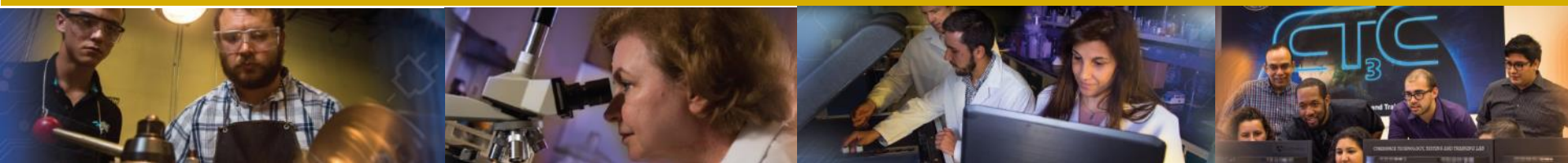
FIU Project 3 – Waste and D&D Engineering and Technology Development

Presented: July 18, 2017

Dr. Himanshu Upadhyay and Mr. Joseph Sinicrope

Florida International University



FIU Personnel and Collaborators

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Project Manager: Leonel Lagos

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

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SRNL: Mike Serrato, Aaron Washington, Connor Nicholson

SRS: Jack Musall

Project Tasks and Scope

Task 1 Waste Information Management System (WIMS)

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

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

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

Task 3 Knowledge Management Information Tool (KM-IT)

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

Deactivation and Decommissioning (D&D) Research

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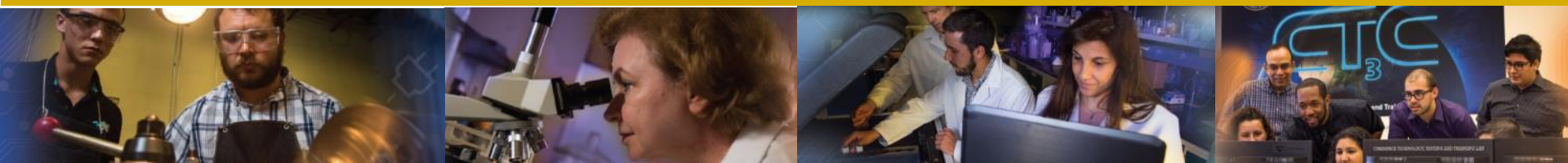

Task 2 – D&D Support for Technology Innovation, Development, Evaluation and Deployment

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Site Needs:

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

Year 7 Objectives:

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

Present Tasks:

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

Performance Year 7 Executive Highlights

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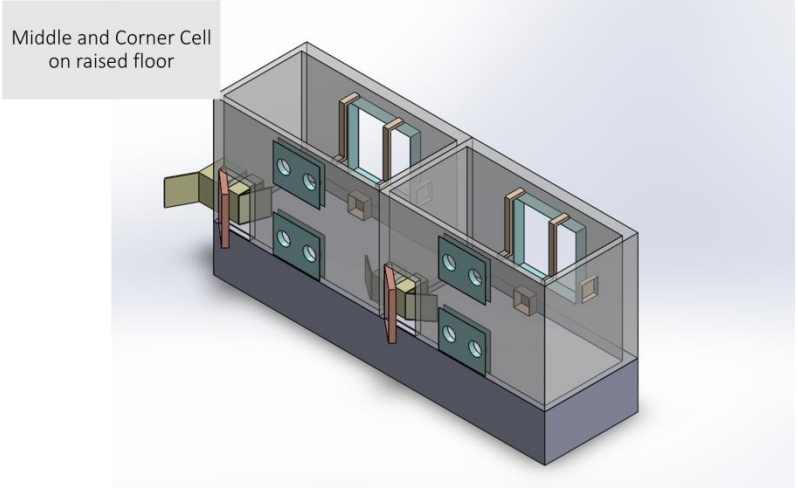
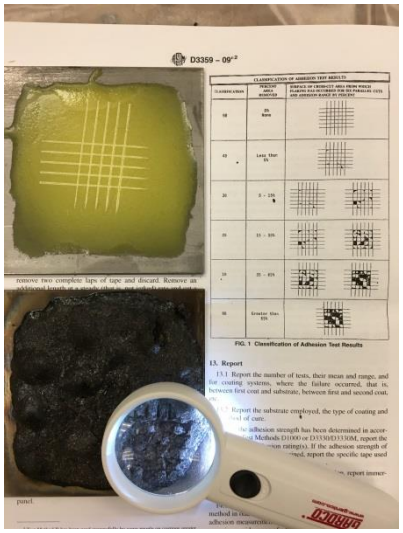
1. Constructed SRS 235-F Hot Cell Test Bed
   a) Support to adapting intumescent coatings task
   b) Future test/evaluate of other technologies (e.g. robotics) intended to support D&D of hot cells
2. Developed two (2) standards for fixative technologies with ASTM International
   a) ASTM E3104-17: Specification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



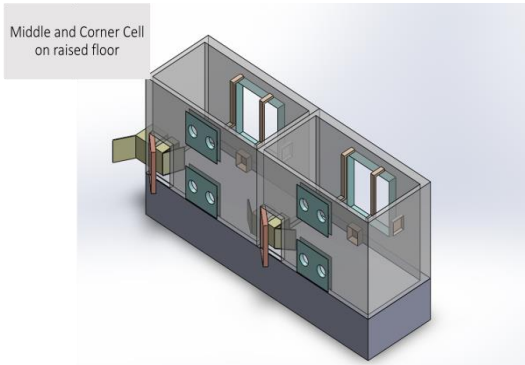


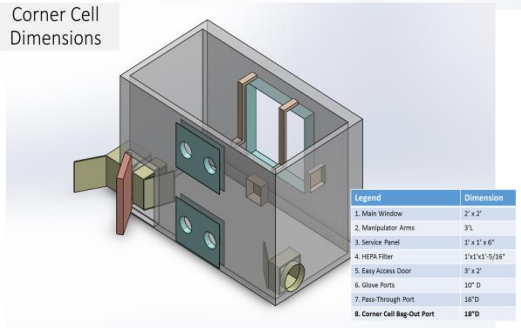
Performance Year 7
Hot Cell Test Bed

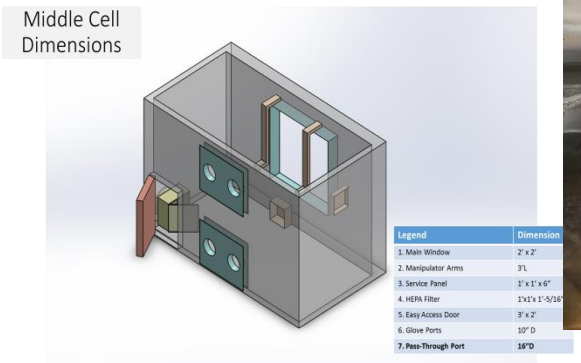
- Extensive coordination with SRS and SRNL personnel
  - Based on actual facility schematics
  - Survey conducted by SRS Project Engineer in May

- Hot cell test bed applications:
  - Currently supporting intumescent coatings as incombustible fixatives testing
  - Supported ICM Crawler demo during DOE EM Robotics Seminar
  - Incorporated into 4 x robotics proposals for “cold” test & eval of technologies

- ARC Fact Sheet released to publicize availability







Requirement for Fire Resistant Fixatives Across DOE EM Complex

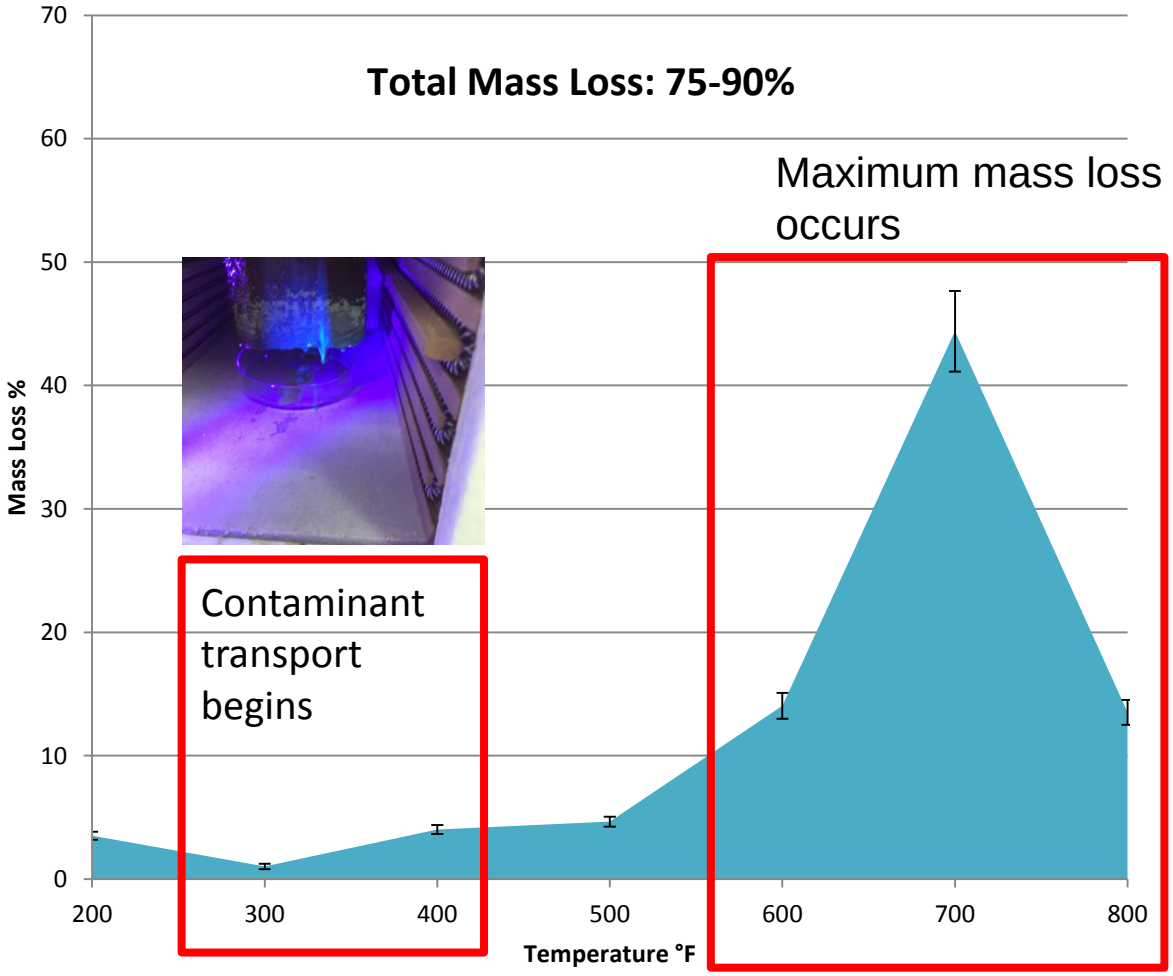
Table 1. Types of Accidents (and Frequencies) Summarized

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

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

Current State of Fixatives
Basic Fixative Profile

Start: fixative intact



Finish: significant mass loss, discoloration, desiccation, cracking, and flaking.

Adaptation of Intumescent Coatings as a Fire Resilient Fixative

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- Designed to swell 50 to 100 times original thickness into an insulating char upon exposure to heat / fire
  - Provides physical barrier to heat and mass transfer
- Inhibits transport of volatiles to the environment and the transport of oxygen to unburned regions beneath char
  - Retention of mass in the char limits further involvement of the underlying materials in the fire
- Undergo rigorous ASTM, NFPA, UL, and UBC fire testing:
  - UL 263 / UL 723 / ASTM E-119 / ASTM E-84 / ASTM E-2768/ UL 10B
  - NFPA: 251 / NFPA: 255 / NFPA: 703 / NFPA: 252
  - As context, ASTM E119 test subjects a given wall / structure to 24 gas flames that reach temperatures between 1800-2000º F for periods between 1-2 hours
- Exceptionally cost effective (as low as $0.75 cents per square foot)
- Easily applied via brush, roller, or sprayer to a wide variety of substrates (stainless steel, wood, sheetrock, sheet metal, etc.)
- Resilient to environmental conditions (heat, humidity, etc.) and radiation

Phase II Test Plan Execution

Applying Intumescent Coating in Hot Cell

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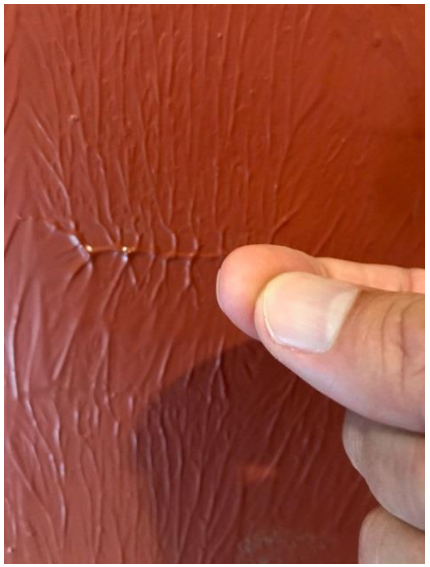
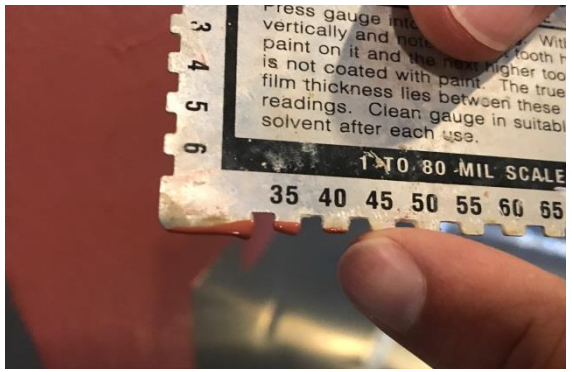
- Applying selected intumescent coating under operational constraints
  - Outside hot cells using glove ports
  - Restricted entry points (bag in and pass through ports)
  - Approved tool list
  - Horizontal and vertical surfaces
- Special emphasis on floor surfaces and determining coating thickness remotely
  - Initial assays estimate 95% of contamination resides on hot cell floor
    - Potential for “slow pour” method
  - Confirming coating thickness to ensure fire resistant pedigree is intact





International Standards and Uniform Testing Protocols

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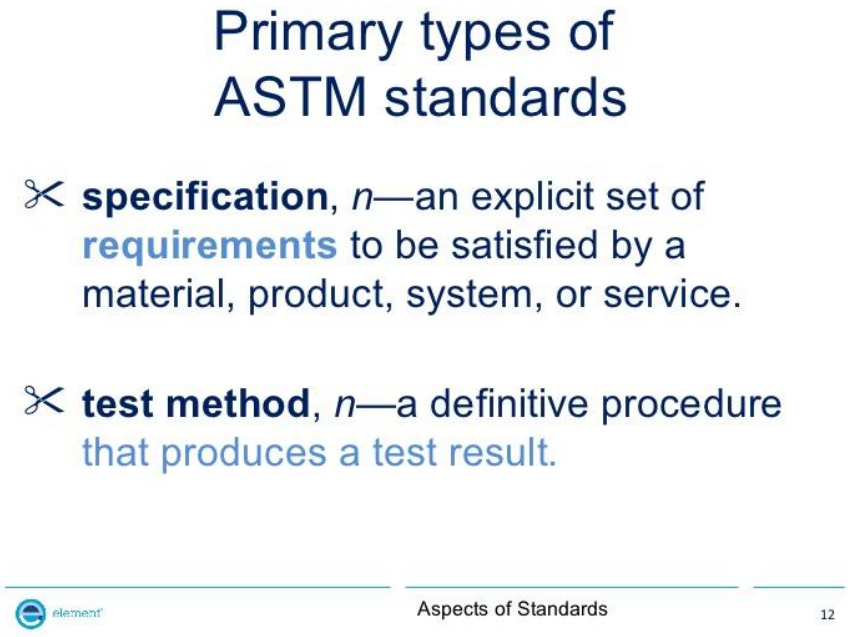
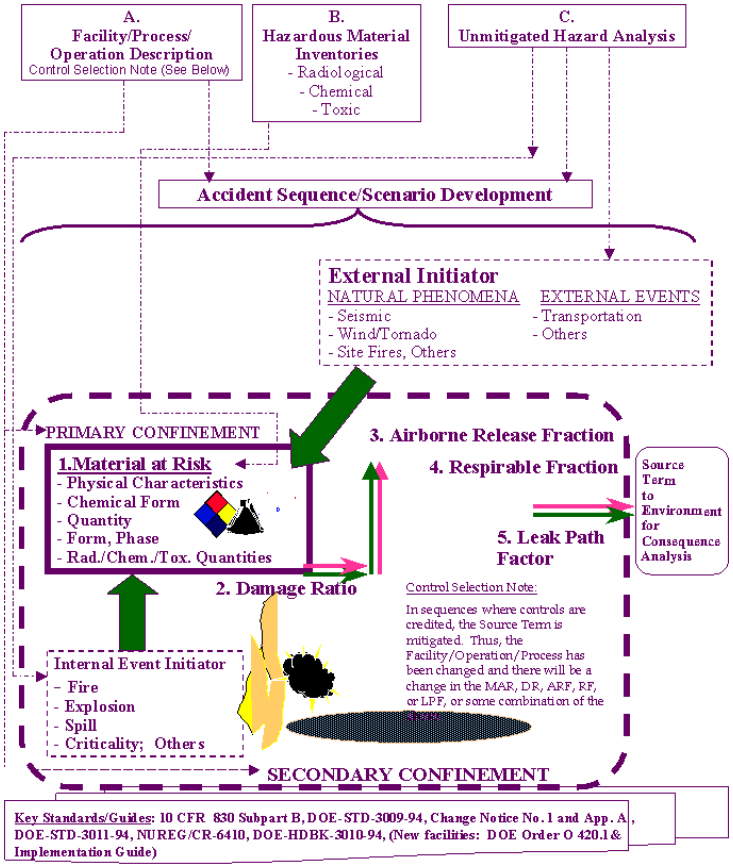
- Leveraging position as ASTM International E10.03 Subcommittee Chairman to develop standards and testing protocols for D&D technologies
  - Initial focus on fixative technologies
    - ASTM E3104-17 and E3105-17
- Testing protocols for determining impacts of fixatives on Source Term Formula in DOE-HDBK-3010
  - Airborne Release Fractions (ARF) and Respirable Fractions (RF)
- Significantly reduces risks associated with deployment of technology for end users
- Provides basis to update directives



DOE-HDBK-3010

- Contains methodology for calculating the Source Term Formula
  - Source Term Formula serves as foundation to: 1) safety basis calculations; 2) computer modeling programs; 3) remediation methods and safety control measures; 4) schedule and costs
  - Material-at-Risk (MAR – radioactive contaminant) x DF (Damage Factor) x LF (Leak Factor) x ARF (Airborne Release Fraction) x RF (Respirable Fraction)
- Best estimates using data available 25 years ago
- Critical shortfalls:
  - Assumes MAR remains in a powder state
    - Premise: Change of state occurs with fixative technologies – powder to polymer
  - Experimental designs for thermal and seismic stressors on ARF and RF not validated



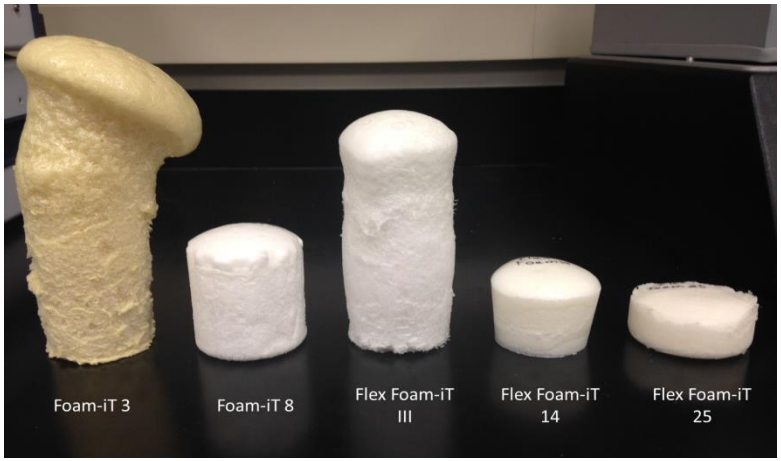
Performance Year 8 Proposed Tasks

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

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

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

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



Goals of DOE-HDBK-3010

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

Knowledge Management Information Tool (KM-IT)

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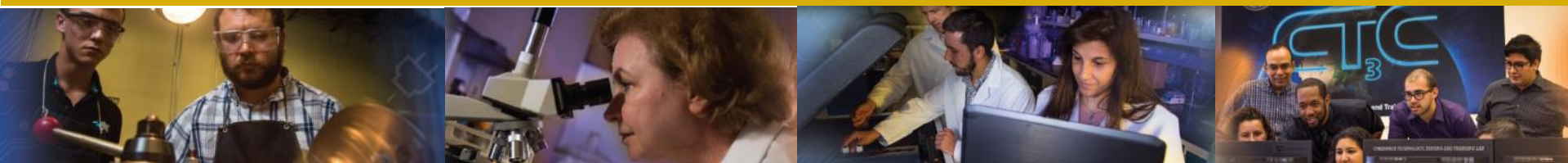

Task 3 – D&D Knowledge Management Information Tool (D&D KM-IT)

Site Needs:

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

Year 7 Objectives:

Knowledge management (KM) is a modern approach & discipline being used within EM to capture D&D knowledge. Objectives for D&D KM-IT are to attain the long-term active use, operation, and continued growth of the D&D knowledge from across the D&D global community and capture within the D&D KM-IT system resulting in enhanced worker safety, improved operational efficiencies, improved communication & knowledge among stakeholders, and the cross-generational transfer of D&D knowledge to the future workforce.

IMPORTANCE OF KM TO EM

- A significant portion of the EM workforce (including DOE and contractors) is nearing retirement age.
- KM aids in the retention of knowledge and experience when employees leave.
- KM provides a centralized location for data and information, improving time management of users.
- KM allows experiences to be captured and shared with Lessons Learned and Best Practices.
- KM reduces redundant work by helping users avoid re-inventing the wheel.
- KM allows the sharing of valuable information throughout the organization.

D&D KM-IT Modules

- D&D Hotline
- Technology Module
- Vendor Module
- Collaboration tools
- Mobile applications
- Lessons Learned
- Documents
- Pictures/videos
- Search tools
- Training
- Specialists
- Best Practices

D&D KM-IT – Mobile Applications

The D&D KM-IT mobile web application is now available on the iPhone, iPad, Blackberry, Android, or Windows smart devices to access the following modules:

- Vendors
- Technology
- Specialist Directory
- Picture Library
- Hotline
- Lessons Learned
- Best Practices

M.DNDKM.ORG

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

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Accomplishments Year 7:

- Addition of current and relevant data to the D&D KM-IT system, including news items, additional vendors, and technologies.
- Performance of website analytics and reporting to track usage metrics.
- Oral presentation and live demonstrations at WM17
- Development of articles, newsletters and infographics relevant to the D&D community
- Deployment of a pilot native mobile application for the D&D Fixatives Module
- Integration of 38 DOE EM Project Management Lessons Learned from the Office of Project Assessment

www.dndkm.org

D&D KM-IT Statistics as of June 2017

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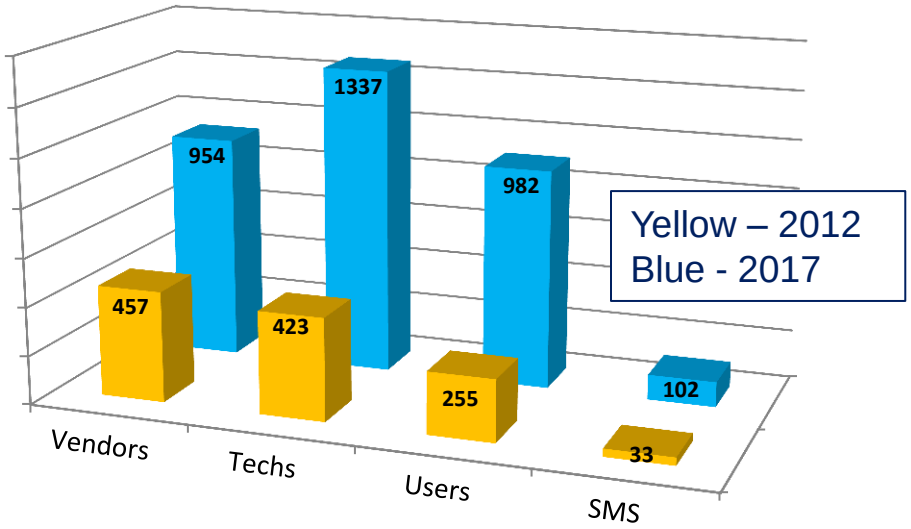
- 982 registered users
- 102 subject matter specialists
- 954 D&D vendors
- 1337 D&D technologies
- 521 robotic technologies
- 195 questions and solutions in Hotline module

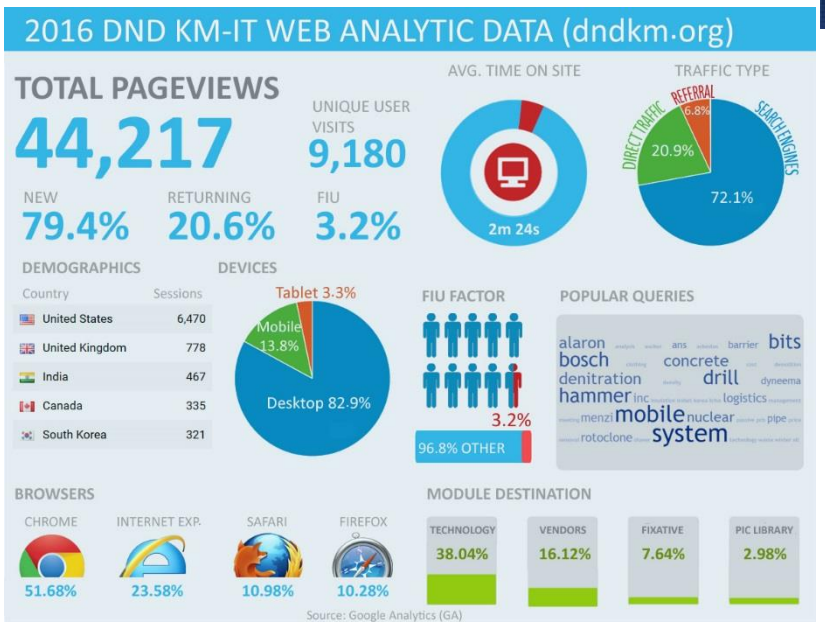


Growth from March 2012 to May 2017

Fully searchable resources – Original sources no longer available

- 169 ALARA Center reports archived (Hanford and SRS)
- 231 Innovative Technology Summary Reports archived

Web Analytics – Method & Application



- To measure and optimize web usage
- Provides baseline measurements of critical metrics
- Used to improve weak metrics and enhance strong metrics
- Follow up on feedback from visitors
- Measures the impact of D&D KM-IT on the D&D community

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

Proposed Scope for Year 8

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

Waste Information Management System (WIMS)

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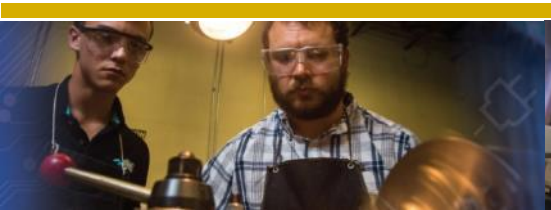
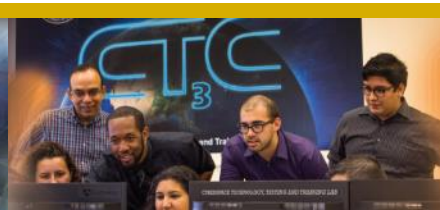




Task 1 – Waste Information Management System (WIMS)

Site Needs:

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

Year 7 Objectives:

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

Present Tasks:

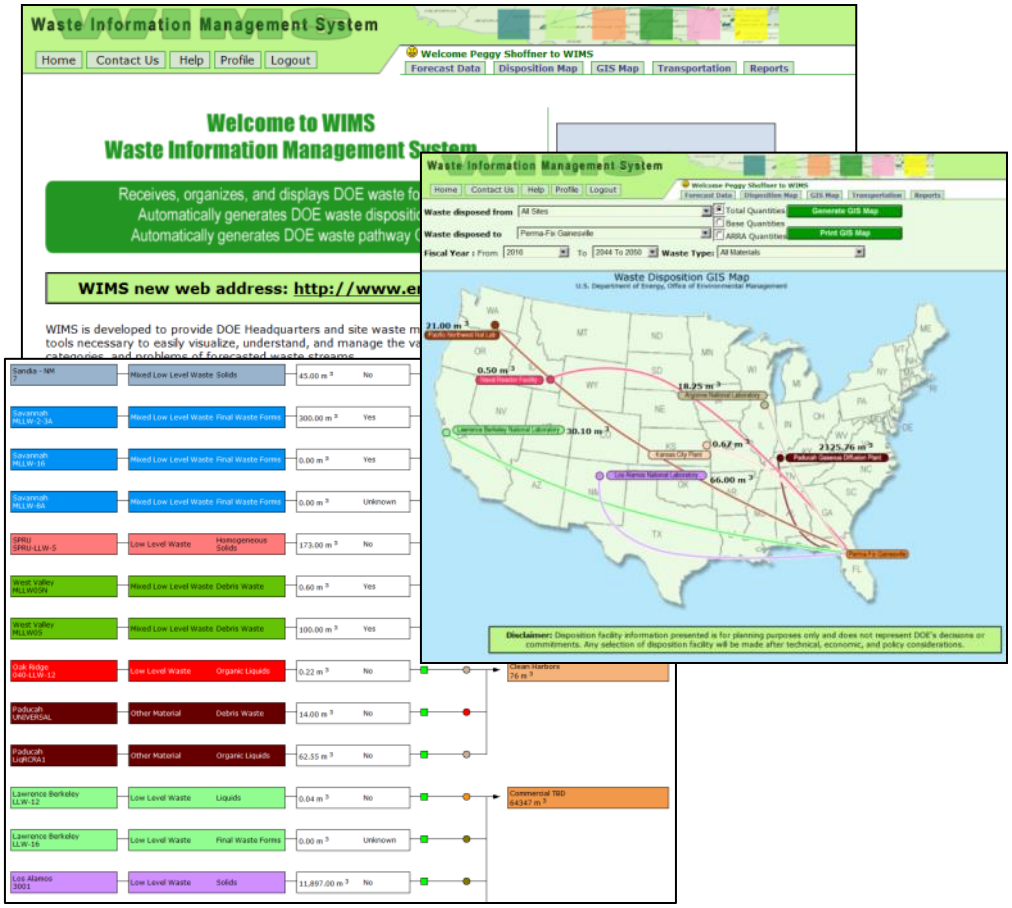
- Maintain existing system via database management, application maintenance, and performance tuning
- Incorporate new data files into WIMS on an annual basis

Task 1 – Waste Information Management System

FIU Applied Research Center

Accomplishments Year 7:

- WIMS is successfully deployed http://www.emwims.org
- Easy-to-use tool to visualize and understand the forecasted DOE waste streams.
- Completed integration of 2017 waste forecast and transportation data into WIMS.
- New 2017 dataset launched on public website on May 10.
- Oral presentation at WM17.



WIMS Tasks for FIU Performance Year 8

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