhyay, H., L. Lagos, W. Quintero, P.Shoffner. *Application of Robotics Technology to D&D, Waste Management Symposia*, Phoenix, AZ, March 5-9, 2017.

OVERALL PROJECT CONCLUSIONS

WIMS continues to successfully accomplish the goals and objectives set forth by DOE for this project. WIMS has replaced the historic process of each DOE site gathering, organizing, and reporting their waste forecast information utilizing different database and display technologies. In addition, WIMS meets DOE's objective to have the complex-wide waste forecast information available to all stakeholders and the public in one easy-to-navigate system. The enhancements to WIMS made over the last year include annual updated data sets.

The D&D support work for this period of performance included: 1) performing testing and evaluation of intumescent coatings technologies with the objective of enhancing the stabilization of radioactive contamination and fire resiliency and protection for fixatives and facilities in support of D&D activities at SRS 235-F and across the DOE EM complex; 2) implementing a phased approach for the standards development, testing, evaluation, and deployment of D&D technologies, with an emphasis working with ASTM International E10 Committee on Nuclear Technologies and Applications to develop testing protocols and performance metrics for testing and evaluating D&D technologies; and 3) investigating cross-cutting applications of robotic technologies from FIU's high-level waste research area (Project 1) in support of D&D activities. FIU also participated in workshops and conferences and served as subject matter experts.

These activities provide DOE with the information necessary to complete D&D safely and effectively for facilities which contain hazards that prevent the use of safe manual techniques; enhance safety while reducing risk to workers, the public, and the environment; reduce the future cost, schedule, and risk for similar work through a thorough understanding of existing technologies and technical approaches from past D&D projects, and provide the tools necessary to successfully complete difficult D&D tasks that can then be applied complex-wide to similar DOE facilities.

Planning for the D&D of facilities across the DOE complex is a tremendous undertaking. Capturing the knowledge, experience, and lessons learned from historic D&D activities at DOE sites is imperative to the successful and safe management of future D&D projects. The DOE D&D support task and the D&D KM-IT are two central initiatives to accomplish these goals and FIU has made significant contributions towards developing these tools. The D&D KM-IT system was developed by FIU in collaboration with DOE, EFCOG, and the former ALARA Center at Hanford and former ISSC at Savannah River. The D&D KM-IT system is ultimately a tool for and by the D&D community. Its success will be dependent on the participation and cooperation of those for whom it was designed. FIU will continue to work closely with DOE and the D&D community to ensure that the KM-IT system meets their needs for accurate and timely D&D information.

APPENDIX

The following reports are available at the DOE Research website for the Cooperative Agreement between the U.S. Department of Energy Office of Environmental Management and the Applied Research Center at Florida International University: http://doeresearch.fiu.edu

1. Florida International University, *D&D Knowledge Management through Contributions in Wikipedia*, Summary Report, June 2017.
2. Florida International University, *Adapting Intumescent Coating as Fire Resilient Fixatives ISO SRS 235-F D&D Activities – Phase II: Construction of SRS 235-F Hot Cell Test Bed and Application Demonstration*, Test Plan, January 2017.
3. Florida International University, *Incombustible Fixatives – Adapting Intumescent Coatings as Fire Retardant Fixatives to Support D&D Activities*, Technical Report, October 2017.
4. Florida International University, *Project Technical Plan*, Project 3: Waste and D&D Engineering and Technology Development, September 2016.