



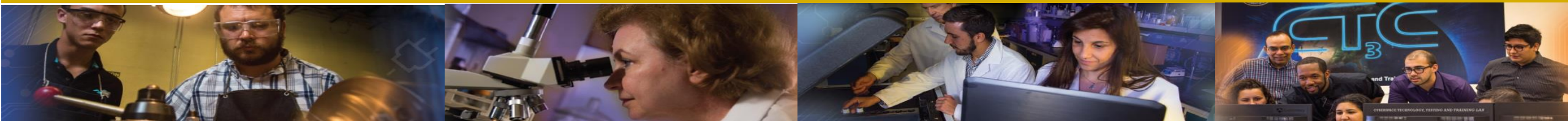
Project 3 D&D

ARC Staff: Joseph Sinicrope, Mellissa Komninakis, Thomas Donoclift, Leo Lagos

SRNL Collaborators: Connor Nicholson, Aaron Washington, Brent Peters, Michael Serrato

DOE Fellows: Tristan Simoes-Ponce, Joshua Nunez

FLORIDA INTERNATIONAL UNIVERSITY





Project 3 D&D Portfolio: Guiding Tenets for Research Project Selection



- **High profile mission sets / challenge areas (Pull)**
 - SRS 235-F Risk Reduction Program (mission set)
 - DNFSB compliance
 - Incombustible Fixatives (challenge area)
 - Response to a release incident
- **Employ a Holistic Solutions Approach to gain synergistic effects among research tasks**
 - Depth vs breadth
 - Not just about the “box”, but also address the critical enablers (e.g.: standards) and institutional barriers (e.g.: approved tool list, handbook update, etc.)
- **Technology deployment and diffusion mindset**
 - Focus on COTS technologies
 - 3 year timeline from concept to hot demo / deployment
- **Fill critical test and evaluation gaps**
 - Fire testing
 - Full scale operational testing





D&D Current Mission Sets and Research Areas



- Evaluating COTS-based Intumescent Technologies for D&D Applications
 - Incombustible Fixative Coating ISO SRS 235-F PUFF Facility
 - Incombustible Foam Fixatives as "Plugs" to Decommission Piping
 - Passive Thermal Insulators for Waste Packaging
- Empirically quantifying operational performance of fixative technologies
 - Open Air Demolition activities (e.g.: impact and environmental stressors)
 - Safety Basis contingency scenarios (e.g.: fire and extreme heat stressors)
- Leveraging ASTM International's E10.03 Subcommittee to develop standards and testing protocols for D&D technologies
 - Foundation for a "standards-based" technology test and evaluation program



Application #1: Incombustible Fixatives SRS 235-F Onsite Hot Demonstration

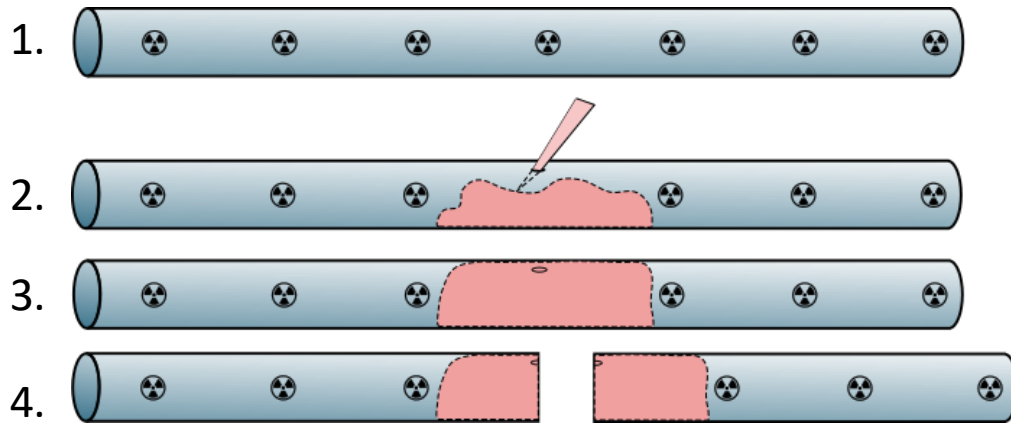


- Down-selected COTS-based intumescent technology successfully deployed in Process Cell #7 and the entry hood of Process Cell #1 at the SRS 235-F PUFF Facility
 - FIU / SRNL/ SRS collaborative effort
 - Concept to operational T&E in 3 years
 - Highlighted in DNFSB 2018 Annual Report
 - Targeting joint (FIU / SRNL / SRS) closeout report in Year 10
 - Engage vendor to open new market for product





Application #2: Intumescent Foams as "Plugs" for Nuclear Pipework



- Concept of Operations:
 - Place fire resistant plugs at strategic cutting points along pipework
 - Serves as a barrier to segregate / trap / immobilize contamination to mitigate potential release while cutting, packaging and storing





Down-Selection Process Identified Frontrunner

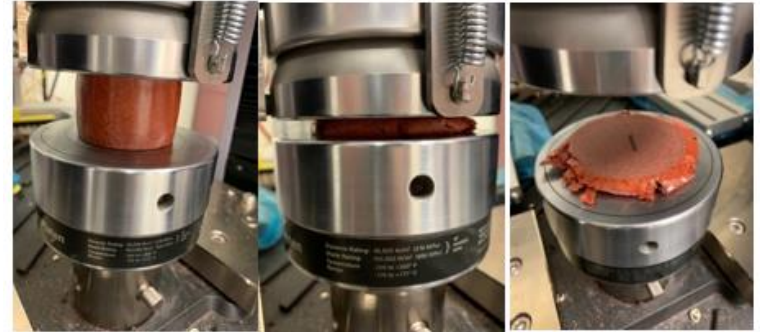


- Mechanical testing performed by DOE Fellow, Tristan Simoes-Ponce, during summer internship at SRNL
- Compression Test:
 - Used best-fit testing protocol ASTM D1621-16.

Intumescent Foam – Cylindrical Samples	Concrete
2169 psi	2500 psi (residential) 4000 psi (commercial)

- 304-SS Pipe Adhesion Test: Initial Trial
 - Up to \approx 2,800 lb. before foam delaminated from pipe
- Continued to immobilize contamination after exposure to extreme thermal stressors
- Defined operational parameters and additional testing is required

Compression



Pipe Adhesion



Fire Testing





Non-Destructive Evaluation to Determine Uniform Application of Foam Plug

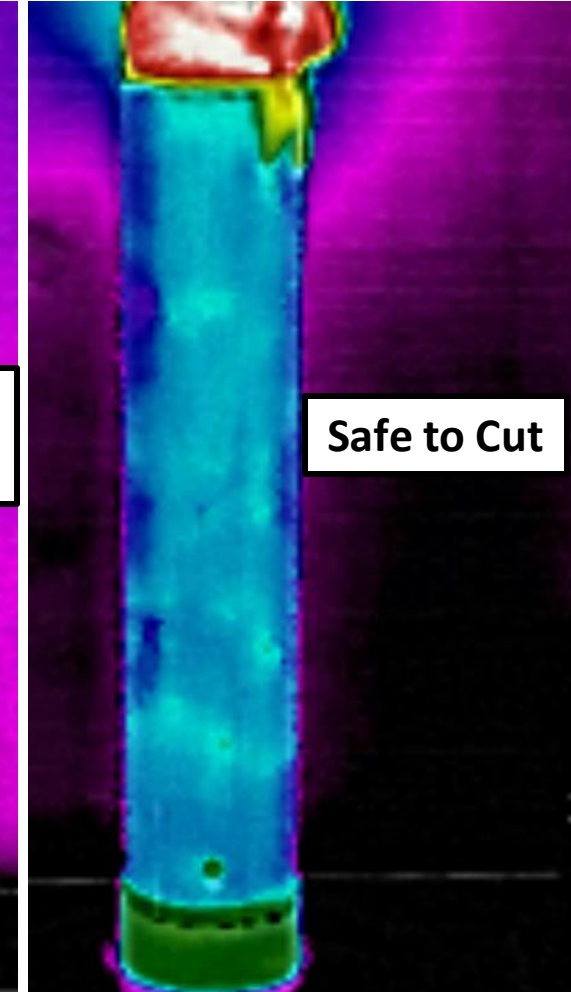
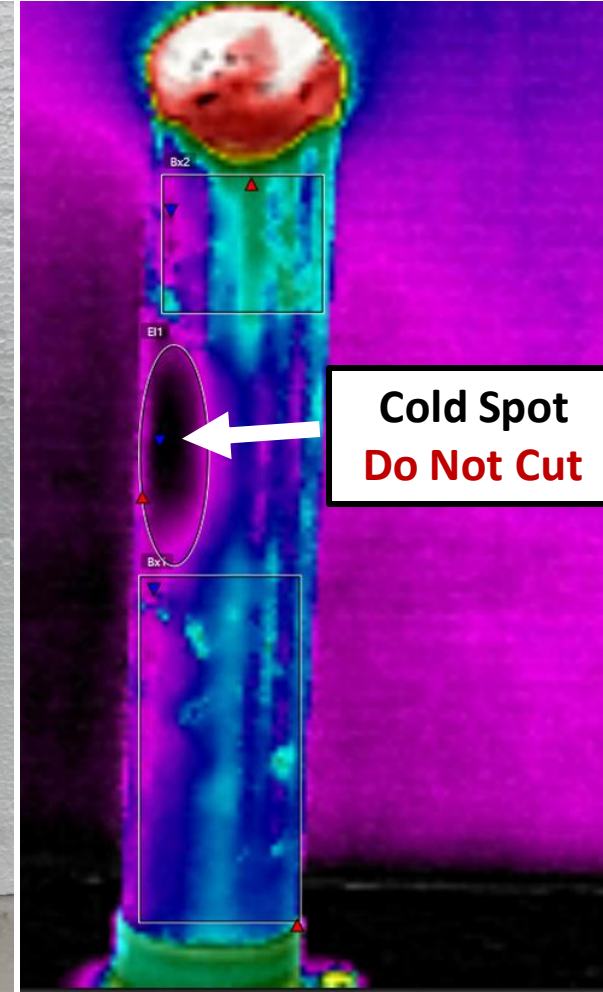


Proof of Concept Experiment #2

- **Hypothesis:** Can we combine advancements in thermal imaging systems with understanding of foam curing temperature profiles to identify anomalies in application in 304-SS pipe?



- **Confirmed:** Able to identify anomalies up to 3/8" steel wall thickness.





The Path Forward - Roadmap to Operational T&E

TRL-5:

- **Component and/or breadboard validation in a relevant environment**
- *Proof of concept validated and specific COTS-based technology identified - Completed 2019*

TRL-6:

- **System or prototype demonstration in a relevant environment**
- *Testing will be focused on refining and validating key operational parameters to support approval by safety basis personnel for an operational test and evaluation - Completed 2020*

TRL-7:

- **System prototype demonstration in an operational environment**
- *Close collaboration with SRNL and/or INL will hopefully yield an opportunity to apply the foam system in an operational environment in 2021*

Validation:
 Fire Resistance
 Mechanical Limits
 Curing Temperature Limits
 Extent of Contamination Immobilization
 NDE by Thermography

Increase scale and introduce more challenging operationally relevant scenarios

Collaborate with SRNL and leverage ASTM practices and principals to define the operational requirements



Application #3: Passive Thermal Insulator for Packaging Containers



- Potential applications in mitigating container pressurization of radioactive waste during a fire scenario
- Intumescent Coating: serves as an excellent thermal insulator in initial proof of concept tests
- Next round of testing scheduled for 8 August
- Working with SRNL to refine operational requirements and concept of operations with site personnel

No Coating



Intumescent Coating

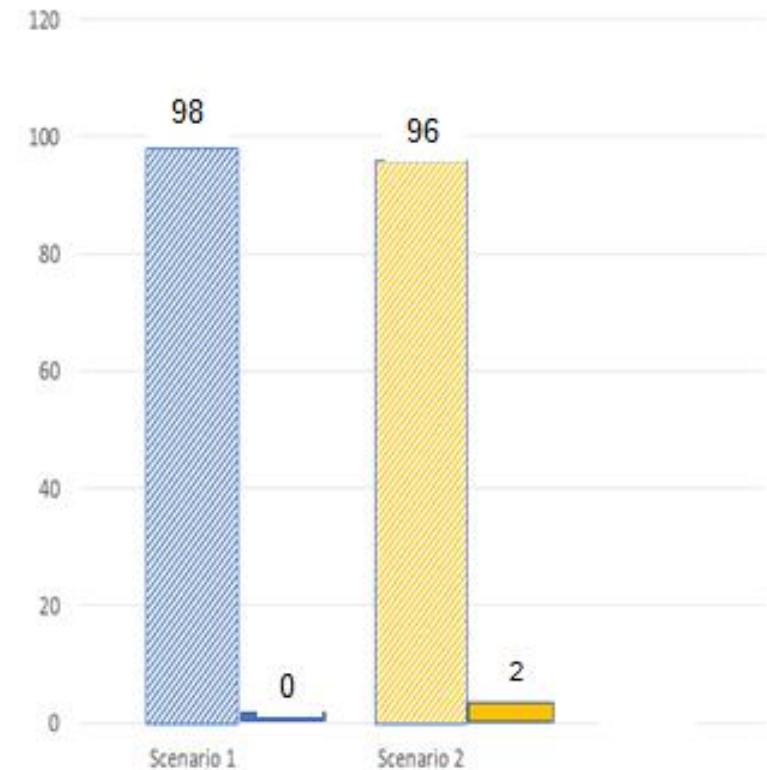




Potential Power of International Standards in Facilitating Technology Acceptance in D&D Space



- Choose between the two technologies based on the given information:
 - Technology 1: Fixative intended to stabilize residual radioactive material when exposed to a fire. \$0.75 / square foot.
 - Technology 2: Fixative intended to stabilize residual radioactive material when exposed to a fire. \$0.75 / square foot. Met ASTM E84, NFPA 701, and UL723 fire test standards.
- Choose between the two technologies based on the given information:
 - Technology 1: Fixative intended to stabilize residual radioactive material when exposed to a fire. \$0.75 / square foot.
 - Technology 2: Fixative intended to stabilize residual radioactive material when exposed to a fire. \$1.00 / square foot. Met ASTM E84, NFPA 701, and UL723 fire test standards.





Linking Standards Development with Operational Requirements



- Sets foundation for uniformed evaluation of technology performance against defined operational requirements
- 4 x ASTM standards for fixative technologies formally approved to date
- Referenced in Test Plans across DOE EM Complex
- Increased recognition by community on critical role of standards
 - Awarded Best in Track / Paper of Note at WM'19





Empirically Quantifying Fixative Performance Against Operational Stressors



- **Fire and thermal** hazards often receive the most attention as the consequences can be severe and may lead to significant release
- During demolition, **impacts from debris** are unavoidable yet there is no current means of assessing their effects on fixatives
- **Water** is used as a dust suppressant during demolition; however, many polymer fixatives are water soluble or easily delaminate when subjected to water
- Uniform, peer-accepted testing protocols facilitate comparison of performance against these stressors
- Allows for direct A-B type comparisons to be made between fixatives

Example of Thermal Stressor



Example of Water Stressor

