

## **FINAL TECHNICAL REPORT**

May 7, 2010 to August 28, 2015

# **Waste and D&D Engineering and Technology Development**

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**Applied Research Center**

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## **FIU STUDENTS DIRECTLY SUPPORTING DOE EM PROJECTS**

DOE Fellows from the DOE-FIU Science & Technology Workforce Development Program as well as FIU Graduate Research Assistants provide direct support to DOE EM projects around the complex. The following DOE Fellows and FIU Graduate Research Assistants supported the D&D research and information technology for EM tasks under FIU Project 4:

**DOE Fellow: Jesse Viera, Janesler Gonzalez, Orlando Gomez, Mariana Evora, Meilyn Planas**

Mentors: Joseph Sinicrope, Peggy Shoffner, Leo Lagos

Project Task: D&D Research for DOE EM-13, SRS, and INL: Testing and Evaluation of the FX2 Advanced Fogging Technology; Incombustible Fixatives; and Fixative Decision Model

**DOE Fellows: Revathy Venkataraman, Mariela Silva, Pedro Cordon, Jorge Deshon, Andrew De La Rosa, Steve Noel, Meilyn Planas**

**FIU Graduate Research Assistants: Santosh Joshi, Kavitha Megalageri**

Mentors: Himanshu Upadhyay, Peggy Shoffner

Project Task: Data mining activities and entries to populate D&D KM-IT

A complete list of DOE Fellows supporting the DOE EM research efforts can be found in the Year End Report for Project 5, section 8, “DOE Fellows Directly Supporting DOE EM Projects” on pages 57-58.

Addendum:

This document represents one (1) of five (5) reports that comprise the Final Technical Reports for the period of May 18, 2014 to August 28, 2015 (FIU Year 5) 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. A summary of FIU Year 1 to FIU Year 4 (May 7, 2010 to May 17, 2014) is also included.

The complete set of FIU's Final Technical Reports for this reporting period includes the following documents and 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://doersearch.fiu.edu>):

Project 1: Chemical Process Alternatives for Radioactive Waste  
Document number: FIU-ARC-2015-800000393-04b-237

Project 2: Rapid Deployment of Engineered Solutions for Environmental Problems  
Document number: FIU-ARC-2015-800000438-04b-228

Project 3: Remediation and Treatment Technology Development and Support  
Document number: FIU-ARC-2015-800000439-04b-232

Project 4: Waste and D&D Engineering and Technology Development  
Document number: FIU-ARC-2015-800000440-04b-229

Project 5: DOE-FIU Science & Technology Workforce Development Initiative  
Document number: FIU-ARC-2015-800000394-04b-090

Each document will be submitted to OSTI separately under the respective project title and document number as shown above.

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## TABLE OF CONTENTS

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LIST OF FIGURES .....	ii
PROJECT 4 OVERVIEW .....	1
TECHNICAL PROGRESS FROM FIU YEAR 1 TO FIU YEAR 4 .....	3
Task 1 Summary – DOE’S Waste Information Management System.....	3
Task 2 Summary – D&D Toolbox Support .....	4
Task 3 Summary – D&D Knowledge Management Information Tool .....	7
Task 4 Summary – Centralized Knowledge Base System and FIU-DOE Research Website.....	9
Task 5 Summary – Cyber Security Compliance and Deployment of Environmental Contamination and Remediation Models.....	10
TASK 1. DOE’S WASTE INFORMATION MANAGEMENT SYSTEM (FIU YEAR 5) .....	11
Task 1: Executive Summary .....	11
Task 1: Introduction .....	11
Task 1: Experimental .....	11
Task 1: Results and Discussion.....	11
Task 1: Conclusions .....	15
Task 1: References .....	16
TASK 2. D&D SUPPORT FOR DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT (FIU YEAR 5) .....	17
Task 2: Executive Summary .....	17
Task 2: Introduction .....	17
Task 2: Experimental .....	17
Task 2: Results and Discussion.....	17
Task 2: Conclusions .....	32
Task 2: References .....	33
TASK 3. D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (FIU Year 5).....	34
Task 3: Executive Summary .....	34
Task 3: Introduction .....	34
Task 3: Experimental .....	34
Task 3: Results and Discussion.....	34
Task 3: Conclusions .....	56
Task 3: References .....	56
OVERALL PROJECT CONCLUSIONS .....	58
APPENDIX.....	59

## LIST OF FIGURES

---

Figure 1. WIMS screenshot displaying new 2015 data set as GIS map. ....	12
Figure 2. WIMS screenshot displaying new 2015 data as a waste disposition map.....	13
Figure 3. ARC staff Walter Quintero and Himanshu Upadhyay presenting WIMS at WM15. ...	15
Figure 4. HandiLaz Mini from Particle Measuring Systems. ....	19
Figure 5. Hot cell mockup facility (left), DOE Fellows with FX2 fogging agent (right).....	20
Figure 6. Mixing FX2 (left), filling fogger (middle), photographing sample for ImageJ (right). 21	
Figure 7. Applying compressed air to metal sample (left) and applying brush test to metal sample (right). ....	22
Figure 8. Red-tinted FX2 agent covers all horizontal surfaces in 10'x15'x10' hot cell mockup after fogging (left). Fogged challenge sample located inside apparatus facing away from foggers (right). ....	23
Figure 9. Intumescent coating reacting to flame / heat source. (Source: One Stop Shop in Structural Fire Engineering, Professor Colin Bailey, University of Manchester). ....	24
Figure 10. Preliminary work on decision model using pair-wise comparison of the criteria. ....	25
Figure 11. Decision Model created in Matlab. ....	26
Figure 12. Partial Screenshot of the Data Table for Contamination Control Products.....	27
Figure 13. ARC Fact Sheet for D&D Decision Model for selection of fixative, strippable coating, and decontamination gel products .....	28
Figure 14. ARC scientists/engineers and DOE-EM leadership (Mr. Mark Gilbertson) during the Wrap Up session. ....	29
Figure 15. DOE Fellow Jesse Viera presenting his research poster at WM15. ....	30
Figure 16. DOE Fellow Meilyn Planas presenting her research poster at WM15.....	31
Figure 17. FIU presenting remote platform during Robotics D&D technical session at D&RS Conference. ....	32
Figure 18. Poster presentation of FX2 test and evaluation at the EPRI Decommissioning Workshop.....	32
Figure 19. Overview of D&D KM-IT Technology module presented at D&RS Conference.....	35
Figure 20. Dr. Hiimanshu Upadhyay presenting D&D KM-IT during WM15.....	36
Figure 21. DOE Fellows and ARC staff at FIU booth during WM15 Exhibit Hall. ....	37
Figure 22. Ms. Peggy Shoffner presenting D&D KM-IT at the EPRI Decommissioning Workshop.....	38
Figure 23. Mr. Walter Quintero and Dr.Himanshu Upadhyay hosting the FIU ARC information booth at the 2015 ANS Utility Working Conference.....	38
Figure 24. Sample presentation slides on D&D KM-IT web analytics .....	39

Figure 25. Example slide from D&D KM-IT Overview Presentation.....	40
Figure 26. Infographic based on Web Analytic Data for D&D KM-IT for 2014.....	41
Figure 27. Infographic based on Web Analytic Data for D&D KM-IT for the first quarter of 2015.....	42
Figure 28. 2014 vs 2013 & 2012. Pages Per Session, Average Duration, Bounce Rate and Percentage of New Sessions. ....	42
Figure 29. Newsletter announcing ITSR availability on D&D KM-IT .....	44
Figure 30. Screenshot of final fixatives newsletter for D&D KM-IT user base.....	45
Figure 31. Newsletter on Hanford PPE best practice. ....	46
Figure 32. Newsletter to announce D&D KM-IT presence at WM15.....	47
Figure 33. Thank you notice to new D&D KM-IT users.....	47
Figure 34. Robotics Database newsletter for D&D KM-IT.....	48
Figure 35. Technology Database newsletter for D&D KM-IT.....	49
Figure 36. New popular keyword display from D&D KM-IT homepage. ....	50
Figure 37. Screenshots during testing of D&D KM-IT lessons learned lite application.....	51
Figure 38. Screenshot of the D&D KM-IT Lessons Learned landing page, showing the external link to the DOE HSS Lessons Learned database. ....	52
Figure 39. Omni Jaw 5 Technology added to D&D KM-IT.....	53
Figure 40. Technology module homepage showing robotics technologies.....	55
Figure 41. Robotic technologies newly integrated into D&D KM-IT Technology module. From left: Mighty Mouse by Sandia National Lab, Big Dog by Boston Dynamics, and HRP-3 Promet MK-II by Kawada Industries.....	55
Figure 42. Industry news links displayed on homepage of D&D KM-IT. ....	56

## PROJECT 4 OVERVIEW

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The Waste and D&D Engineering and Technology Development Project (Project 4) 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-1 with the Nuclear Decommissioning Authority (NDA) in England and the International Atomic Energy Agency (IAEA). This project included the following tasks during the May 7, 2010 to August 28, 2015 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-13 in meeting the D&D needs and technical challenges around the DOE complex. FIU concentrated its efforts during FIU Year 5 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-1 International Program and the EM-13 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 (EM-13 & EM-72), 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 accessed from web address <http://www.dndkm.org>.

### **Task 4: Centralized Knowledge Base System and FIU-DOE Research Website**

This was a new task executed during FIU Year 4. The centralized knowledge base system and FIU-DOE research website serves to capture and make easily available the work that FIU performs for DOE under the FIU-DOE Cooperative Agreement. These virtual tools function as a



point-of-access for easy retrieval by the users. The objective of this task was to centralize the virtual systems that FIU uses to capture and make available the work they perform for DOE under the FIU-DOE Cooperative Agreement.

#### **Task 5: Cyber Security Compliance and Deployment of Environmental Contamination and Remediation Models**

This was another new task executed during FIU Year 4. Under this task, FIU published and deployed one environmental contamination and remediation model, developed under Project 3, through the secured KM-IT platform to improve access to the models by project stakeholders.

## **TECHNICAL PROGRESS FROM FIU YEAR 1 TO FIU YEAR 4**

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### **TASK 1 SUMMARY – DOE’S WASTE INFORMATION MANAGEMENT SYSTEM**

In order to facilitate accelerated cleanup initiatives, waste managers at DOE field sites and at DOE headquarters in Washington, D.C., need timely waste forecast information regarding the volumes and types of waste that will be generated by DOE sites over the next 25 years. Each local DOE site historically collected, organized, and displayed site waste forecast information in separate and unique systems. However, waste information from all sites needs a common application to allow interested parties to understand and view the complete complex-wide picture. A common application would allow identification of total waste volumes, material classes, disposition sites, choke points, and technological or regulatory barriers to treatment and disposal. The Applied Research Center (ARC) at Florida International University (FIU) in Miami, Florida, developed this needed web-based waste forecast system.

The initial requirement from DOE Headquarters (HQ) was to consolidate waste forecast information from separate DOE sites and build forecast data tables, disposition maps and geographical information system (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. 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 2000. Visual Studio 2003, SQL server reporting services, Dream Weaver and Photoshop were also used as development tools to construct the system. FIU completed the deployment of a fully operational web-based waste forecast system with waste information from an initial 24 DOE sites in May 2006.

The Waste Information Management System (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, GIS maps, and other displayed and printed 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. Individuals may visit the web site at <http://www.emwims.org>.

During FIU Years 1 to 4, FIU efforts on WIMS included updating the WIMS application, reports and data interfaces to display the new sets of forecast data on an annual basis. As a part of the 2010 data import, FIU modified all of the WIMS modules (Forecast, Disposition, GIS and Transportation) to show waste streams associated with the American Recovery & Reinvestment Act (ARRA) funding in addition to the waste streams associated with the baseline funding. FIU also completed an upgrade of the WIMS database from SQL Server 2000 to SQL Server 2005 database server on January 31, 2011. This upgrade was needed to optimize the administration and maintenance of the database server. With the 2012 data import, FIU modified the WIMS modules (Forecast, Disposition Map, GIS, and Transportation) to add 3 new commercial disposal sites and facilities to the system as well as 2 new onsite disposal locations.

FIU also participated in relevant meetings and conferences in support of this task. FIU submitted papers and presented WIMS at the Waste Management Conference held in Phoenix, AZ during the February/March timeframe each year: an oral presentation at WM11 and poster presentations at WM12, WM13, and WM14.

WIMS continues to successfully accomplish the goals and objectives set forth by DOE. 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 years since its web deployment, the new functional modules and the annual waste forecast data updates continue to ensure the long-term viability and value of this system.

## **TASK 2 SUMMARY – D&D TOOLBOX SUPPORT**

In FIU Year 1, FIU performed a technology demonstration of a remote sprayer platform for the application of strippable coatings and decontamination gels, supported SRS in research and experimental testing for *in situ* decommissioning, provided D&D support to DOE-EM international programs and EFCOG, and participated in workshops and conferences, and served as subject matter experts.

The objective of the technology evaluation was to document the ability of an International Climbing Machine (ICM) remote system to spray three different strippable coating products onto vertical concrete and metal surfaces. The selected technology was demonstrated at the ICM facility in Ithaca, NY, where the technology was shown to be capable of traveling across the floor of the building module and climbing the walls unassisted while being controlled remotely by the operator. The technology sprayed the products to the vertical wall surfaces and a sufficient thickness of each product was achieved to promote the ability of the product to be stripped from the surface once dry. Overall, the three products sprayed well and were relatively easy to strip, once dry, from the stainless steel and concrete panels. A final report was prepared to document the findings of this technology demonstration and a DOE Tech Fact Sheet was developed. In addition, information, photographs, and video were gathered and incorporated into the web-based D&D KM-IT for complex wide distribution.

FIU also performed experiments to conduct a thermal analysis of a special grout mixture in support of SRNL who was implementing *in situ* decommissioning (ISD) at two reactor facilities by filling all subsurface areas with a special grout. Temperature differences as the mixture cures can affect the properties of the grout as well as cause the material to expand and contract as it heats and cools, which may in turn cause thermal cracking. An initial experimental setup was performed at FIU in order to measure and record the changes in temperature along the radial and axial direction of the grout mixture with respect to time. The experiment focused on determining the presence of localized hot spots and determining the extent of thermal uniformity. The fresh and cured quality analysis testing of the grout was close to or within the range of the figures from those developed at SRNL. The maximum temperature the grout generated during the hydration was 100°F, with subsequent lower peaks occurring after the first 24 hours. The overall results of this experiment proved that the temperature generated by the grout does not significantly affect its properties, and therefore that the grout cured properly. FIU conducted a second similar experiment to gain a better understanding on the performance of various cementitious materials

that could be used during the process of ISD. FIU developed a thermocouple tree and concrete maturity logger to investigate the temperature distribution and strength generated by this grout. The temperature and strength data obtained was compared with the temperature data modeled by SRS.

Two DOE Fellows completed summer internships at ORNL in 2010 during which conceptual designs for a stack characterization system (SCS) were created as a collaborative project between the Robotics and Energetic Systems Group at ORNL and ARC at FIU. The SCS was designed as a remote system which can characterize the quantitative and qualitative levels of contamination inside off-gas stacks, protecting workers from the physical, radiological and chemical hazards. The work completed during the internship included a core drill design capable of retrieving six core samples, a design for a radiation detector deployment mechanism, re-designs to a mechanism capable of collecting loose material from concrete surfaces and experimental testing to determine the best collection material for the sampler. Before the end of the internship, a re-design for the smear sampler carousel was created, modeled in 3D software, fabricated and assembled. The core drill design was completed and, along with lessons learned on the design, was used on a final design completed by the head mechanical engineer of the Robotics and Energetic Systems group. Upon their return to FIU, the DOE Fellows continued to work on the system, including the development of conceptual designs for a containment system to protect the surrounding environment near the stacks from contamination, and the performance of studies on varying concrete materials to determine the best way of retrieving loose contamination from the surface.

During FIU Year 2, FIU worked with ICM to conduct an initial feasibility and trade study to identify the requirements for the remote removal of strippable coatings using the existing remote controlled platform. The initial feasibility study entailed analyzing the technical challenges of developing such a device as well as bench-scale testing to study and test various potential tools and mechanisms that could be integrated with the remote platform. The preliminary testing served as a proof-of-concept that the tools are capable of removing strippable coating. The tools were further evaluated using factors such as size and weight, motor or electricity usage, and complexity of movement to determine a reasonable mechanism for integrating the tool with the ICM platform. During FIU Year 3, FIU worked with ICM on improvements to the methods that were identified during the Phase I feasibility study. The two tools used for this study were re-designed, enhanced and improved versions of the tools built and tested during Phase I. The silicon carbide-bristled brush with a vacuum shroud was effective at removing the coatings tested from both concrete and metal surfaces. The gripper/scrapper (robotic arm with mechanical “hand”) was also effective at removing the coatings from both concrete and metal. This method was particularly fast after an edge had been lifted, pulling off the coating in sheets.

Another subtask in FIU Year 2, in an effort to aid in the evaluation of a sensor network for *in situ* decommissioning projects at SRS, a meso-scale concrete experimental test bed was designed and constructed at FIU-ARC in order to deploy and evaluate various sensors embedded in a specially formulated grout mixture. This experiment consisted of using various sensors, including electrical resistivity tomography, advanced tensiometers, piezoelectric sensors, and fiber optic sensors to measure strain, crack detention, corrosion, fluid mobility, moisture, pH and temperature. The main purpose of the experiment was to identify the limitations of these sensors for potential future use in monitoring decommissioned nuclear facilities.

During FIU Year 3, FIU completed the design, procurement, fabrication, and installation of a renewable energy system to support two of the sensor systems used on the meso-scale test bed. The system became operational and was used to power the thermocouple and tensiometer systems, as well as the weather station and ancillary networking equipment. The power system was implemented on a stand-alone structure that provided the appropriate wind-load capabilities for Miami, FL. Once installed and operational, FIU continued monitoring the usage and performance of the PV power system to maintain stable operation of the sensor systems continuously.

For FIU Year 4, FIU performed a focused literature review and developed a technical report on contamination control products (including strippable coatings, fixatives, and decontamination gels) for radiological surface decontamination in support of the SRS 235-F Risk Reduction Project. The summary report will help the project team develop their decontamination concepts for the PuFF process cells and define the outyear's technical activities.

Also during FIU Year 4, FIU worked in collaboration with the EFCOG DD/FE working group on the issue of aging infrastructure. FIU completed a literature search on this issue to gather any existing articles, papers, reports, and other documents from within the DOE complex. FIU also reached out to DOE site points of contact through the EFCOG DD/FE Working Group members to solicit information on the efforts being taken at the DOE sites to identify all the excess facilities, prioritize the maintenance/surveillance activities, and prioritize D&D when funding becomes available. The resulting information was compiled into a technical report to provide an overall picture on the status of aging infrastructure across the DOE complex.

Throughout FIU Years 1 to 4, FIU completed the development, review, and approval for best practice documents and lessons learned in collaboration with the EFCOG D&D Working Group. The objective of these efforts was to capture previous work performed by the D&D community and facilitate the transfer of knowledge and lessons learned. The documents included the following:

- The Washington Closure Hanford Site Explosive Demolition of Buildings 337 and 337B
- Lawrence Livermore National Laboratory Open Air Demolition of Asbestos Gunitite by Using Track Mounted Wet Cutting Saw Best Practice
- Savannah River Site 185-3K Cooling Tower Demolition Best Practice
- Lawrence Livermore National Laboratory Historical Hazard Identification Process for D&D Best Practice
- Closure of the Reactor Maintenance, Assembly, and Disassembly Facility and the Pluto Disassembly Facility at the Nevada National Security Site
- Unanticipated High Dose During the Removal of Wire Flux Monitor Cabling from the Heavy Water Component Test Reactor (HWCTR) Vessel
- Radiological Contamination Event During Demolition of the Separations Process Research Unit (SPRU) Building H2
- Structural Code Guidance for D&D Activities at DOE Facilities
- Electrical Code Guidance for D&D Activities at DOE Facilities

- Savannah River Site R and P Reactor Disassembly Basin In Situ Decommissioning
- Use of Earthen Benches and other Technologies to Support River Structures' Demolition Activities at the Hanford Site
- Hanford Site 327 Facility Source Term Stabilization and/or Removal Prior to Demolition
- Use of a Remote Tapping Tool at INL to Minimize Worker Exposure and Avoid Future Contamination Accidents

Finally, FIU participated in relevant meetings and conferences in support of this project. During FIU Year 1, FIU participated in the Hanford ALARA Workshop; participated in and helped coordinate a session at the Decommissioning, Decontamination & Reutilization (DD&R) Conference; and participated in the Waste Management 2011 Conference where FIU made presentations on the D&D research activities. As part of FIU Year 2, FIU participated in the International Conference on Environmental Remediation and Radioactive Waste Management (ICEM) conference held in Reims, France, as well as the Waste Management 2012 Conference. During FIU Year 3, FIU participated in the American Nuclear Society (ANS) Decontamination, Decommissioning, and Reutilization (DD&R) conference and the Waste Management 2013 Conference. As part of FIU Year 4, FIU participated in the Waste Management 2014 Conference.

### **TASK 3 SUMMARY – D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL**

#### *Outreach and Training*

Significant effort was made towards community outreach in support of the D&D KM-IT system during FIU Years 1 through 4. FIU participated in meetings and conferences, hosted conference exhibitor booths, provided presentations and workshops, drafted a user group charter, developed a project overview PowerPoint presentation, researched and wrote a white paper for leveraging Wikipedia and wiki-based technologies, contributed D&D information to Wikipedia, drafted a marketing plan document, collaborated with international organizations, and disseminated newsletters on D&D KM-IT to registered users, subject matter specialists, and conference attendees.

FIU participated in relevant meetings and conferences in support of this project during FIU Years 1 through 4. The D&D KM-IT system was demonstrated at the Hanford ALARA Workshop (2010 in Richland, WA), the ANS DD&R Conference (2010 in Idaho, ID and 2012 in Chicago, IL), and the ICEM Conference (in Reims, France). FIU also presented the KM-IT system to the Waste Management Conferences (WM11, WM12, WM13, and WM14) via professional presentations and via live demonstrations of the system to conference participants at the FIU booth in the exhibition hall.

In researching innovative ways to increase the effectiveness of the outreach efforts, FIU developed a white paper titled, "Leveraging Wikipedia and Wiki-Based Technologies," on the use of internet resources (e.g. Wikipedia) and how they are of value to the D&D KM-IT site. Wikis are an excellent tool for D&D KM-IT, to both increase the website's visibility on the web and further the mission of knowledge management for the D&D KM-IT and online wikis. ARC subsequently 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 information sources focused on for this initial effort were the EFCOG lessons learned and best practices that have been developed in collaboration between FIU and EFCOG and published on D&D KM-IT. Wikipedia articles were edited with information from an EFCOG best practice or lessons learned document, relevant and significant text was added to the body of the article and a reference to the information source was included in the article's list of references.

Also as part of the outreach effort, FIU created targeted newsletters to send electronically to D&D KM-IT registered users, 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. A total of 15 newsletters were developed and disseminated between January 2012 and March 2014.

An article on D&D KM-IT entitled, *Deactivation & Decommissioning (D&D) Knowledge Management– A Partnership between DOE, Contractors and Academia*, was published in the September-October 2012 edition of Radwaste Solutions.

FIU developed a PowerPoint presentation to present the D&D KM-IT project to upper level DOE management and other audiences. The presentation was used to present D&D KM-IT during a webinar with the Environmental Radiological Assistance Directory (ERAD) in 2012. Portions of the presentation were also used during the FIU Research Presentations to DOE in 2013. FIU also conducted a videoconference with EM-13 and EM-72 on January 6, 2014. In addition to a demonstration of the D&D KM-IT system, FIU presented the efforts on collecting and analyzing the website analytics as well as the cyber security of the system.

As an outreach effort for international collaboration, FIU worked with Sellafield Ltd to find areas of collaboration within the scope of D&D KM-IT: registration of international experts as D&D KM-IT subject matter specialists, links between D&D KM-IT and the Sellafield intranet, Sellafield technology report added to D&D KM-IT document library, and 23 D&D related technologies extracted from the report and added to the Technology module.

### *Application Development*

The D&D KM-IT system was made officially live to the D&D community during FIU Year 1. Further application development was performed during FIU Years 1 through 4. The D&D web crawler was developed to search and retrieve information from the web through customized web sites and links. The vendor management module was deployed to provide information on vendors who provide D&D products and services. The D&D collaboration tools provide a platform for collaboration among the D&D community members and currently include features such as news, event calendars, links, and FAQs. FIU developed mobile applications to allow D&D community members to access the information on KM-IT from smart phones and other hand-held devices. The global search feature uses keywords provided by the user to search through all the modules of KM-IT, including all documents and webpages. A D&D Dictionary was developed and deployed for common D&D keywords. The training module provides a central location for information on D&D related training, including D&D conferences and workshops, classroom training, available D&D certifications, training videos, and training documents. Twenty-six help videos were developed and added to assist users in the overall use of D&D KM-IT and the specific use of each module. A community contribution module was

deployed to foster greater community contribution in the area of D&D. The popular content module displays popular and related content to the user. FIU also created an external library webpage to direct users to external D&D web resources available.

### *Data Mining*

Data mining was also a major activity performed for D&D KM-IT throughout FIU Years 1 to 4. The full history of reports from the Hanford ALARA Center as well as the SRS Integrated Safety Solutions Center were compiled and integrated into the D&D KM-IT document library, making them available to the entire D&D community. A search feature was added to make these documents searchable by keyword. Relevant information from these reports was also extracted for publication in other relevant KM-IT modules (e.g., Hotline, Technology, etc.). FIU also added a total of 201 Innovative Technology Summary Reports (ITSR) to D&D KM-IT to provide a central location where users can find and download any of these technology reports. A set of legacy VHS tapes displaying D&D technologies were received from DOE, converted to a digital format and edited to provide brief clips for the picture/video module.

### *Application Optimization*

The first application optimization completed by FIU was the design and development of a completely new website look for D&D KM-IT which incorporated more user interaction, a fresher appearance and more intuitive navigation. The second type of application optimization that FIU performed was a search engine optimization process to improve the visibility of the website in the search results provided by internet search engines (e.g., Google, Bing).

The third type of application optimization that FIU utilized throughout FIU Years 1 to 4 was review and analysis of the website analytics. The information gathered from the web analytics software is valuable since it provides insight on site visitor behavior and is helpful to anticipate users' interests and needs. Web analytics has allowed D&D KM-IT to respond to its users' needs by making the information they seek easier for them to access. FIU developed regular reports (monthly at first and then switching to quarterly) to document the website analytics.

### *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 throughout FIU Years 1 through 4. System administration included the day-to-day maintenance and administration of the D&D KM-IT servers while database administration included database backup, optimization, performance tuning, and system security and network administration involved monitoring the network and server traffic, installing and maintaining the network hardware/software, troubleshooting network activities and performance tuning.

## **TASK 4 SUMMARY – CENTRALIZED KNOWLEDGE BASE SYSTEM AND FIU-DOE RESEARCH WEBSITE**

This task, conducted during FIU Year 4, consisted of the development of two tools for easy retrieval of the research work FIU performs for DOE EM. The first was the design and development of a simple interface, via a single web page, to illustrate the connection between all the independent applications or systems developed for DOE EM under different projects. The second, a centralized knowledge base system, was a DOE Research website to capture and make



available all the results developed by FIU for DOE under the Cooperative Agreement, available at [www.doeresearch.fiu.edu](http://www.doeresearch.fiu.edu). The DOE Research webpage includes technical reports, quarterly progress reports, end of year reports, presentations, journal articles, conference papers, and more. The DOE Research webpage is updated on a continual basis with the most recent research documents.

## **TASK 5 SUMMARY – CYBER SECURITY COMPLIANCE AND DEPLOYMENT OF ENVIRONMENTAL CONTAMINATION AND REMEDIATION MODELS**

Under this task for FIU Year 4, FIU published and deployed one environmental contamination and remediation model through a secured platform. The flow and transport models developed for the East Fork Poplar Creek in Oak Ridge resided on servers and personal computers at the Applied Research Center at FIU in Miami. This task published and deployed one of these environmental contamination and remediation models on a secured platform to demonstrate the improved access to the models by project stakeholders.

## **TASK 1. DOE'S WASTE INFORMATION MANAGEMENT SYSTEM (FIU YEAR 5)**

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### **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 to the online WIMS in order to ensure a consistent high level of database and website performance. New waste forecast and transportation forecast data is imported into WIMS on an annual basis.

The 2015 waste forecast and transportation data was collected, reviewed, and transmitted from DOE to FIU on April 15, 2015. FIU completed the data import into the master database by

building 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. The new data set was deployed onto the test server and FIU performed quality review and testing of the data. FIU then sent the link to DOE for further testing and review (completing project milestone 2014-P4-M1.1) on May 14, 2015. FIU incorporated the feedback from the data review and deployed the new data on the public WIMS server on June 9, 2015. The 2015 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 2015 data update and Figure 2 provides a screenshot of the waste disposition map displaying the 2015 data update.

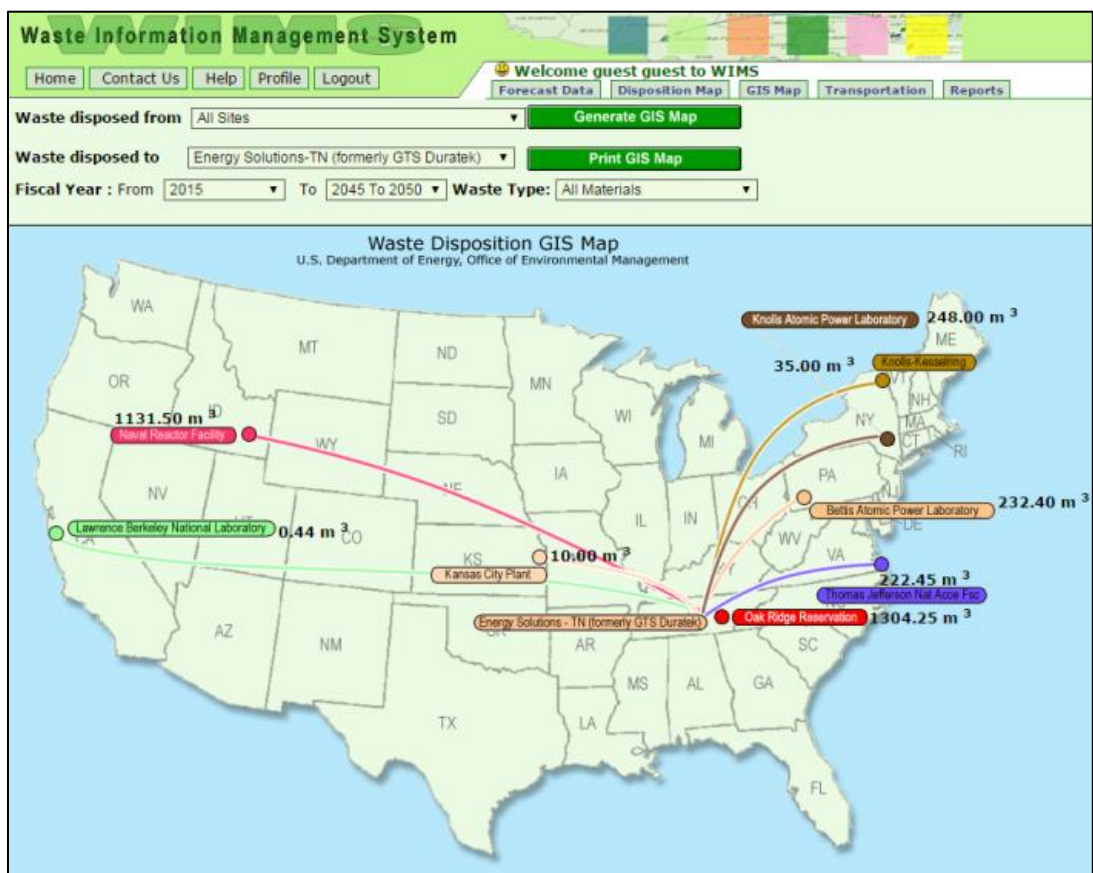


Figure 1. WIMS screenshot displaying new 2015 data set as GIS map.

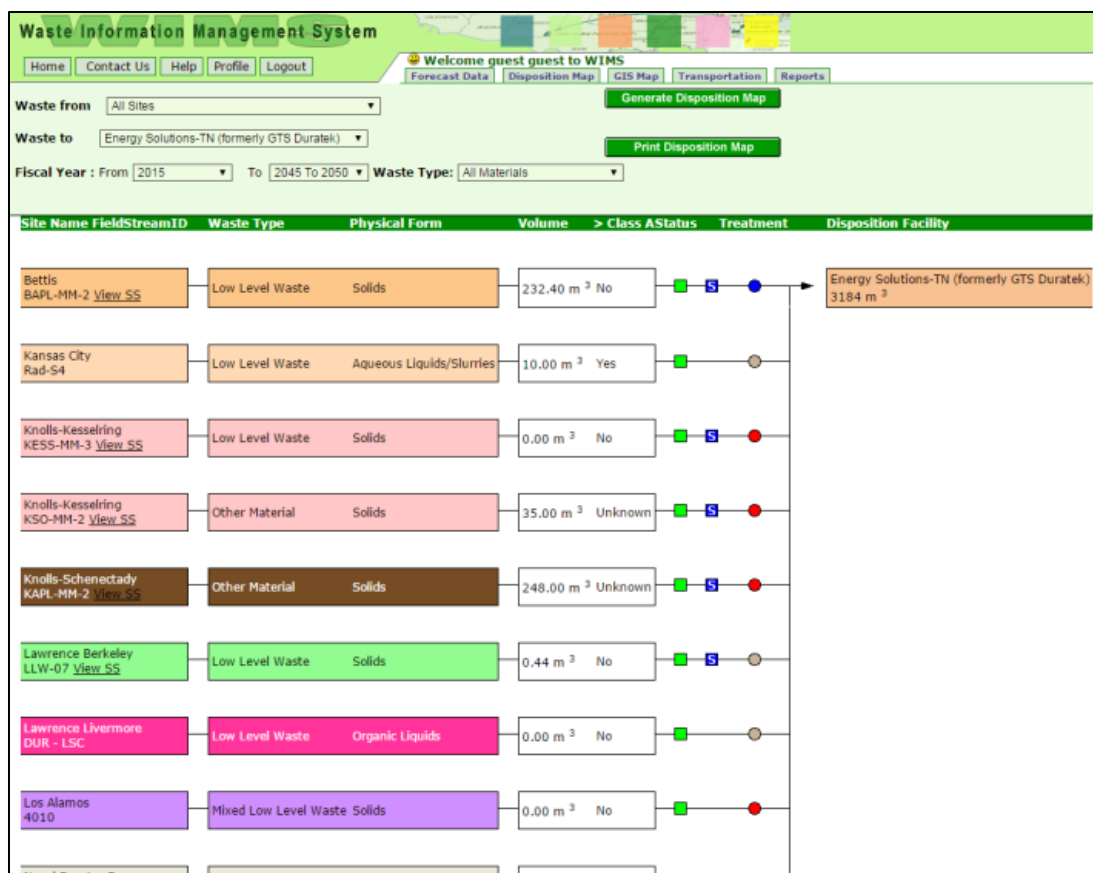


Figure 2. WIMS screenshot displaying new 2015 data as a waste disposition map.

### 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:

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020-2024
- 2025-2029
- 2030-2034
- 2035-2039
- 2040-2044
- 2045-2050

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
- 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
- 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 2014 (milestone 2014-P4-1.2) and a technical paper in November 2014 for WIMS and submitted these to the Waste Management Symposium 2015 (WM15). WM15 accepted the technical paper and a professional poster entitled, *Waste Information Management System with 2014-15 Waste Streams*, was presented during poster session 49C on March 17, 2015. This poster presented WIMS with the 2014 dataset of wastestream and transportation forecast information from the various DOE sites and facilities. FIU also demonstrated WIMS to interested conference attendees at the FIU exhibitor booth during the conference. Figure 3 is a photograph the poster being presented at the conference.



Figure 3. ARC staff Walter Quintero and Himanshu Upadhyay presenting WIMS at WM15.

## 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, J. Phillips, L. Lagos, *Waste Information Management System 2014-15*, Waste Management 2015 Conference, Phoenix, AZ, March 2015.



## **TASK 2.**

### **D&D SUPPORT FOR DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT (FIU YEAR 5)**

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#### **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 DOE EM-13 in meeting the D&D needs and technical challenges around the DOE complex. FIU concentrated its efforts during FIU Year 5 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-1 International Program and the EM-13 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 D&D and Facility Engineering and 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 and demonstrate 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 Year 4 in support of technology innovation, development, evaluation and deployment.

#### **TASK 2: EXPERIMENTAL**

For FIU Year 5, FIU performed preliminary development of a decision making model to better guide end users on the selection of appropriate strippable and fixative coatings based on their specific needs, completed the testing and evaluation of the FX2 advanced fogging agent developed at INL, and developed a draft test plan for the Phase I testing to baseline incombustible fixatives and conduct a proof of principle on the hypothesis that fire resiliency for fixatives can be significantly enhanced by layering or combining with an intumescent coating. FIU also participated in workshops and conferences and served as subject matter experts.

#### **TASK 2: RESULTS AND DISCUSSION**

##### **Advanced Fogging Technology Research and Evaluation**

The objective of this research task was to collaborate with SRNL and INL to perform a technology demonstration to test and evaluate the FX2 advanced fogging technology, developed at INL, for potential implementation at the SRS 235-F facility. FIU kicked off this effort with a teleconference with Michael Serrato at SRNL and Rick Demmer at INL to discuss the fogging research and evaluation task. INL had received funding to execute a related research task and FIU aimed to collaborate where feasible to optimize the overall impact of the research and



minimize any duplication of effort between FIU and INL. FIU coordinated with the SRNL POC (Mike Serrato) and INL POCs (Rick Demmer and Steve Reese) to refine the scope for FIU's advanced fogging technology research and evaluation subtask. FIU further coordinated with INL to plan for a site visit and to receive all literature to date associated with FX2 fogging agent and delivery system for review.

On November 18-20, 2014, Mr. Joseph Sinicrope and Mr. Amer Awwad from FIU conducted a site visit to INL to be briefed on the FX2 fogging agent. Participants from INL included Mr. Rick Demmer, Mr. Steve Reese, and Mr. Don Fox. Meetings included a detailed history of the development of the FX2 fogging agent to date, a review of the tests and results achieved thus far by INL, a demonstration of the equipment and parameters used during the last test, and development of the test objectives for the next iteration of experiments at FIU. Based on the general concurrence received from all the various stakeholders, FIU started development of the cold demonstration test plan to be conducted at FIU.

FIU completed development of the initial draft for the FX2 Fogging Agent Test Plan in December 2014. The test plan outlined all components associated with the demonstration, testing, and evaluation of the FX2 fogging agent. The test plan was completed and reviewed by the primary stakeholders (FIU ARC, INL, and SRNL), receiving concurrence and final approval by all signatories in January 2015. All test objectives, testing methods, roles and responsibilities, and a detailed timeline and program of action and milestones were agreed upon.

All equipment and materials necessary to support the FX2 fogging agent test plan were identified and vendor quotes were obtained for needed equipment. FIU ARC also identified and engaged potential vendors for quotes associated with outsourcing the ASTM standardized tests designed to characterize the FX2 fogging agent, specifically in the areas of burn rate, viscosity, density, and surface tension. Once a vendor was selected, FIU completed preparing a purchase order for outsourcing ASTM standardized tests to the analytical laboratory.

ARC prepared the Radioactive Materials Handling Request Form required by the FIU Radiation Safety Officer (RSO) as outlined in the FX2 test plan. The final request form was forwarded to the FIU RSO and final approval from the FIU RSO and FIU Radiation Control Committee was received for the use of Po-210 sealed point sources during the testing. A PO was subsequently forwarded to the selected vendor and FIU received shipment of the Po-210 sealed point sources.

In addition, FIU prepared a PO and purchased a commercial airborne particle counter (HandiLaz Mini from Particle Measuring Systems, Figure 4). The HandiLaz Mini airborne particle counter supported a portion of the FX2 Test Plan to evaluate the fogging agent in its ability to control potential airborne particulates.



**Figure 4. HandiLaz Mini from Particle Measuring Systems.**

FIU completed the design phase of the hot cell mockup modifications required to support the execution of the FX2 test plan and purchased all necessary materials needed to complete the modifications. The facilities were inspected by the FIU RSO and determined to be satisfactory to support test objective for determining the shielding properties against an alpha emitter. During March, FIU finalized the modifications to the hot cell mock-up facility.

FIU acquired the ImageJ software necessary to support portions of the test plan objectives. Familiarization and training with the software was conducted in order to ensure a high level of proficiency with the software prior to actual execution. FIU also received two (2) commercial foggers and associated equipment as well as the FX2 fogging agent from INL to support the FX2 test plan. FIU performed functional testing of the equipment received from INL to ensure that everything was in working condition. These tests were all favorable.

The technology demonstration was performed from March 30 to April 8, 2015 at the ARC Technology Testing & Demonstration Facility in Miami where an existing hot cell mockup facility was modified to meet the objectives of the demonstration (Figure 5). Steve Reese from INL participated in the testing and evaluation.



**Figure 5. Hot cell mockup facility (left), DOE Fellows with FX2 fogging agent (right).**

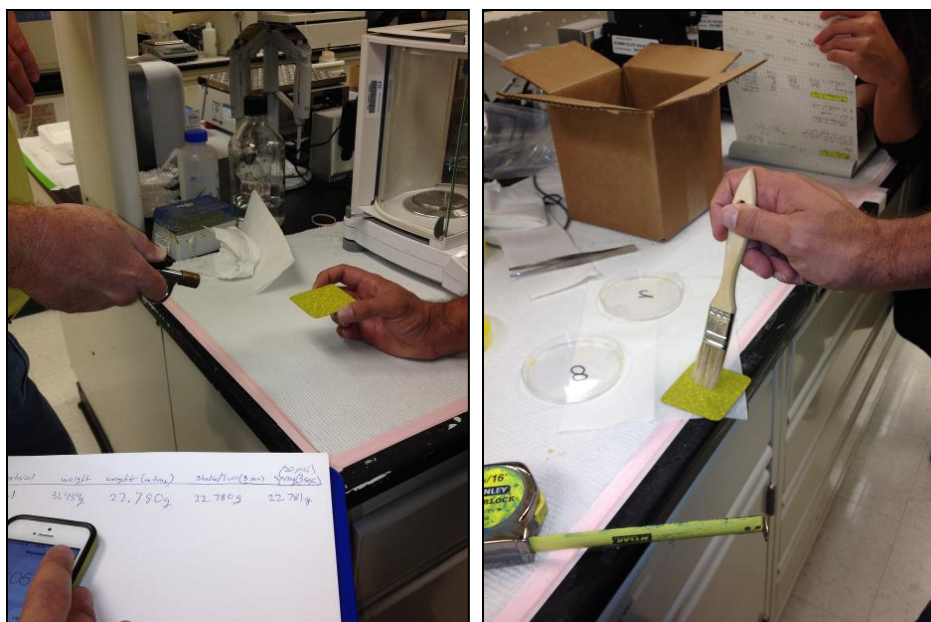
The technology demonstration of the FX2 Advance Fogging Technology at FIU included tests to evaluate the following:

- Ability to fix loose contamination to different types of surfaces (glass, concrete, steel, and plastic) and adhesiveness to the surface (Figure 7).
- Ability to cover locations outside of the direct line-of-sight of the fogger (Figure 8).
- Capacity to knockdown airborne particulates.
- Characteristic properties of the product:
  - Burn Rate (ASTM E84)
  - Flammability (ASTM D3065)
  - Viscosity (ASTM D2196)
  - Surface Tension (ASTM D1331)
  - Density (ASTM D1475)
- Reactivity to flame and heat sources during application of the fogging agent.
- Ability to shield against an alpha emitting point source.
- Coverage of surface area, as quantified via use of ImageJ software analysis.
  - Uses contrast analysis to determine coverage of the product.
  - Correlates radiation shielding to the coverage results.



**Figure 6. Mixing FX2 (left), filling fogger (middle), photographing sample for ImageJ (right).**

Overall, the technology was capable of successfully achieving the objectives of this demonstration. The FX2 advanced fogging agent, dispersed via commercial off-the-shelf foggers (Cyclone Ultra-Flex Fogger by Curtis Dyna-Fog), had a clear qualitative and quantitative ability to cover horizontal surfaces within the hot cell mock-up facility. The FX2 advanced fogging agent was very effective at reaching line-of-sight and non-line-of-sight areas. There did not appear to be any difference in the coverage achieved by the FX2 regardless of placement/location in the test facility. In addition, the advanced fogging agent demonstrated excellent fixing capacity for potential airborne particles such as dust and lint on metal, glass, plastic, concrete, and wood surfaces. The bond appeared slightly less durable on wood, but additional samples may be required before a definitive correlation can be made. The FX2 advanced fogging agent also demonstrated conclusive results in providing shielding against alpha sources as well as its non-flammability during the application phase. The results of the flammability tests performed by FIU indicated that the fogging agent is not flammable, with the exposed flame extinguishing within seconds of being exposed to the dispersed fog. Finally, the commercial off-the-shelf Cyclone foggers appeared to do an excellent job at dispersing the FX2 advanced fogging agent in its current composition.



**Figure 7. Applying compressed air to metal sample (left) and applying brush test to metal sample (right).**

A few challenges were encountered during the demonstration. Initial test runs using a single Cyclone fogger in the hot cell mockup facility failed to achieve a uniform application of the FX2 fogging agent. Since the objectives of the technology demonstration were test the FX2 agent itself and not specifically the delivery device, additional test runs were performed to optimize airflow throughout the entire space in a uniform fashion. The final solution implemented included using two Cyclone foggers at the same height (53”), along the same wall and blowing diagonally across each other’s stream. This set-up manipulated the air flow to move uniformly within the given space.

Another challenge faced was that a comprehensive NIST/ASTM standard for fixatives designed to operate in a radioactive environment does not exist. The requirement for a singular ASTM standard was previously identified by the industry but apparently lost momentum before culminating in an accepted published standard. FIU recommends the development and establishment of standardized testing protocols and performance measures for fixatives and related contamination control products. The testing protocols that FIU implemented during this technology demonstration for the ability of a product to fix loose and potential airborne contamination, ability to effectively cover non-line-of-sight areas, and ability to shield against radioactivity, could be used to begin this process.

One innovative methodology employed by FIU during this technology demonstration was the implementation of ImageJ software to determine the percent of surface coverage by the fogging agent. The software performed well in this regard and provided standardized analyses for documenting the results of the demonstration. The use of ImageJ software is worth further consideration in future testing protocols.





**Figure 8. Red-tinted FX2 agent covers all horizontal surfaces in 10'x15'x10' hot cell mockup after fogging (left). Fogged challenge sample located inside apparatus facing away from foggers (right).**

Following the completion of the technology testing and evaluation, FIU completed development of the FX2 technology demonstration report and the DOE Tech Fact Sheet and submitted these to DOE EM, SRNL, and INL on May 15, 2015. FIU completed clean-up activities for the test site and ARC laboratory as well as packed and shipped the fogging equipment back to INL. FIU also began developing a technical abstract to submit to appropriate publications and professional journals to publish findings on FX2 test and evaluation. In addition, DOE Fellows provided support in the research on strippable coating development for fogging applications (Jesse Viera) and mercury abatement through the use of an advanced fogging technology (Janesler Gonzalez) during their summer 2015 internships at INL.

### **Incombustible Fixatives for SRS 235F Facility**

The main objective for the research under this task is to enhance the stabilization of radioactive contamination even if a facility is subjected to a fire. Through regular discussions with Mike Serrato and Aaron Washington (SRNL), FIU refined the task scope for the incombustible fixatives research to include a comprehensive literature/industry search as well as the development of a Phase I test plan to evaluate the selected fixative products for incombustibility characteristics and to conduct a proof of principle on the hypothesis that fire resiliency for fixatives can be significantly enhanced by layering or combining with an intumescent coating.

A literature search, as well as engagement with end users, was performed to identify the best fixative products to be tested. The desired objective for the literature search was to identify the top fixatives that are industry leaders in trapping radionuclides and determine if they can be combined/layered with the industry leaders in fire protection (flash point/burn rate) or intumescent coatings to produce a synergistic effect that enhances overall fire resiliency.

FIU also assessed the requirements for performing testing/evaluation of incombustible fixatives at FIU, including locating an appropriate lab/facility for the testing, identifying equipment requirements, and researching the additional health and safety requirements for working with high temperature and/or open flames. FIU contacted vendors who have performed similar testing to gather information and request prices and availability for fixatives that could be tested using the combining/layering approach.

FIU worked closely with SRNL to develop and refine the list of fixatives, strippable coatings, decontamination gels, and fire resistant coatings that may best meet SRNL's needs for an incombustible fixative. A Phase I test plan to test these fixatives was then developed, first focusing on baseline testing for each fixative product used in isolation. FIU ARC held a meeting with the ARC D&D project team, FIU Radiation Safety Officer (RSO), and SRNL to provide a briefing and reach consensus on the test plan objectives and methodologies. The draft test plan was revised based on feedback from the ARC project team as well as the SRNL collaborators and subsequently finalized. The test plan was approved and signed by FIU and SRNL on July 9, 2015.

FIU ARC met again with the FIU RSO and conducted a site survey of the FIU Radiation Lab in order to outline the major components associated with the approved Test Plan. The results of these series of meetings will serve as the foundation and basis for the Radioactive Materials Handling Request Form that will be sent to the FIU Radiation Control Committee for review and approval. ARC also began the requisition process for the required fixatives, decon gels, and intumescent coatings needed to support the execution of the test plan. Research on the most appropriate muffle furnace and coating thickness gauges to support the experiments was also conducted. Figure 9 shows photos of an intumescent coating reacting to a heat source.



**Figure 9. Intumescent coating reacting to flame / heat source. (Source: One Stop Shop in Structural Fire Engineering, Professor Colin Bailey, University of Manchester).**

After execution of the Phase I test plan during the next performance period, additional future work on this task will consider the best fixatives in the areas of flash point and burn rate that could potentially be combined/layered to achieve an optimization in resiliency against fire hazards.

### **Development of a Decision Model for Contamination Control Products**

During FIU Year 4, FIU conducted a focused literature review (using D&D KM-IT, archived ALARA Reports, internet research, and vendor info) on contamination control products for radiological surface decontamination in support of the SRS 235-F Risk Reduction Project. The resulting summary report will help the project team develop their decontamination concepts for the PuFF process cells and define the out year's technical activities. FIU compiled data on each of the 40 products identified in the study and developed a matrix spreadsheet.

For FIU Year 5, due to the large variety of products available for decontamination, FIU began to work on a decision making model capable of receiving inputs and respectively returning appropriate outputs. Criteria being taken into consideration include the type of radiation being encountered, the properties of the surface where the radiation is found as well as the surface type, the location, and the isotopes involved. Each one of these criteria was then further expanded into sub-criteria in order to improve the accuracy of the model (Figure 10). FIU interacted with SRS

to identify the product search parameters based on project-specific needs and site applications. A selection of these search parameters were used to develop a preliminary decision model to better guide the product end users in the selection of the appropriate products.

## Pair-Wise Comparison of Parameters

Enter Number of Criteria :		5				
Parameters	Type of Radiation	Surface Properties	Location	Surface Type	Istopes Involved	Normalized Weight
Type of Radiation	1.0	2.0	2.0	2.0	2.0	0.320
Surface Properties	0.5	1.0	2.0	2.0	2.0	0.242
Location	0.5	0.5	1.0	2.0	2.0	0.187
Surface Type	0.5	0.5	0.5	1.0	2.0	0.143
Istopes Involved	0.5	0.5	0.5	0.5	1.0	0.108
sum	3.0	4.5	6.0	7.5	9.0	1.0
Consistency Check						
Lambda max	5.22					
CI	0.05					
RI	1.12					
Consistency Ratio	0.05					

## Pair-Wise Comparison of Sub-Criteria

Number of Sub Criteria:		3			
Type of Radiation	Alpha	Beta	Gamma	Weight	
Alpha	1.0	1.0	1.0	0.333	
Beta	1.0	1.0	1.0	0.333	
Gamma	1.0	1.0	1.0	0.333	
sum	3.0	3.0	3.00	1.0	
Consistency Check					
Lambda max	3.00				
CI	0.00				
RI	0.58				
Consistency Ratio	0.00				

**Figure 10. Preliminary work on decision model using pair-wise comparison of the criteria.**

FIU created code for the preliminary decision model in Matlab, performed testing, and worked to bug the code. The preliminary decision model in Matlab is capable of receiving user input related to the type of product needed and the application surface type; it then retrieves a list of decontamination products which fit the input criteria. A graphical user interface (GUI) was then created to make the application easy to use. This preliminary work on the decision model allows the user to upload Excel files, data files, and/or text files. The uploaded file is then displayed on a table and the user may do a keyword search for the application surface type or whether the product should be strippable or a fixative (Figure 11).



## DECISION MODEL

**Radiation:**

**Surface:**

**Application:**

**Category:**

Alpha  
Beta  
Gamma  
All

Metal  
Concrete  
Frosted Glass  
All

Remote  
Manual  
Either

Strippable  
Fixative  
Either

	Product Name	Manufacturer	Category	Application	Radiation	Surface	Cumulative	Use
1	DECON PEEL 5201 Halogen Free	Prevents contamination	General Chem ...	Strippable	Manual or rem...	Alpha Beta Ga...	Main use are o...	NA Used to immobilize radioactive conta
2	DECON PEEL 2640 (a neutral pH version of 5900)	Heavy D...	General Chem ...	Strippable	Wat...	Use for mercury...	This coating ca...	Non-Fl... Nuclear Equipment (Works best on N
3	DECON KLEAN 5850		General Chem ...	Strippable			Concrete, Glass...	NA Floors, walls and equipment (includi
4	DECON PEEL NUCLEAR 2050		General Chem ...	Strippable			NA	Used to immobilize dispersible radio
5	DECON PEEL Chemclean 5900		General Chem ...	Strippable		Use for mercury...	This coating ca...	NA DeconPeel Chemclean is a non-hazar
6	DECON PASTE 2510		General Chem ...	Strippable			NA	Designed for porous surfaces. This pr
7	CC FIX		InstaCote, Inc.	Fixative		All	N/A	Designed for application to surfaces
8	CC FIX LV		InstaCote, Inc.	Fixative		All	Any place wher...	Designed for hot cells and other high
9	CC WET (use with CC Fix)	First of a two step approach. (Di...	InstaCote, Inc.	Fixative (Water ...			N/A	Recommended for inaccessible areas
10	CC STRIP		InstaCote, Inc.	Strippable		All	Beryllium	N/A To decontaminate any contaminated
11	CC EPOXY 609 (Pipe Stabilizer)		InstaCote, Inc.	Fixative				CC Epoxy is a fixative control agent u
12	CC T 207 (Sludge Stabilization)	turns the sludge in to a "br...	InstaCote Inc.	Fixative		N/A	Sludge and soil	Stabilized tank residues that have po

**Figure 11. Decision Model created in Matlab.**

The project task team at FIU interacted with SRNL to gain further insight on what the end users were looking for in the decision model. Several ideas were discussed, including what needs to be added to the list of criteria such as: level of contamination, delivery system, etc. As a result of this conference call, a visit to SRS was scheduled for FIU to tour the site and meet with the manager of the SRS 235-F facility to discuss the decision model with the targeted end users. FIU visited SRNL and met with Mike Serrato as well as the technical team for the 235F facility; feedback for this task was received from the SRNL engineers/scientists who will perform the facility D&D. Based on these discussions, FIU began revising the Decision Model in order to fulfill the end users' requirements. The updated Decision Model allows for 4 inputs from the user including: radiation type, surface type, application, and product category. The Decision Model output consists of a list of products that fit any of the criteria, with the end goal that the product which fits the most criteria is the best fit for the job.

FIU also contacted the product vendors to update and expand on the information in the contamination control products database. Figure 12 shows a partial screenshot of the data table. Planning and preparations also began for developing a web application for the decision model. A design was selected for the graphical user interface (GUI) that will be displayed and the functionality of each item was mapped out.

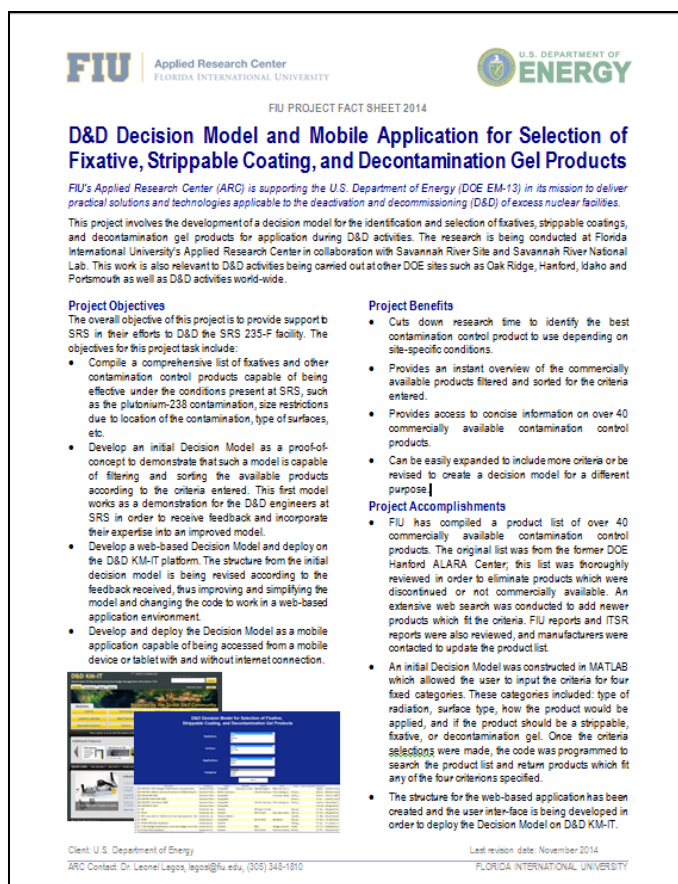
The design and development the web-based fixative model application is in progress. Design of the web-based database has been initiated. The group (criteria), category (sub-criteria) and products are taken as main credentials and other requirements are linked for decision making. SQL statements for the database have been created and will be tested for normalization. The database will be implemented in SQL server. Once the web-based application is complete

(planned for the next period of performance), it will be made available through the D&D Knowledge Management Information Tool portal for beta testing and input from field site users.

Product Name	Manufacturer	Strippable	Application	Use	Cost	Coverage
DECON PEEL 5201 Halogen Free Prevents contamination	General Chem Corp.	Yes	Apply the product as received using an airless spray to proper thickness (recommended a minimum of 30 mils) may also be applied with a roller or brush. Approx. 1 to 3 hour of drying time depending on the films thickness. The coating encompasses contaminants into the film mass. For airless equipment recommended to use a .015 or .017 nozzle at 1200-1500 psi. It is removed by peeling. More than one application is recommended.	Used to immobilize radioactive contamination, minimize exposure and facilitate consequent decontamination.	\$48.99 / gal	200 sqft/ gal at 8 mils.
DECON PEEL 2640 (a neutral pH version of 5900) Heavy Duty Decontamination pH Neutral Chemical, nuclear Equipment	General Chem Corp.	Yes	DeconPeel 2640 is normally used as received. Can be applied by an airless sprayer, a roller or a brush. Approx. 1 to 3 hours drying time depending on film thickness.	Nuclear Equipment (Works best on Metals)	\$48.97/gal	aprox - coverage 200 sqft/ gal at 8 mils.
DECON KLEAN 5850	General Chem Corp.	Rinse	DeconKlean, liquid cleaner, can be used as received (highly concentrated) or dilute in water, depending upon the severity of the soils to be removed. When used with mechanical agitation as in a floor scrubber, DeconKlean can be diluted up to 5% (1:20).	Floors, walls and equipment (including tools). Clean of loose particles.	\$40.95/gal	
DECON PEEL NUCLEAR 2050	General Chem Corp.	Yes	It can be applied by spray, roll or brush. The sprayed coating dries, depending on the film thickness, in 30 minutes to 4 hours.	Used to immobilize dispersible radioactive contamination deposited on buildings and equipment.	Approx. (\$47/gal)	50 sqft/gal

**Figure 12. Partial Screenshot of the Data Table for Contamination Control Products.**

An ARC Fact Sheet was developed for the Contamination Control Decision Model task and provided to DOE EM-13 in November 2014. This fact sheet is shown in Figure 13.



**Figure 13. ARC Fact Sheet for D&D Decision Model for selection of fixative, strippable coating, and decontamination gel products**

## EFCOG Lessons Learned and Best Practices

During FIU Year 5, FIU received notification that the DOE Energy Facility Contractors Group (EFCOG) DD/FE Working Group, as well as most of the other EFCOG working groups, were being discontinued and re-organized into a total of 4 working groups (Project Management, Waste Management, Safeguards & Security, and Safety). FIU had been providing support to the DD/FE WG in the development of lessons learned and best practices for deactivation and decommissioning (D&D) throughout the DOE complex. The objective of these efforts is to capture previous work performed by the D&D community and facilitate the transfer of knowledge and lessons learned. DOE Fellows at FIU work closely with the DD/FE Working Group members as well as site contacts in the collection of information and the development of these documents. Once approved by EFCOG and DOE, these documents are made available via D&D KM-IT and the EFCOG website.

During July 2014, FIU received comments and suggestions from DOE on 2 best practices: 1) SRS R and P -Reactor Disassembly Basin *In Situ* Decommissioning, and 2) Use of a Remote Tapping Tool at Idaho National Laboratory to Minimize Worker Exposure and Avoid Future Contamination Accidents. FIU completed the revisions on the SRS best practice in coordination with the SRS site contacts and based on the comments received from the DOE review. This document was sent back to DOE for final review and approval for publishing on the EFCOG and D&D KM-IT websites. FIU received approval from DOE and published the SRS best practice on

D&D KM-IT and sent it to the EFCOG webmaster for publishing on the EFCOG website on September 3, 2014.

Two other best practice documents were sent to the new site point of contact at Hanford for review: 1) Use of Earthen Benches and other Technologies to Support River Structures' Demolition Activities; and 2) 327 Facility Source Term Stabilization and/or Removal Prior to Demolition. FIU worked with the new site point of contact at Hanford to complete the revision of the two best practices. These documents were sent to DOE for review/approval on September 5, 2014. FIU received comments from DOE on these best practices, which were incorporated to finalize the documents.

### **Presentations, Meetings and Conferences**

FIU also participated in relevant meetings and conferences in support of this task. On November 12, FIU provided a presentation brief to Mr. Andrew Szilagyi (DOE EM-13, Office of D&D/Facility Engineering) on the D&D subtasks under this project, including the contamination control decision model, incombustible fixatives, and advanced fogging. Based on feedback received, all subtasks were aligned with guidance received from DOE-EM, and compliment several strategic initiatives being pursued in other areas. Input was incorporated and the updated brief was forwarded to SRNL and INL lead POCs as well.

From March 31 to April 3, 2015, a program review via videoteleconferencing was conducted between DOE EM and FIU ARC as part of the DOE Cooperative Agreement. A total of six (6) technical presentations were conducted over the 4-day period. The DOE-FIU program review included participation from colleagues at DOE Headquarters (DC and Maryland Office), DOE national laboratories (Savannah River National Lab, Pacific Northwest National Lab, and Idaho National Lab) and DOE contractors (Washington River Protection Solutions and Savannah River Nuclear Solutions).



**Figure 14. ARC scientists/engineers and DOE-EM leadership (Mr. Mark Gilbertson) during the Wrap Up session.**

The presentations included one on the D&D and IT for Environmental Management applied research. In addition, DOE Fellows presented during the technical presentations to highlight the applied research they are performing for DOE EM as part of this Cooperative Agreement. A final Wrap Up presentation was given on Friday to highlight the major applied research accomplishments during the current year and to present the proposed research tasks for the new performance cycle. All presentations are available for downloading on FIU's DOE Research webpage at <http://doeresearch.fiu.edu>.

Mr. Rod Rimando from DOE EM visited FIU on July 17, 2015. FIU developed a detailed update brief on the D&D tasks and made a presentation to Mr. Rimando to support discussions on current and future scope of work under the Cooperative Agreement.

In addition, two DOE Fellows prepared and presented student posters based on the research under this project at the Waste Management Symposium 2015 held in Phoenix, AZ in March. Jesse Viera (Figure 15) presented a student poster entitled, "FX2 Advanced Fogging Technology" and Meilyn Planas (Figure 16) presented a student poster entitled, "D&D Decision Model and Mobile Application for Selection of Fixative, Strippable Coating, and Decontamination Gel Products."



Figure 15. DOE Fellow Jesse Viera presenting his research poster at WM15.





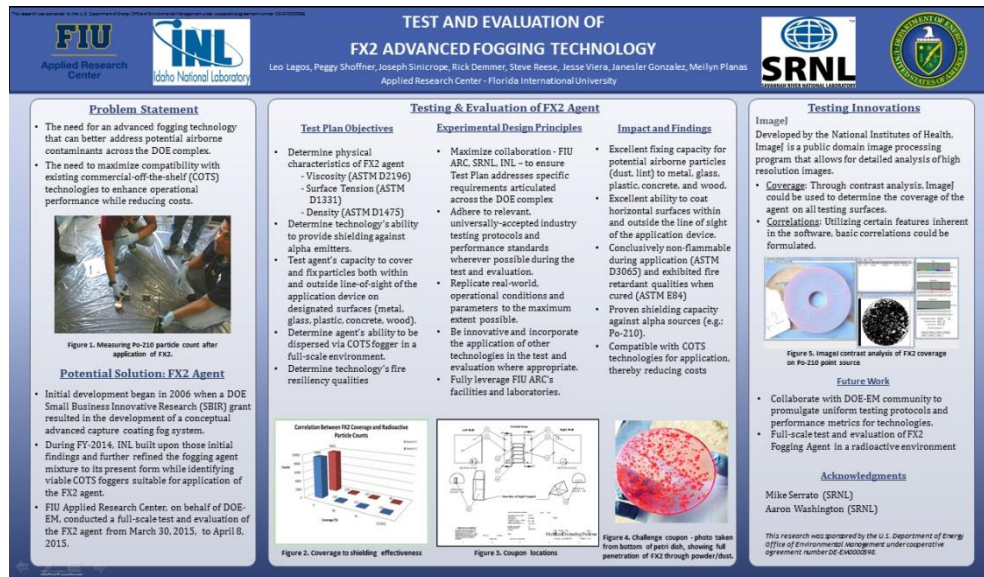
**Figure 16. DOE Fellow Meilyn Planas presenting her research poster at WM15.**

FIU participated in the Decommissioning and Remote Systems (D&RS) conference at the American Nuclear Society (ANS) 2014 Annual Meeting in Reno, Nevada, on June 15-19, 2014. ARC staff co-chaired a technical session on “International Decommissioning” on June 17, 2014, in which presentations were given on decommissioning projects in Germany, France, and Canada. One (1) professional oral presentation was also given by ARC staff on June 17, 2014, during a session titled “Robotics D&D” (Figure 17). The presentation was titled “Remote Platform for the Performance of Deactivation and Decommissioning Tasks” and was based on the work FIU performed in collaboration with the technology vendor, International Climbing Machine, demonstrating proof-of-concept abilities of the remote system to spray fixatives, strippable coatings, and decontamination gels as well as the feasibility for the remote system to remove the strippable coatings and decontamination gels in hazardous areas that prevent worker entrance.



**Figure 17. FIU presenting remote platform during Robotics D&D technical session at D&RS Conference.**

FIU also developed and presented a research poster on the advanced fogging agent research for the EPRI Decommissioning Workshop in June in Orlando, FL (Figure 18). During this conference, FIU also participated as a panel member in a discussion focused on U.S. Nuclear Plant Decommissioning Overview.



**Figure 18. Poster presentation of FX2 test and evaluation at the EPRI Decommissioning Workshop.**

## 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.

## **TASK 2: REFERENCES**

Florida International University, *FX2 Advanced Fogging Technology: Technology Demonstration Test Plan*, January 2015.

Florida International University, *FX2 Advanced Fogging Agent*, DOE EM Tech Fact Sheet, April 2015.

Florida International University, *FX2 Advanced Fogging Agent*, Technology Demonstration Report, May 2015.

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

Shoffner, P., L. Lagos, S. Maggio, *Remote Platform for the Performance of Deactivation and Decommissioning Tasks*, American Nuclear Society Decommissioning and Remote Systems Conference, Reno, NV, June 2014.

Sinicrope, J., P. Shoffner, L. Lagos, R. Demmer, S. Reese, J. Viera, J. Gonzalez, M. Planas. *Test and Evaluation of FX2 Advanced Fogging Technology*, EPRI Decommissioning Workshop, Orlando, FL, June 2015.

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## **TASK 3.**

### **D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (FIU Year 5)**

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#### **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 Year 5, 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 and 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 (EM-13 & EM-72), 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 accessed from web address <http://www.dndkm.org>, as well as via mobile devices at <http://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 Year 5 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 Year 5. FIU participated in meetings and conferences, hosted conference exhibitor

booths, held workshops, 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 developed and submitted a summary report defining the outreach and training metrics that would be used this year. This document expanded on the outreach and training activities for D&D KM-IT as described in the Project Technical Plan by defining specific metrics and capturing the tools and techniques to 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: *D&D KM-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.* FIU reported on the metrics progress for outreach and training activities for D&D KM-IT with a preliminary report to DOE on January 16, 2015 and a final report on May 8, 2015.

### Conferences

FIU participated in relevant meetings and conferences in support of this project, including the Decommissioning and Remote Systems (D&RS) conference at the American Nuclear Society (ANS) 2014 Annual Meeting, the Waste Management Symposium 2015, the EPRI Decommissioning Workshop, and the American Nuclear Society Utility Working Conference 2015.

FIU participated in the Decommissioning and Remote Systems (D&RS) conference at the American Nuclear Society (ANS) 2014 Annual Meeting in Reno, Nevada, on June 15-19, 2014. At the conference, FIU introduced the D&D KM-IT during an oral presentation (Figure 19). A brief overview of its Technology module and a demonstration of how searches can be performed for “remote” or “robotic” technologies from the almost 700 technologies related to D&D currently in the system was provided. The ARC staff who participated in the conference also distributed postcards with information on D&D KM-IT to all the technical sessions related to decommissioning as well as remote technologies. Conference attendees expressed interest in the system and a significant number noted that they were already familiar with and have used D&D KM-IT.



**Figure 19. Overview of D&D KM-IT Technology module presented at D&RS Conference.**

FIU submitted a technical abstract on D&D KM-IT to the Waste Management 2015 Symposia on August 12, incorporated comments from DOE, and resubmitted the abstract to the conference. FIU completed drafting a paper on D&D KM-IT and submitted it to the Waste Management 2015 Symposium (milestone 2014-P4-M3.1). FIU received comments from DOE on the draft paper, incorporated the comments, and submitted the final paper to the conference before the conference deadline of January 16, 2015.

FIU presented D&D KM-IT during an oral presentation for Session 067 of the Waste Management Symposium 2015 on March 17, 2015 (Figure 20). FIU also hosted a booth (#733) in the exhibitor hall during the conference (Figure 21). During the operation of the exhibitor booth and oral presentation of D&D KM-IT, FIU encouraged conference attendees to become active users of the system as well as to register as subject matter specialists. Significant interest was shown in the knowledge management of D&D as reflected by the increase in user registrations (65) during the conference, increasing the total number of registered users from 660 to 725. In addition, the number of subject matter specialists increased by 14, from 69 to 83.



**Figure 20. Dr. Hiimanshu Upadhyay presenting D&D KM-IT during WM15.**



**Figure 21. DOE Fellows and ARC staff at FIU booth during WM15 Exhibit Hall.**

Additional DOE Fellows and FIU graduate students also presented research posters related to this project during the WM15 student poster competition, including: Andrew De La Rosa (DOE Fellow) - Malware Forensics on Mobile Devices for DOE-EM Applications; Steve Noel (DOE Fellow) - D&D Knowledge Management Information Tool Feasibility Study for Cross-Platform Mobile Applications; Santosh Joshi (Graduate Research Assistant) - Deactivation and Decommissioning Web Log Analysis Using Big Data Technology; Jorge Deshon (DOE Fellow) - Best Practices Mobile Application for D&D KM-IT; and Kavitha Megalageri (Graduate Student Assistant) - Knowledge Management Information Tool Analytics with Distributed Database Engine.

FIU prepared and submitted an abstract on the D&D KM-IT and international KM-IT tasks and submitted it to the EPRI Decommissioning Workshop for consideration. Upon acceptance, FIU developed a Powerpoint presentation and participated in the EPRI Decommissioning Workshop in Orlando, FL on June 15-16, 2015. During this conference, FIU also participated in a panel discussion focused on U.S. Nuclear Plant Decommissioning Overview and provided an oral presentation on D&D KM-IT and the international KM-IT task (Figure 22).





**Figure 22. Ms. Peggy Shoffner presenting D&D KM-IT at the EPRI Decommissioning Workshop.**

FIU attended the American Nuclear Society (ANS) Utility Working Conference and Vendor Technology Expo in Amelia Island, FL, from August 10 to August 13, 2015. During the conference, FIU hosted a booth (#510) in the exhibitor hall to provide conference attendees with additional information on the applied research being conducted at ARC for the Department of Energy Office of Environmental Management (Figure 23). At the booth, FIU also provided live demonstrations of D&D KM-IT and invited and encouraged the conference attendees to register with the system. Approximately 83 conference attendees took advantage of the opportunity to register with the D&D KM-IT and 6 of those newly registered users also signed up as subject matter specialists (SMS) with the system. The SMS, through a directory of deactivation and decommissioning experts, share knowledge and experience in their areas of expertise, providing solutions to the challenges being faced by other members in the D&D community.



**Figure 23. Mr. Walter Quintero and Dr. Himanshu Upadhyay hosting the FIU ARC information booth at the 2015 ANS Utility Working Conference.**

### Workshops and Presentations

FIU provided a workshop/presentation in collaboration with DOE EM-13 to share approaches and lessons learned in developing web analytics for D&D KM-IT with the DOE Office of Learning & Workforce Development (HC-21) on August 20, 2014. Participants included FIU, EM-13, EM-72, and HC-21 on August 20. The workshop/presentation via Adobe Connect described what web analytics are, how we use it in relation to D&D KM-IT, our methodology, and how we are applying and reporting based on the information gained. Sample workshop/presentation slides are provided in Figure 24.

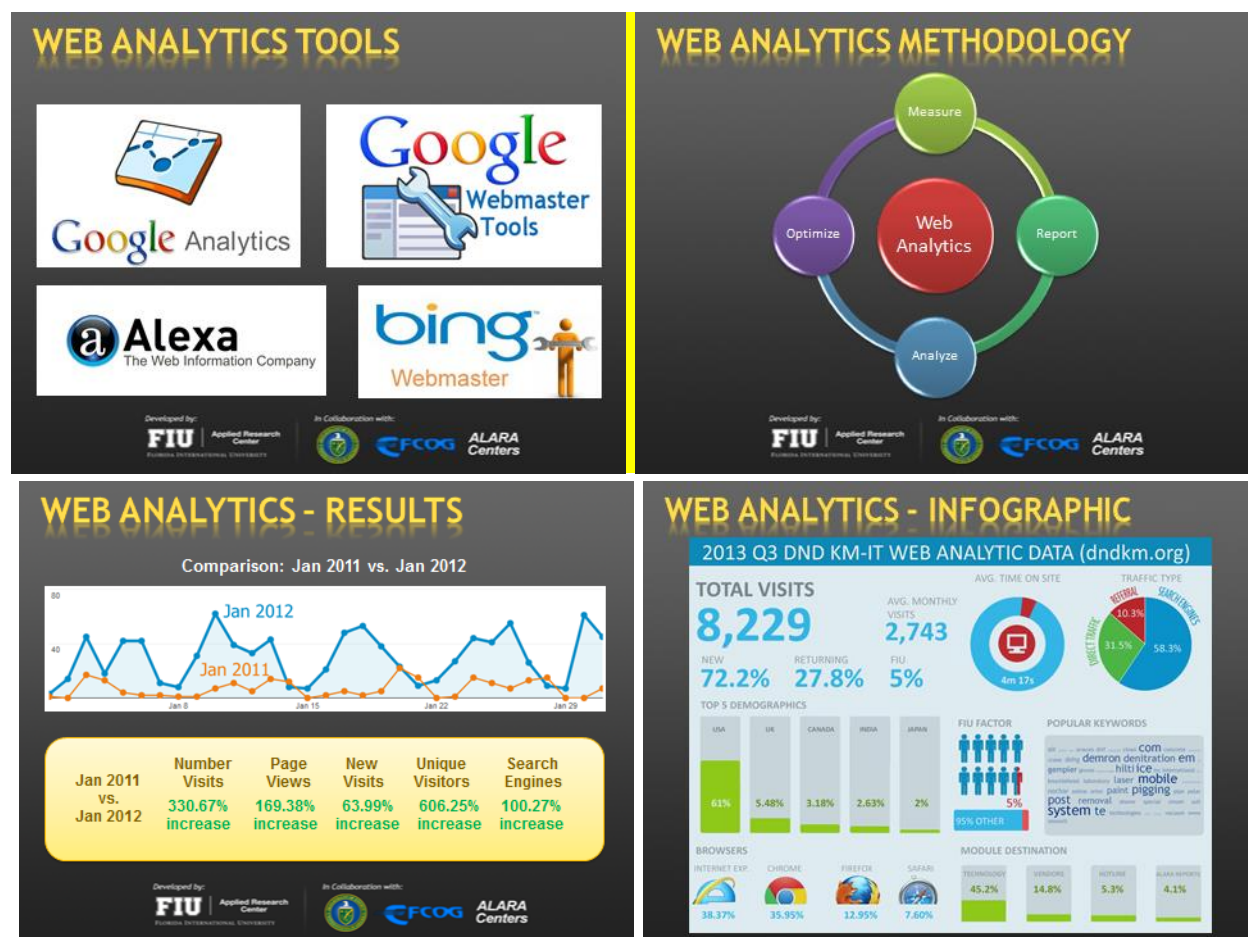
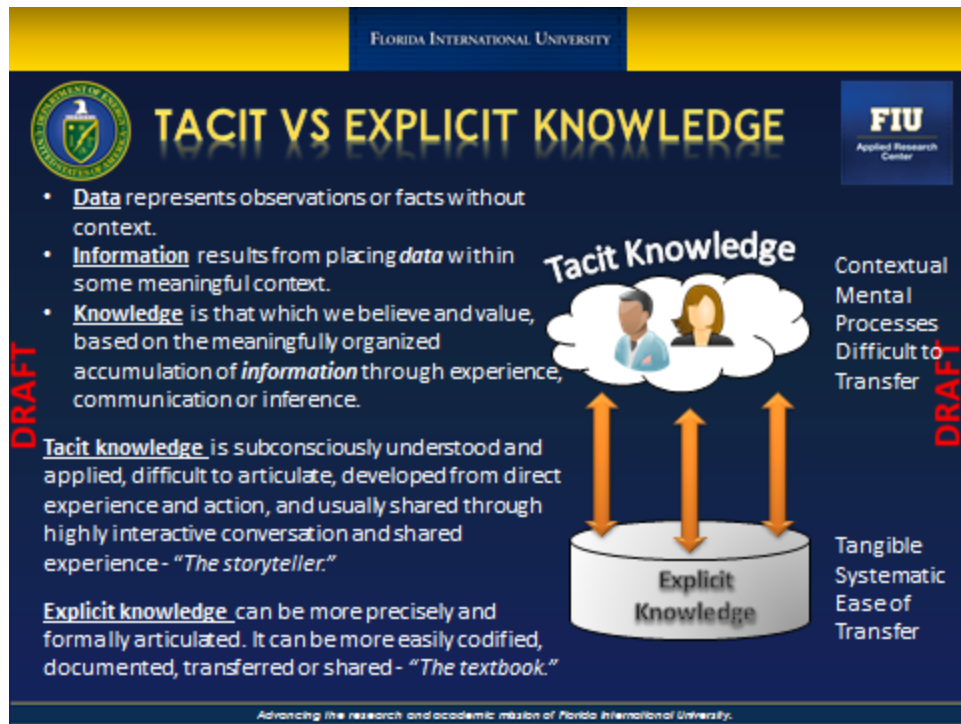


Figure 24. Sample presentation slides on D&D KM-IT web analytics

In preparation for holding D&D KM-IT workshops to a broader DOE HQ audience, FIU developed an overview presentation. This presentation was sent to DOE for review on January 9, 2015. FIU revised the D&D KM-IT overview presentation to incorporate comments received from DOE and to update the statistics included. The revised presentation was sent to DOE on June 10, 2015 (example slide shown in Figure 25). This presentation will be used to brief DOE management during the planned D&D KM-IT Workshops to DOE HQ.



**Figure 25. Example slide from D&D KM-IT Overview Presentation.**

FIU also hosted a workshop on D&D KM-IT on Monday, March 16, during the Waste Management 2015 Symposium. This workshop, held at the FIU booth in the exhibition hall, provided live demonstrations of the system and showed the available features and the newly added content, including over 400 newly added robotic technologies from the robotics database developed by Cogentus/NuVision.

### *Website Analytics*

FIU developed a D&D KM-IT Website Analytics Performance Report on a quarterly basis. These reports included information from Google Analytic and Google Web Master tools and provide multiple graphics and a narrative to explain the results.

FIU revised the D&D KM-IT Website Analytics Performance Report for the first quarter of calendar year 2014 (January to March 2014) and incorporated the suggestions received from DOE EM. The final report was sent to DOE on June 25, 2014. The reports for the following quarters were completed and submitted on: September 12, 2014 for the second quarter of 2014 (April to June); January 8, 2015 for the third quarter of 2014 (July to September); March 4, 2015 for the fourth quarter of 2014 (October to December); and April 28, 2015 for the first quarter of 2015 (January to March).

Figure 26 provides the infographics for the website analytics during each of the quarters of 2014 and Figure 27 shows the first quarter of 2015. The results for the fourth quarter of 2014 reflect that the D&D KM-IT website was recovering from the second and third quarter traffic drop. All of the major metrics showed improvement with the exception of Bounce Rate and Percentage of New Sessions. The largest improvements were in Pageviews with an increase of 21% closely followed by Pages per Session with a 19% increase. The results for the first quarter of 2015 reflected another increase in the major metrics. The largest increase was in the number of page



views with a 239% increase over previous quarter. Also of interest, the user registration increased by 11% (from 652 the last quarter of 2014 to 725 for the first quarter of 2015) and the SMS registrations increased by 20% (from 69 to 83). The main reason for this increase was the FIU participation in the Waste Management Symposium 2015 where the FIU team was able to engage with industry participants to demonstrate the functionality of D&D KM-IT and generate interest from users to become SMS. The ANS Utility Conference participation by FIU resulted in another significant increase in registers users and SMS with 83 conference attendees registering as users and 6 also signing up as SMS. Conference participation continues to be one of the best platforms to bring industry awareness of the D&D KM-IT.



Figure 26. Infographic based on Web Analytic Data for D&D KM-IT for 2014.



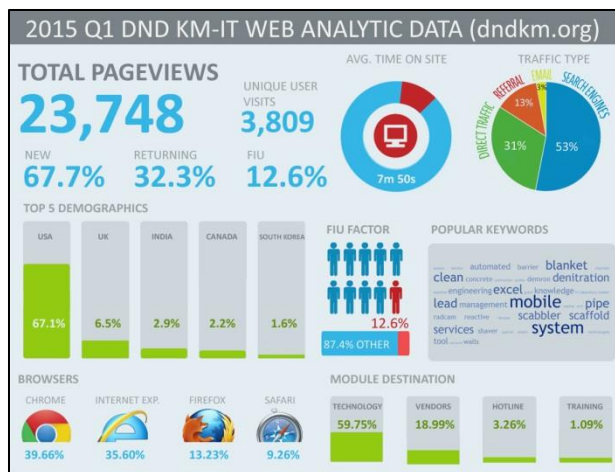


Figure 27. Infographic based on Web Analytic Data for D&D KM-IT for the first quarter of 2015.

FIU completed and submitted the annual Google Web Analytic report for D&D KM-IT for calendar year 2014 (January to December 2014) to DOE on July 16, 2015. This report included information from Google Analytic and Google Web Master tools and provided graphics and a narrative to explain the results. Figure 28 provides a sample graphic showing a comparison of pages per session, average duration, bounce rate, and the percent of new sessions for calendar years 2012, 2013, and 2014.

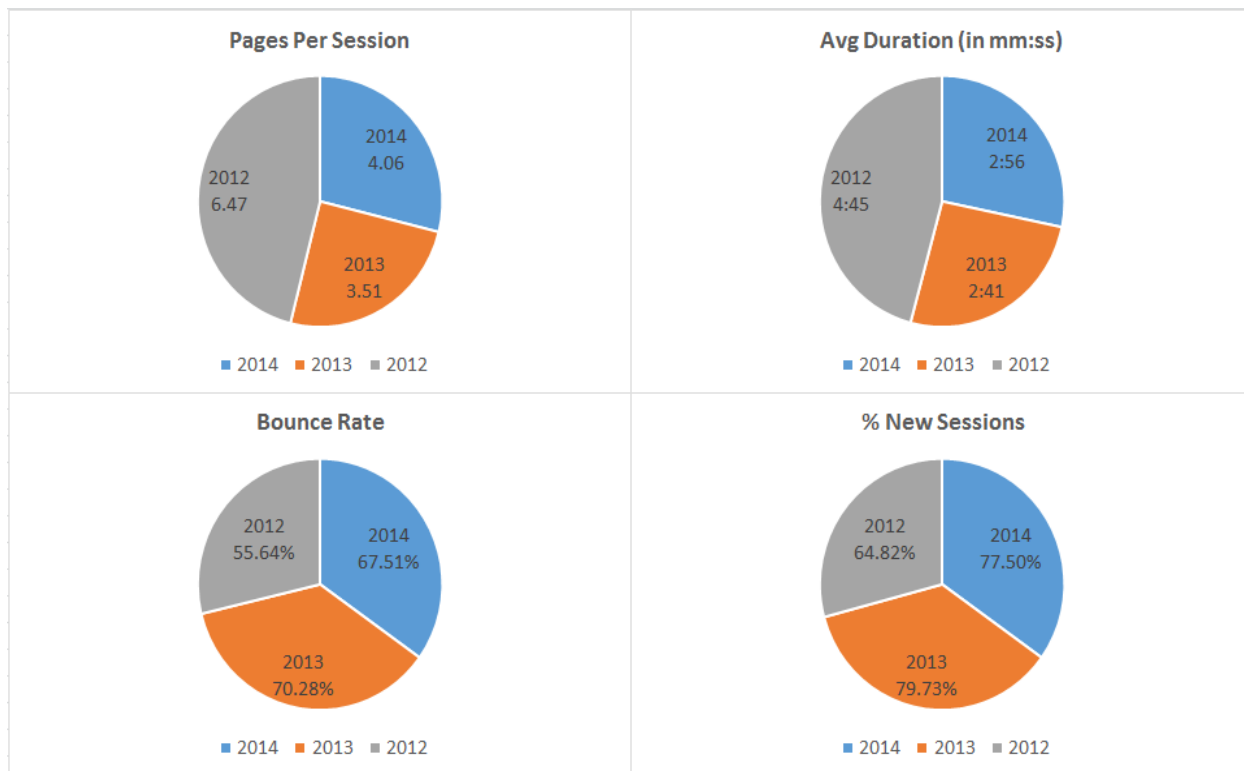


Figure 28. 2014 vs 2013 & 2012. Pages Per Session, Average Duration, Bounce Rate and Percentage of New Sessions.

### *Strategic Plan*

During July 2014, FIU worked with DOE on finalizing 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.” This paper 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 also 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; the projected schedule and status evolve over time as the recommended strategic approaches are implemented. The update document, which will be developed on a quarterly basis, provides an update to the table of recommended actions contained in the original document.

### *Fact Sheet*

FIU updated the DOE Technical Fact Sheet for D&D KM-IT and sent the document to DOE on June 27, 2014. The updated fact sheet was also posted to the D&D KM-IT Document Library. FIU provided a second update of the DOE Technical Fact Sheet for D&D KM-IT on May 15, 2015.

### *Newsletters*

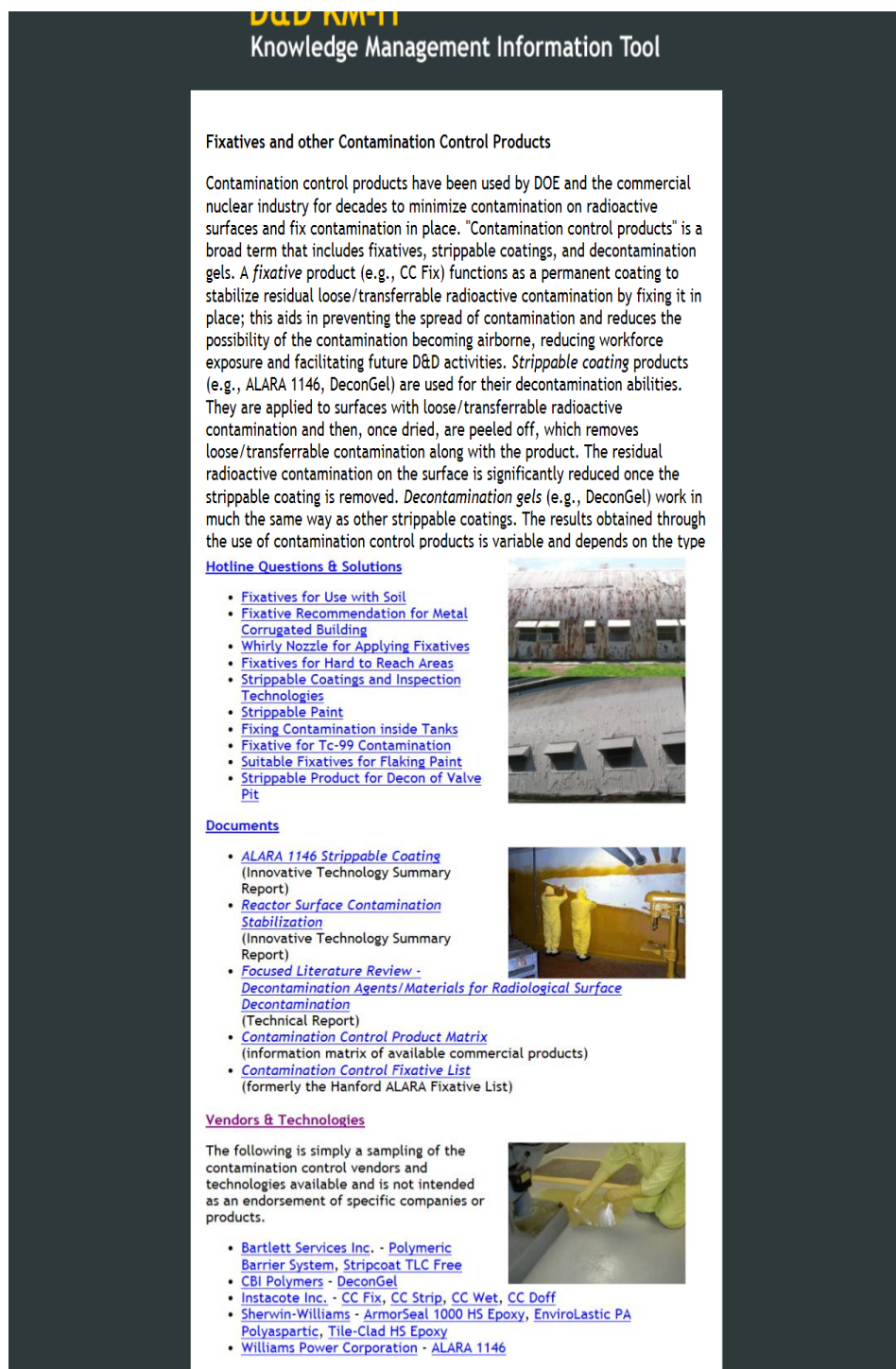
Also as part of the outreach effort, FIU created targeted newsletters to send electronically to D&D KM-IT registered users, subject matter specialists, and Waste Management Conference attendees. These newsletters informed the recipients of current and newly added features of D&D KM-IT and provided quick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

FIU developed a newsletter and sent it out to all D&D KM-IT registered users to announce the availability of the Innovative Technology Summary Reports on D&D KM-IT (Figure 29). These reports cover technologies, systems, and processes that were developed and tested with funding from DOE's Office of Science and Technology (OST) during the 1990's to early 2000's. A total of 201 ITSRs have been compiled, ranging in publication date from April 1995 to June 2002, and can be found within the Document Library of the D&D KM-IT. Each report presents the full range of problems that a technology, system, or process addresses and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation at the time the report was prepared is also included. The ITR module on D&D KM-IT was developed to make a repository of the ITSRs available and easily retrievable to the D&D community. The ITSRs can be browsed by focus area (D&D, Tanks, Subsurface Contaminants, TRU and Mixed Waste, and Crosscutting).



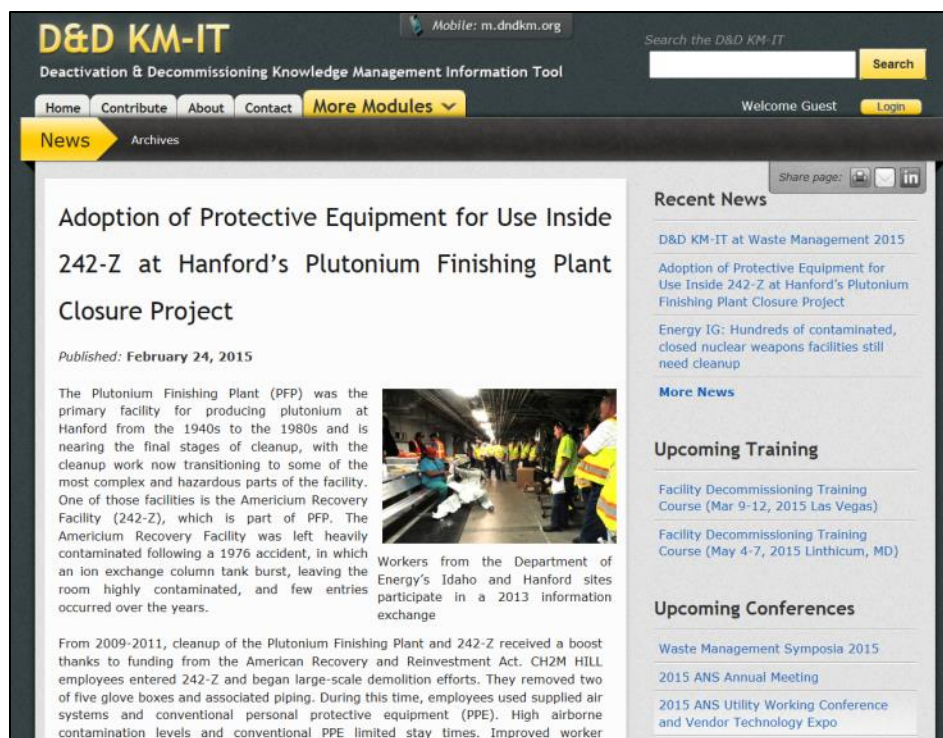
**Figure 29. Newsletter announcing ITSR availability on D&D KM-IT**

FIU created a newsletter on fixatives and other contamination control products, an area of interest identified from the ongoing web analytics. The newsletter was sent to DOE on September 29, 2014, for review and approval to send out to all D&D KM-IT registered users. FIU finalized the newsletter based on comments received from DOE and the final newsletter was sent out to all D&D KM-IT registered users on October 17, 2014 (Figure 30).



**Figure 30. Screenshot of final fixatives newsletter for D&D KM-IT user base.**

FIU developed and sent out a newsletter from D&D KM-IT on best practice for the modified protective suits (i.e., PPE) developed at Richland on February 25, 2015 (Figure 31).



**Figure 31. Newsletter on Hanford PPE best practice.**

Another newsletter announcing the events for D&D KM-IT at WM15 was sent to the conference attendees on March 4, 2014 (Figure 32). After the conference, FIU developed a brief “Thank you” notice and sent it out to the new users who registered on D&D KM-IT during the Waste Management 2015 conference to thank them for their interest and encourage them to continue using and contributing to the system (Figure 33).



**D&D KM-IT at Waste Management 2015**

*Published: March 04, 2015*



Applied Research Center  
Florida International University

Come learn about new developments and capabilities integrated into the D&D Knowledge Management Information Tool (<http://www.dndkm.org>) at our booth #733 in the exhibitor hall at Waste Management Conference 2015 in Phoenix, AZ from March 15-19, 2015. We also have a formal presentation in Session 067 on Tuesday, March 17, during the 1:30-5:00 pm session in Room #106B.

Plan to attend a workshop on D&D KM-IT at our booth #733 on Monday, March 16, at 2:00, where we will conduct a demonstration of the D&D Knowledge Management Information Tool (D&D KM-IT), the web-based knowledge management information tool custom built for the D&D user community.



Come to our "one-on-one" demonstrations of D&D KM-IT being offered at our booth during exhibitor hall hours. The capabilities of the

*Waste Management 2014*

Figure 32. Newsletter to announce D&D KM-IT presence at WM15.

Is this email not displaying correctly? [View it in your browser.](#)

**D&D KM-IT**  
Knowledge Management Information Tool

**Thank You for visiting our booth at WM2015**



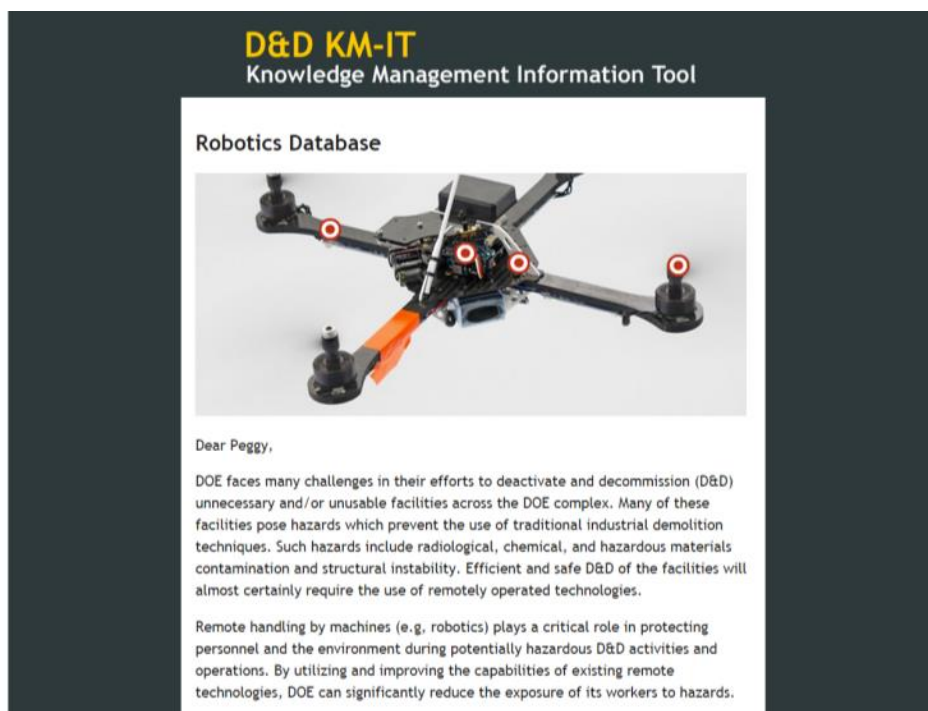
Dear \*|FNAME|\*,

Thank you for visiting us in the Waste Management 2015 vendor hall and registering with the D&D Knowledge Management Information Tool

Over the last few years, the D&D Knowledge Management Information Tool (KM-IT) has evolved as a leading web-based information tool for the D&D user community. As a newly registered user, you have become part of this exciting growth. From the D&D KM-IT team, we simply want to thank you for your interest and support.

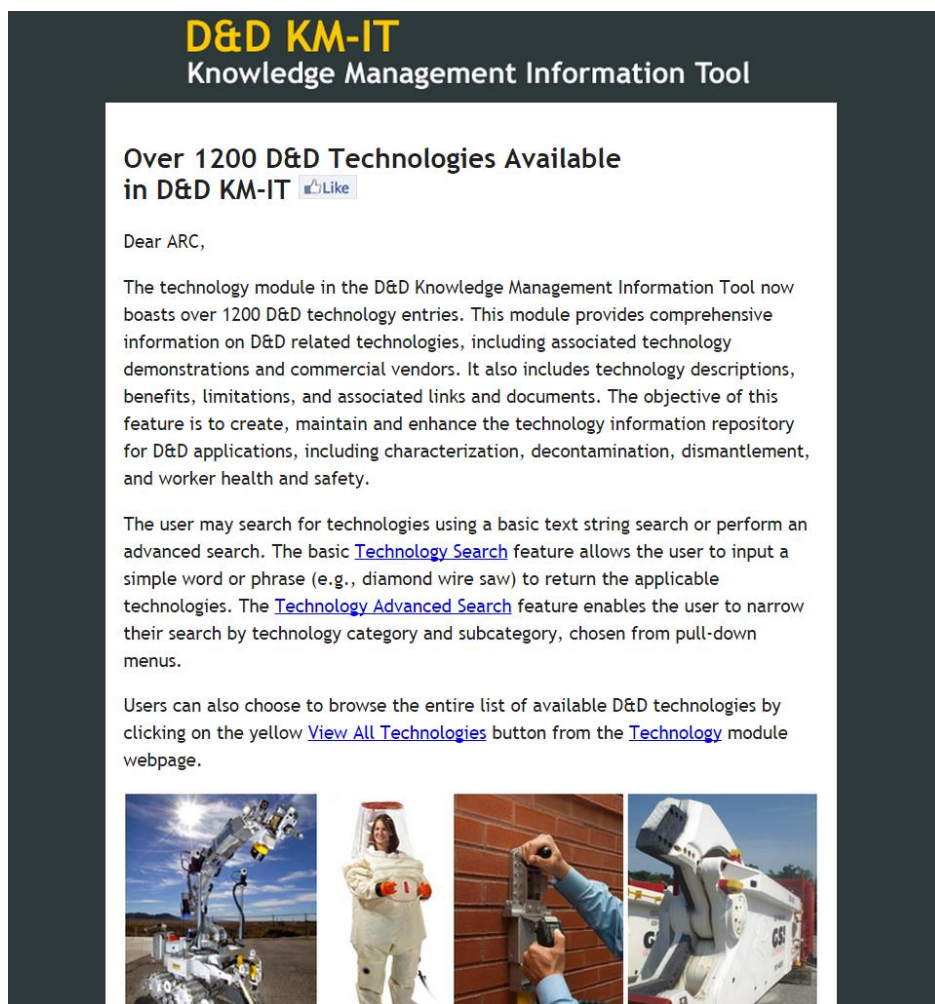
Figure 33. Thank you notice to new D&D KM-IT users.

A newsletter to announce the availability of the robotic database in D&D KM-IT to all registered users was developed and sent to DOE for review on April 22, 2015 and was distributed to D&D KM-IT users on June 10, 2015 (Figure 34).



**Figure 34. Robotics Database newsletter for D&D KM-IT.**

The next newsletter for D&D KM-IT, highlighting the 1200 D&D technologies included, was distributed to the D&D KM-IT registered users after DOE approval on June 30, 2015. Figure 35 shows a screen snapshot of the newsletter.



**Figure 35. Technology Database newsletter for 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 the related milestone, 2014-P4-M3.5, and sent a summary report to DOE on May 8, 2015. 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. ARC 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.

During the completion of this task, four Wikipedia articles were edited with information. For each of these articles, relevant and significant text was added to the body of the article and a reference to the information source (e.g., lesson learned or best practice on D&D KM-IT) was included in the article's list of references. The edited Wikipedia articles included: 1) Nuclear Power in the United States – Plant Decommissioning Section with information from the best practice titled, “SRS P and R Reactor Disassembly Basin *In Situ* Decommissioning” 2) Occupational Hygiene – Basic Characterization, Hazard Identification and Walk-Throughs



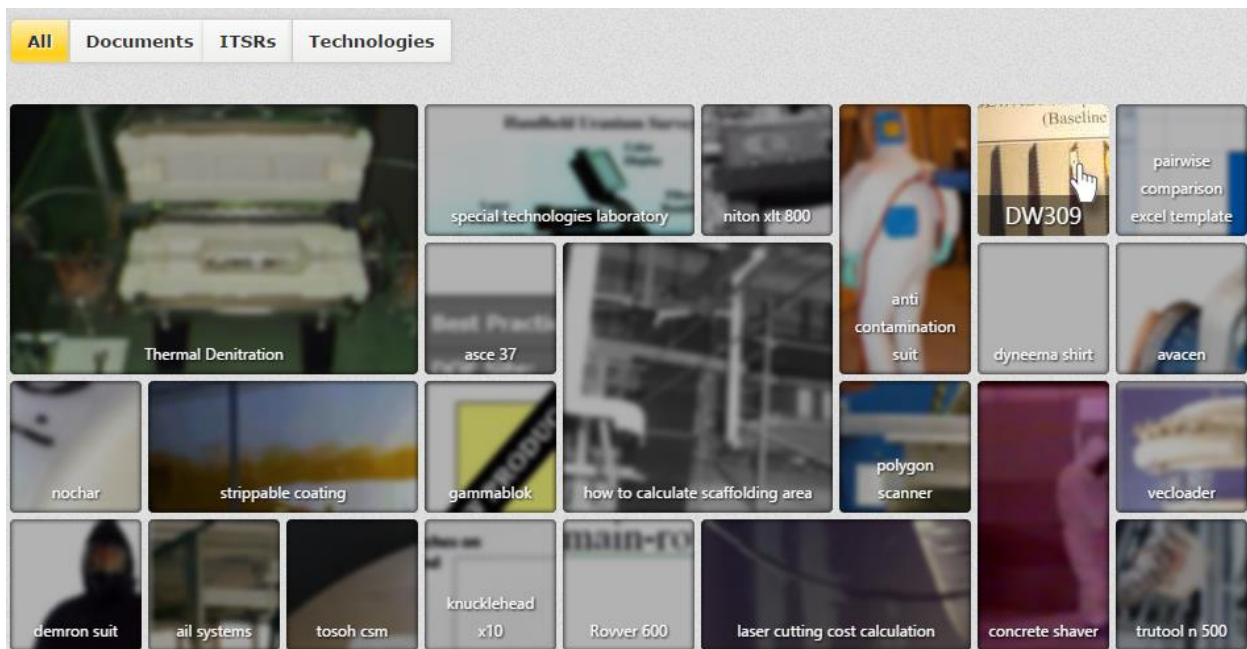
Section with information from the following best practice: “Historical Hazard Identification Process for D&D;” 3) Asbestos Abatement – Removal Procedures Section with information from the best practice titled, “Open Air Demolition of Asbestos Guniting by Using Track Mounted Wet Cutting Saw.” and 4) D&D KM-IT with updated information.

## Application Development

During FIU Year 5, FIU added features to the D&D KM-IT application and maintained the system for the D&D community

### *Popular Display*

FIU designed and developed a popular display for the homepage of D&D KM-IT. This milestone (2014-P4-M3.2) was completed and the link sent to DOE for review and testing on September 5, 2014. After receiving DOE approval, FIU made the new feature live on the public server on September 24, 2014. Popular keywords from the previous month’s Google Analytics are utilized to highlight popular information on the D&D KM-IT homepage. The keywords are categorized and presented using dynamic tiles with corresponding images associated with the keywords. When a user clicks on each of the categories, the tiles rearrange themselves dynamically within the space allocated. The result is a slick and interactive way for users to access relevant information on D&D KM-IT (Figure 36).

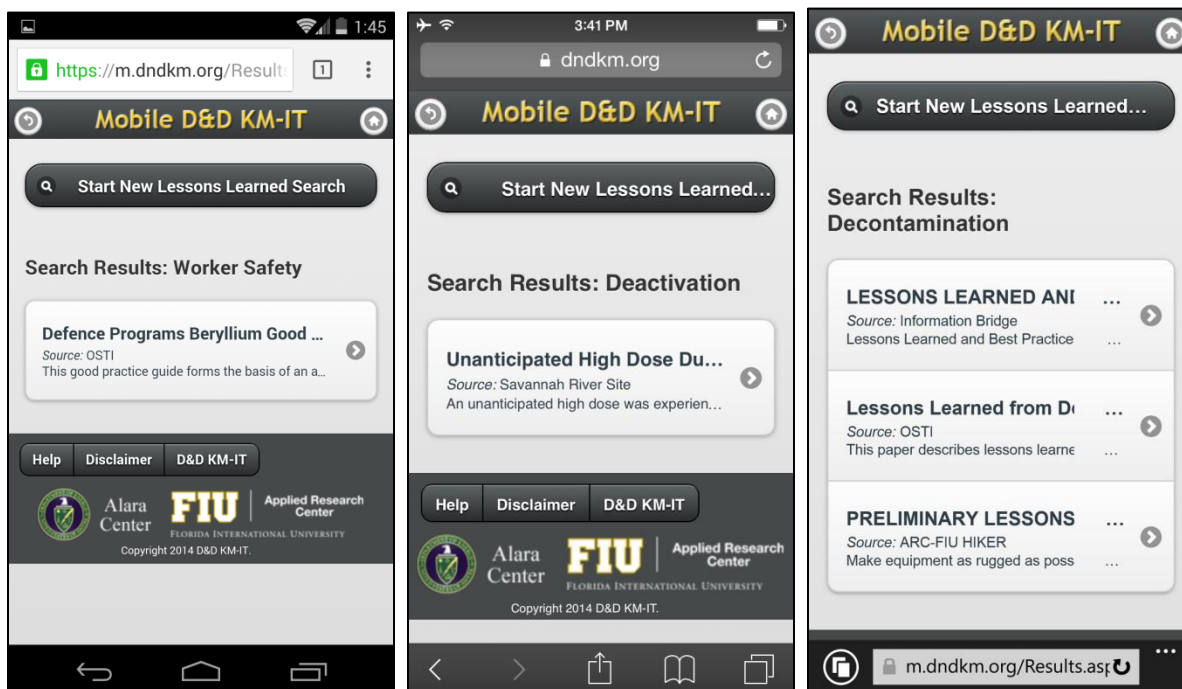


**Figure 36. New popular keyword display from D&D KM-IT homepage.**

### *Mobile Applications for Lessons Learned and Best Practices Modules*

FIU completed the design and development of the lessons learned lite mobile application and sent the link to DOE on November 7, 2014 (milestone 2014-P4-M3.3). FIU also completed the design and development of the best practices lite mobile application and submitted it to DOE on January 16, 2015 (milestone 2014-P4-M3.4). The mobile system component provides access to important D&D KM-IT features through wireless devices, including iPhone (3.1 and above), iPad, Blackberry (6.0 and above), Android (2.1 and above), and Windows (7 and above) smart

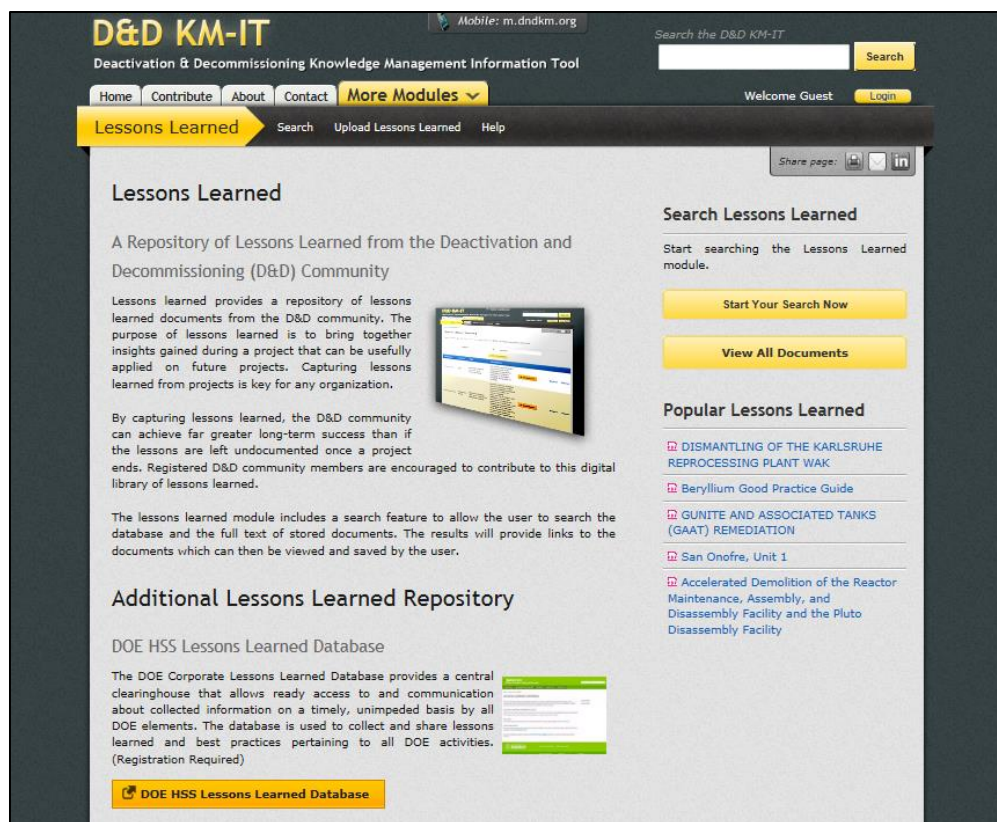
devices. Figures 37 shows screenshots of the lessons learned mobile application for Android, iPhone, and Windows devices during testing.



**Figure 37. Screenshots during testing of D&D KM-IT lessons learned lite application.**

#### *Application optimization*

Based on a recommendation from DOE, FIU updated the landing page of the D&D KM-IT Lesson Learned module (<http://www.dndkm.org/LessonsLearned/Default.aspx>) to include a description and link to the DOE Health, Safety and Security (HSS) Lessons Learned website. This resource is now conveniently located on D&D KM-IT so that it is easily available to users as shown in Figure 38. This resource can also be reached from the External Library section of the Document Library Module on D&D KM-IT.



**Figure 38. Screenshot of the D&D KM-IT Lessons Learned landing page, showing the external link to the DOE HSS Lessons Learned database.**

The IT team at FIU ARC also implemented a solution in response to the announcement that there had been an increase in distributed denial of service (DDoS) attacks using spoofed recursive DNS requests. While all systems communication over the internet need to allow DNS traffic, the spoofed recursive DNS requests could allow the attacker to generate gigabits worth of DNS replies. The solution implemented by the FIU ARC IT team used Windows features for securing the DNS services as recommended by Microsoft.

## 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 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.

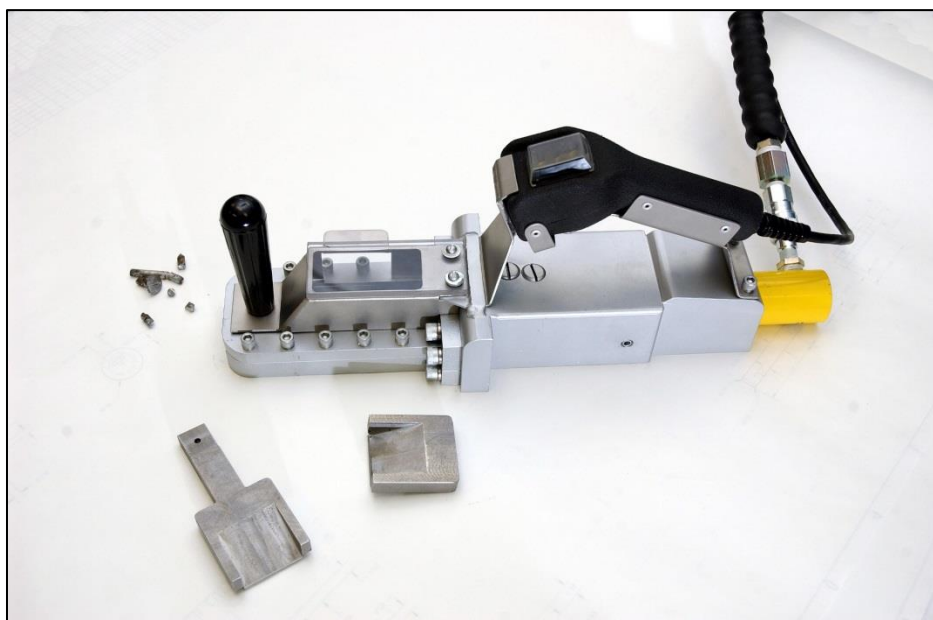
## Data Mining

### *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 August 5, 2015, the Vendor module included a total of 909 vendors, a significant increase of 245 (37%) since May 2014, and the Technology module included a total of 1232 technologies, an even more significant increase of 536 (77%).

### *Omni Jaw*

FIU received a request from DOE on June 2, 2014, to propose the best ways to make information related to a new technology (Omni Jaw 5) available to the D&D community (Figure 39). The Omni Jaw 5 is a hand-held tool used to safely shear bolt heads during demolition and collect the shavings. FIU worked with the DOE to explore the options for disseminating information on the Omni Jaw 5 technology. The actions taken include: 1) FIU posted the news article about the technology to the homepage of D&D KM-IT under Industry News; 2) FIU added the technology vendor (Green Arc Labs) that will be manufacturing the technology to the Vendor module of D&D KM-IT; and 3) FIU added the technology description of the Omni Jaw 5 to the Technology module of D&D KM-IT and attached available literature related to the technology.



**Figure 39. Omni Jaw 5 Technology added to D&D KM-IT**

FIU also received information from DOE on the modified protective suits at Richland with a request to make the information available to the D&D community through D&D KM-IT. FIU added the provided “good practice” document to the D&D KM-IT Best Practices module. FIU added a second document describing the innovative PPE technologies and methodologies to the D&D KM-IT Document Library. The vendors and technologies for the PPE components were added to the Vendor module and the Technology module, as appropriate. A newsletter based on



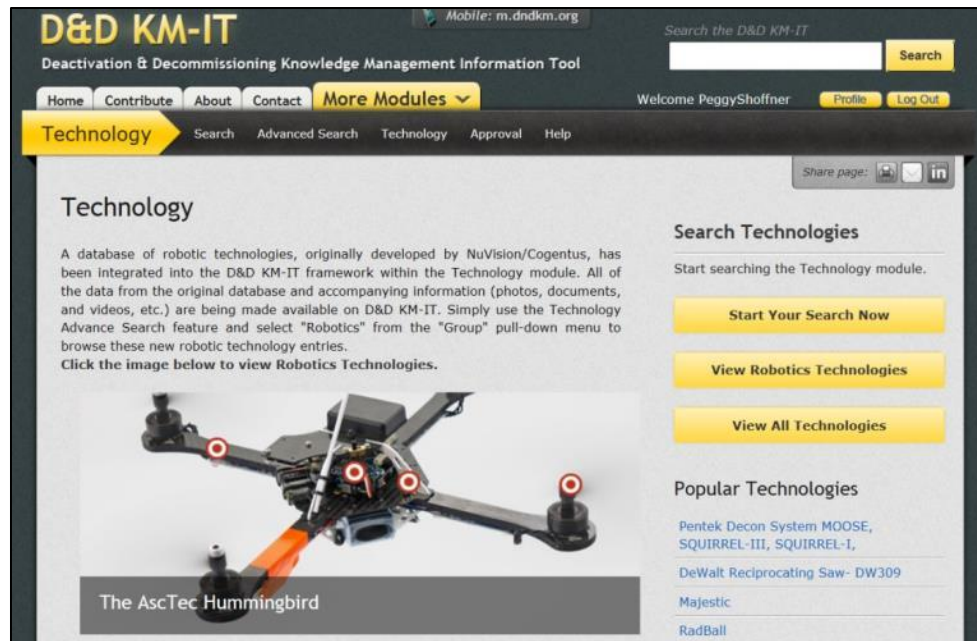
this information was also prepared and distributed to the D&D community via the registered users of D&D KM-IT.

### *Robotics Database*

A database of robotic technologies, originally developed by NuVision/Cogentus, was sent to FIU from DOE, with a request to evaluate the potential for integrating the data into the D&D KM-IT framework for ongoing hosting/maintenance of the information. FIU was able to extract the database from the file received and determined that it was a MYSQL database file format. A MYSQL server database was installed to match the file and then FIU imported that file into the new FIU MYSQL server database.

FIU then created a script and exported the information and documents successfully from the file. FIU developed the data interface and mapping file for the import process since the two data structures (robotics database and D&D KM-IT framework) are different. FIU developed the data structure that could import the technology titles and description mapping to KM-IT as well as combined the technology notes and operational experience data sections and mapped it to a new comments section within KM-IT. In addition, FIU created a new Group within the D&D KM-IT Technology module for “Robotics” and subsequently updated the categories and subcategories within this group based on the main\_function and robotics\_category information included in the original robotics database.

D&D KM-IT links each technology entry to a specific vendor. Within the original robotics database, the vendor information is buried in a column titled manufacturer\_developer with no easy way to extract that information because of the lack of structure. Identifying and extracting the vendor information had to be a manual process. During February 2015, the six (6) DOE Fellows and other FIU Graduate Research Assistants assisted in manually extracting the vendor information from the original database, creating vendor entries in D&D KM-IT for each, and assigning the technologies to the correct vendor. After performing QA/QC on the new robotics entries, 376 were made live on the production server by February 18. During March, FIU continued to research and update the robotic entries that had missing data and an additional 68 robotic technologies were made live on the production server. The final 27 robotic technologies, for a total of 471 robotic technologies, were made live on the production server in April 2015. All of the data and accompanying information (photos, documents, etc.) within the robotics database from NuVision/Cogentus were integrated into the technology datasheets on D&D KM-IT. Figure 40 shows the Technology module homepage with the showing the robotic technology database; Figure 41 shows a few of the robotic technologies now available on the system.



**Figure 40. Technology module homepage showing robotics technologies.**



**Figure 41. Robotic technologies newly integrated into D&D KM-IT Technology module. From left: Mighty Mouse by Sandia National Lab, Big Dog by Boston Dynamics, and HRP-3 Promet MK-II by Kawada Industries.**

### *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 42. 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](http://www.dndkm.org), Applied Research Center, Florida International University.
- Florida International University, *D&D Knowledge Management through Contributions in Wikipedia*, Summary Report, May 8, 2015.
- Shoffner, P., H. Upadhyay, L. Lagos, W. Quintero. *Knowledge Management Information Tool (D&D KM-IT)*, EPRI Decommissioning Workshop, June 2015.
- Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: First Quarter 2014 (Jan 1 to March 31, 2014)*, Applied Research Center, Florida International University, June 2014.
- Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Second Quarter 2014 (July 1 to Sept 30, 2014)*, Applied Research Center, Florida International University, September 2014.
- Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Third Quarter 2014 (July 1 to Sept 30, 2014)*, Applied Research Center, Florida International University, January 2015.
- Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: Fourth Quarter 2014 (Oct 1 to Dec 31, 2014)*, Applied Research Center, Florida International University, March 2015.

Quintero, W., *Web Analytics Narrative Report for D&D KM-IT: First Quarter 2015 (Jan 1 to March 31, 2015)*, Applied Research Center, Florida International University, April 2015.

Quintero, W., *Web Analytics for D&D KM-IT for Calendar Year 2014*, Applied Research Center, Florida International University, July 2015.

Upadhyay, H., L. Lagos, W. Quintero, P. Shoffner, J. De Gregory. *Knowledge Management Information Tool Web Analytics*, Waste Management 2015 Conference, Phoenix, AZ, March 2015.



## OVERALL PROJECT CONCLUSIONS

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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 the preliminary development of a decision making model to better guide end users on the selection of appropriate strippable and fixative coatings based on their specific needs, the testing and evaluation of the FX2 advanced fogging agent developed at INL, the development of a draft test plan for the Phase I testing of baseline incombustible fixatives, and the participation in workshops and conferences. 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

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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, *FX2 Advanced Fogging Technology: Technology Demonstration Test Plan*, January 2015.
2. Florida International University, *FX2 Advanced Fogging Agent*, DOE EM Tech Fact Sheet, April 2015.
3. Florida International University, *FX2 Advanced Fogging Agent*, Technology Demonstration Report, May 2015.
4. Florida International University, *Enhancing Operational Performance of Fixatives and Coatings for D&D Activities: Phase I – Baselineing and Proof of Concept*, Test Plan, June 2015.
5. Florida International University, *D&D Knowledge Management through Contributions in Wikipedia*, Summary Report, May 2015.
6. Quintero, W., *Web Analytics for D&D KM-IT for Calendar Year 2014*, Applied Research Center, Florida International University, July 2015.
7. Florida International University, *Project Technical Plan*, Project 4: Waste and D&D Engineering and Technology Development, June 2014.