YEAR-END TECHNICAL REPORT

May 7, 2010 to May 17, 2011

Waste and D&D Engineering and Technology Development

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TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF FIGURES ii
LIST OF TABLES iv
PROJECT 4 OVERVIEW 1
TASK 1. DOE'S WASTE INFORMATION MANAGEMENT SYSTEM 2
- Task 1: Executive Summary 2
- Task 1: Introduction 2
- Task 1: Experimental 2
- Task 1: Results and Discussion 3
- Task 1: Conclusions 8
- Task 1: References 8

TASK 2. SUPPORT FOR DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT 9
- Task 2: Executive Summary 9
- Task 2: Introduction 9
- Task 2: Experimental 9
- Task 2: Results and Discussion 9
- Task 2: Conclusions 41
- Task 2: References 41

TASK 3. D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL 43
- Task 3: Executive Summary 43
- Task 3: Introduction 43
- Task 3: Experimental 43
- Task 3: Results and Discussion 44
- Task 3: Conclusions 49
- Task 3: References 50

OVERALL PROJECT CONCLUSIONS 51
APPENDIX A: REMOTE SPRAYER PLATFORM 52
APPENDIX B: BEST PRACTICES AND LESSONS LEARNED 111

LIST OF FIGURES

Figure 1. WIMS website home page. 4
Figure 2. WIMS waste forecast showing 2011 data update, including baseline and ARRA funded activities. 4
Figure 3. WIMS transportation forecast showing 2011 data update. 5
Figure 4. WIMS GIS Map showing 2011 data update. 5
Figure 5. ICM System with Spray Boom. 10
Figure 6. Wet coatings being applied remotely by sprayer (left) and dry coatings being stripped manually (right): CC Strip on concrete panel (top), ALARA 1146 on steel panel (middle), and DeconGel on steel panel (bottom). 11
Figure 7. 3-D, side, and top view of the reinforced concrete pipe. 14
Figure 8. Vertical and radial distribution of thermocouples. 15
Figure 9. Temperature fluctuations over time for RCP 1. 17
Figure 10. Temperature fluctuations over time for RCP 2. 18
Figure 11. Radial Temperatures for RCP 1 on Day 1, 2, 90 and 180. 19
Figure 12. Radial Temperatures for RCP 2 on Day 1, 2, 90 and 180. 20
Figure 13. 105-P Reactor Disassembly Basin D & E Canal Cross Section. 21
Figure 14. Design of the experimental test bed. 22
Figure 15. Steps of second ISD grout experiment. 23
Figure 16. Maturity vs Compressive Strength. 24
Figure 17. Day 1 RCP 1 Temperature vs Time. 25
Figure 18. Day 1 RCP 2 Temperature vs Time. 25
Figure 19. Week 1 RCP 1 Temperature vs Time. 26
Figure 20. Week 1 RCP 2 Temperature vs Time. 26
Figure 21. Detector positioning system, assembly view. 28
Figure 22. Smear sampling system. 29
Figure 23. Core drill. 32
Figure 24. Wall core. 32
Figure 25. Process for developing Best Practice and Lessons Learned documents. 34
Figure 26. Explosive demolition of Buildings 337 and 337B at the Hanford Site. 35
Figure 27. Track mounted wet cutting saw at LLNL.with a diamond blade used at LLNL. 36
Figure 28. Implosion demolition of cooling tower at SRS. 37

Figure 29. EFCOG Lessons Learned and Best Practices Poster presented by DOE Fellow Heidi Henderson at the Waste Management 2011 Conference. 41

Figure 30. Basic layout of the failover system. 45

Figure 31. Basic Layout of the backup system. 46

Figure 32. Himanshu Upadhyay presenting the D&D KM-IT system at Waste Management 2011.. 49

Figure 33. D&D KM IT Postcards handed out at the Waste Management 2011 Symposium. 49

LIST OF TABLES

Table 1. Coverage and Production Rate 12
Table 2. Comparison of Product Characteristics 13
Table 3. ZB-FF-8-D Grout for Uncongested Dry Areas Mix 15
Table 4. Results for Fresh/Cured Grout Property Testing 16
Table 5. Results from Quality Analysis Testing 24

PROJECT 4 OVERVIEW

The Waste and D&D Engineering and Technology Development Project (Project 4) focuses on delivering solutions under the waste and D&D areas for the DOE Office of Environmental Management and for the DOE Oak Ridge Office. For FY10, this project included the following 3 tasks:

Task 1: 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 at least annually. WIMS has been designed to be extremely flexible for future additions and is being enhanced on a regular basis.

Task 2: Support for DOE EM-44 in the development of a D&D Toolbox

This task provides direct support to DOE EM for D&D technology innovation, development, evaluation and deployment. The objective of Task 2 is to use an integrated systems approach to develop a suite of D&D technologies (D&D Toolbox) that can be readily used across the DOE complex to reduce technical risks, improve safety, and limit uncertainty within D&D operations. FIU directly supported DOE-EM's Office of Innovation and Technology Development and affiliated DOE sites, national laboratories, and institutions contributing to the development of innovation in D&D. 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.

Task 3: Support for DOE EM-20 and Hanford's ALARA Center in the development of a 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 (EM44 & EM72), the ALARA centers at Hanford and Savannah River, and with the active collaboration and support of 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.

TASK 1.
DOE'S WASTE INFORMATION MANAGEMENT SYSTEM

TASK 1: EXECUTIVE SUMMARY

For Task 1, FIU has developed a Waste Information Management System (WIMS) to receive and organize the DOE waste forecast data from across the DOE complex and to automatically generate waste forecast data tables, disposition maps, and other displayed reports. New features that have recently been added to the WIMS include updated waste forecast data and updated transportation data that displays waste volumes forecasted to be transported in numbers of truck, intermodal, and rail shipments. The data can be displayed to show the regular waste forecast, the American Recovery and Reinvestment Act (ARRA) funded waste forecast, or the combined regular and ARRA funded waste forecast.

TASK 1: INTRODUCTION

Under Task 1, 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 24 DOE sites occurred in May 2006. Individuals may visit the web site at http://www.emwims.org/. Annual waste forecast data updates have been added to ensure the long-term viability and value of this system.

In this report, FIU will present the new features that have recently been added to WIMS. New features of WIMS include the 2010 and 2011 updates to waste forecast data and transportation data that displays waste volumes forecasted to be transported in numbers of truck, intermodal, and rail shipments. The data can be displayed to show the baseline waste forecast, the American Recovery and Reinvestment Act (ARRA) funded waste forecast, or the combined regular and ARRA funded waste forecast.

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 2000. 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 received a new waste forecast and transportation data set from DOE in April 2010 and completed the data import into the master database. The 2010 data set was deployed on the test server for DOE review prior to launching on the public server. Comments were received from DOE and incorporated into WIMS and updates were deployed on the public server on May 27, 2010.

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 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.

FIU received another updated waste forecast and transportation data set from DOE on March 28, 2011. The data import into the master database was completed and deployed on April 13, 2011 on the test server for DOE review. The new data set was subsequently deployed on the public server on April 19, 2011. The data importation effort included updating the WIMS application, reports and data interface to display the new set of forecast data. The 2011 data set includes low-level and mixed low-level radioactive waste data supplied by all DOE programs and includes waste volumes forecasted for the ARRA funding in addition to the baseline waste forecast volumes and transportation information.

The new 2011 dataset 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). The current WIMS home page is shown in Figure 1. The data currently displayed in WIMS was collected in December 2010 and represents project planning information at that time. The data does not take into account any subsequent changes to forecasts.

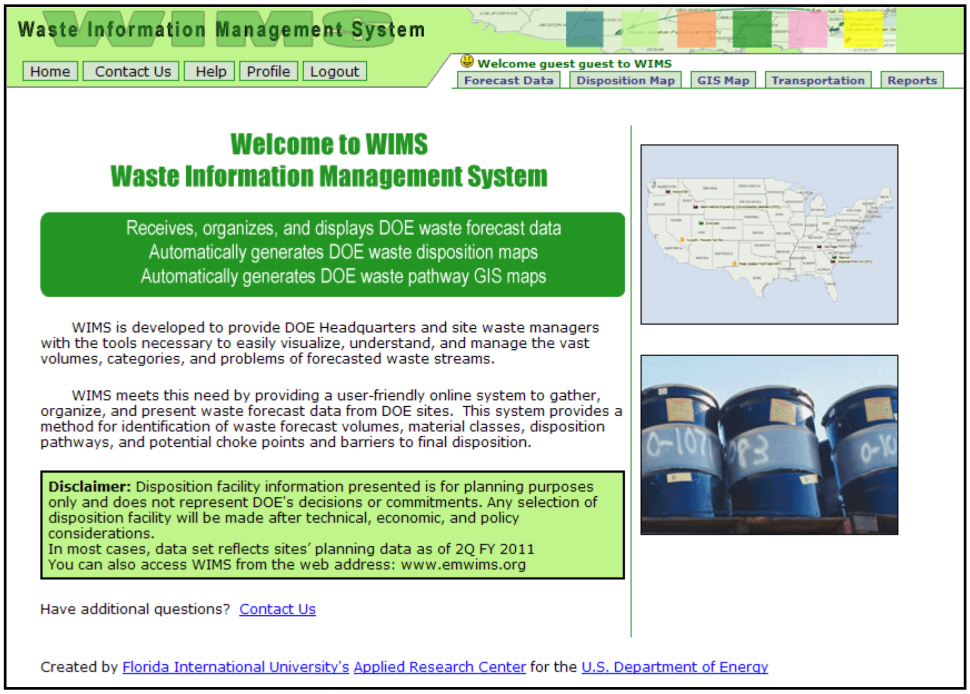


Figure 1. WIMS website home page.

Figures 2 and 3 provide screenshots of the WIMS waste forecast and transportation forecast showing the 2011 data update. Figure 4 provides a screenshot of the GIS map displaying the 2011 data update.

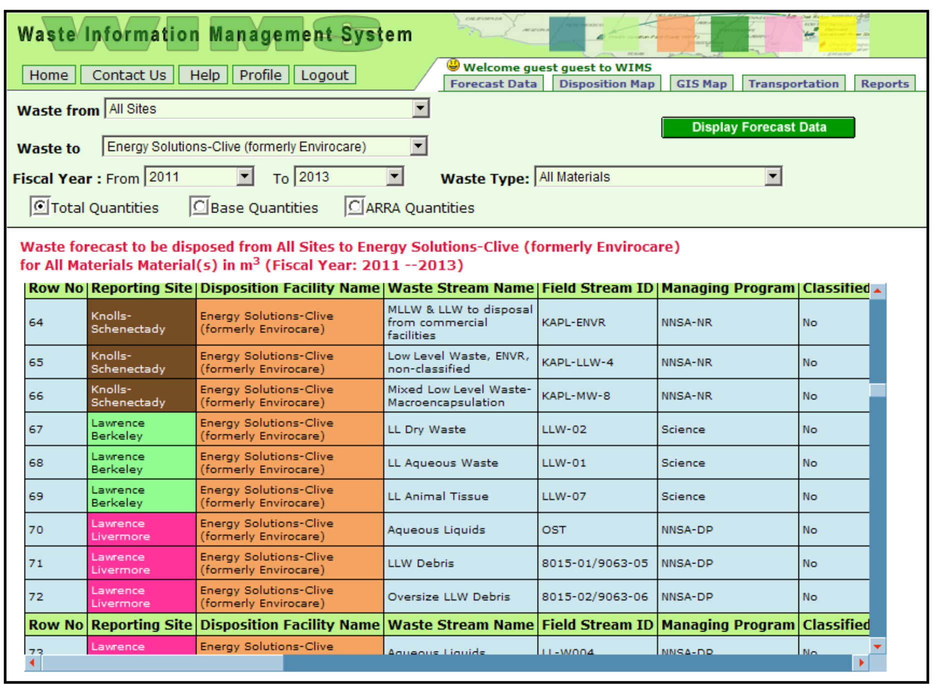
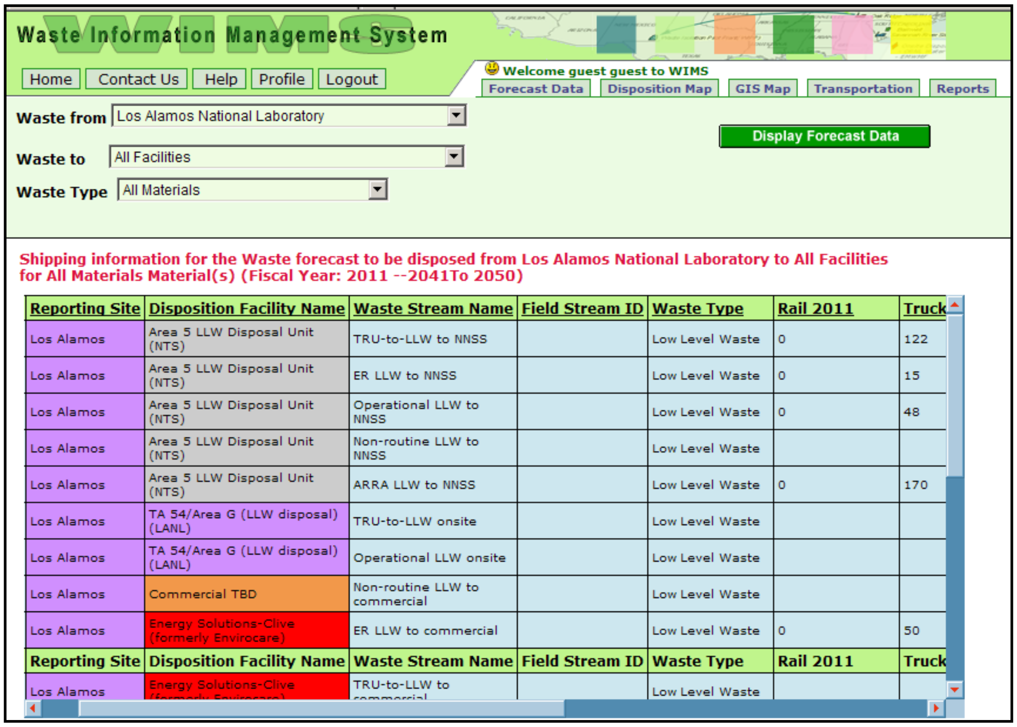


Figure 2. WIMS waste forecast showing 2011 data update, including baseline and ARRA funded activities.



Reporting Site	Disposition Facility Name	Waste Stream Name	Field Stream ID	Waste Type	Rail 2011	Truck
Los Alamos	Area 5 LLW Disposal Unit (NTS)	TRU-to-LLW to NNSS		Low Level Waste	0	122
Los Alamos	Area 5 LLW Disposal Unit (NTS)	ER LLW to NNSS		Low Level Waste	0	15
Los Alamos	Area 5 LLW Disposal Unit (NTS)	Operational LLW to NNSS		Low Level Waste	0	48
Los Alamos	Area 5 LLW Disposal Unit (NTS)	Non-routine LLW to NNSS		Low Level Waste		
Los Alamos	Area 5 LLW Disposal Unit (NTS)	ARRA LLW to NNSS		Low Level Waste	0	170
Los Alamos	TA 54/Area G (LLW disposal) (LANL)	TRU-to-LLW onsite		Low Level Waste		
Los Alamos	TA 54/Area G (LLW disposal) (LANL)	Operational LLW onsite		Low Level Waste		
Los Alamos	Commercial TBD	Non-routine LLW to commercial		Low Level Waste		
Los Alamos	Energy Solutions-Clive (formerly Envirocare)	ER LLW to commercial		Low Level Waste	0	50
Reporting Site	Disposition Facility Name	Waste Stream Name	Field Stream ID	Waste Type	Rail 2011	Truck
Los Alamos	Energy Solutions-Clive	TRU-to-LLW to		Low Level Waste		

Figure 3. WIMS transportation forecast showing 2011 data update.

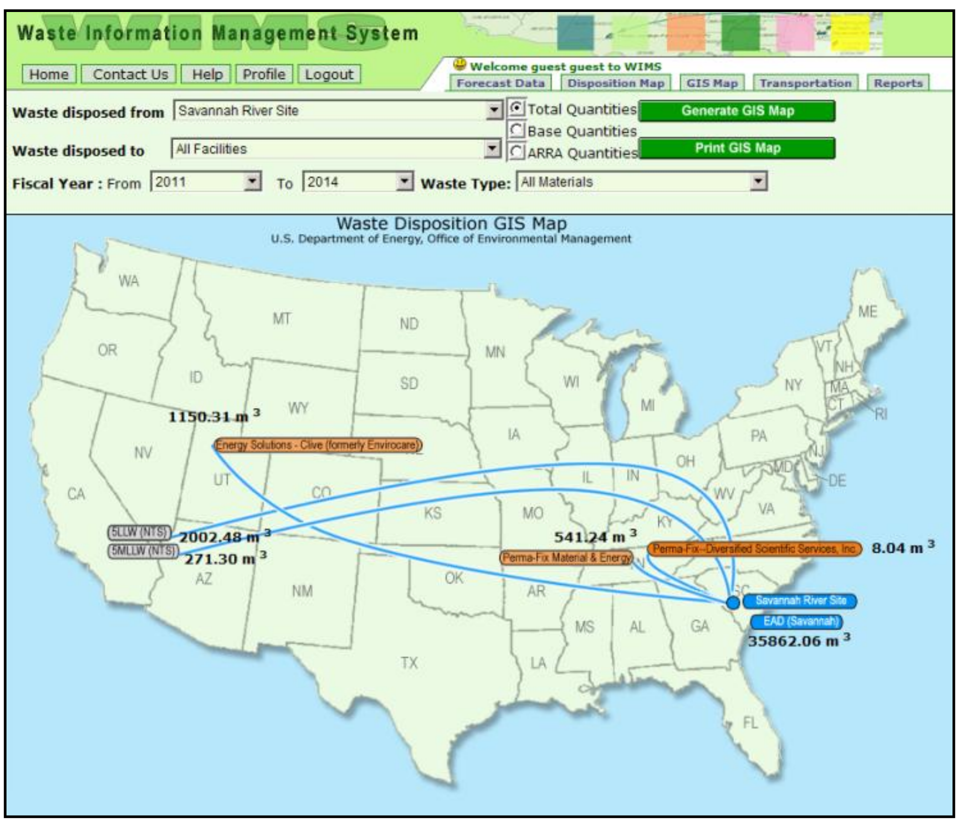


Figure 4. WIMS GIS Map showing 2011 data update.

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 from:

- All Sites
- Ames Laboratory
- Argonne National Laboratory
- Bettis Atomic Power Laboratory
- Brookhaven National Laboratory
- Energy Technology Engineering Center
- Fermi National Accelerator Laboratory
- General Electric Vallecitos Nuclear Center
- Hanford Site – RL
- Handford Site – RP
- Idaho National Laboratory
- Inhalation Toxicology Laboratory
- Kansas City Plant
- Knolls Atomic Power Laboratory – Kesselring
- Knolls Atomic Power Laboratory – Schenectady
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- Miamisburg Environmental Management Project
- 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 Buriel Ground (HANF)
- 746-U Landfill (Paducah)
- Area 5 LLW Disposal Unit (NTS)
- Area 5 MLLW Disposal Cell (NTS)
- Clean Harbors
- Commercial TBD
- Dupont Chambers Work (NJ)
- 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)
- Perma-Fix Gainesville
- Perma-Fix-Diversified Scientific Services, Inc.
- Perma-Fix-Northwest (formerly PEcoS)
- Perma-Fix-Materials & Energy Corp
- RMW Trenches (MLLW/LLW)(HANF)
- RMW Trenches/IDF (HANF)
- RWMC (LLW disposal) (INL)
- TA 54/Area G (LLW disposal) (LANL)
- To Be Determined
- Waste Control Specialists

Waste type:

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

Fiscal Year:

- 2011
- 2012
- 2013
- 2014
- 2015
- 2016-2020
- 2021-2025
- 2026-2030
- 2031-2035
- 2036-2040
- 2041-2050

Waste Management Conference

FIU also participated in relevant meetings and conferences in support of this project. FIU presented WIMS at the Waste Management 2011 Conference (WM11) on March 3, 2011 in Phoenix, AZ. An oral professional presentation entitled, “Waste Information Management System - 2011” was given and WIMS was demonstrated to conference participants.

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 enhancements to WIMS made over the last year include the addition of updated waste forecast data, updated transportation data that displays waste volumes forecasted to be transported in numbers of truck, intermodal, and rail shipments. The data includes low-level and mixed low-level radioactive waste data supplied by all DOE programs and includes waste volumes forecasted for the American Recovery and Reinvestment Act (ARRA) funding in addition to the updated baseline waste forecast volumes and transportation information

TASK 1: REFERENCES

Office of Science & Technology (OST), http://www.em.doe.gov/ost, Office of Environmental Management at US Department of Energy.

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

Waste Information Management System (WIMS), http://wims.arc.fiu.edu/wims/, Applied Research Center, Florida International University.

Upadhyay, H., W. Quintero, P. Shoffner, L. Lagos, and D. Roelant. *Waste Information Management System 2011*, Waste Management 2011 Conference, Phoenix, AZ, March 2011.

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

TASK 2: EXECUTIVE SUMMARY

This task provides direct support to DOE EM for D&D technology innovation, development, evaluation and deployment. The objective of Task 2 is to use an integrated systems approach to develop a suite of D&D technologies (D&D Toolbox) that can be readily used across the DOE complex to reduce technical risks, improve safety, and limit uncertainty within D&D operations. In FY10, FIU performed a technology demonstration of a remote sprayer platform for the application of strippable coatings and decontamination gel, 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 final report for the technology demonstration of the remote sprayer platform is attached as Appendix A.

TASK 2: INTRODUCTION

FIU directly supports DOE-EM's Office of Innovation and Technology Development 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 FY10 in support of technology innovation, development, evaluation and deployment.

TASK 2: EXPERIMENTAL

For FY10, FIU performed a technology demonstration of a remote sprayer platform for the application of strippable coatings and decontamination gel, 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.

TASK 2: RESULTS AND DISCUSSION

Innovative technologies demonstrations and development for D&D application of fixatives/ strippable coatings inside contaminated structures

FIU continued supporting the development and demonstration of a remote platform for the application of fixatives and strippable coatings for application in radiological contaminated facilities. The selected technology was previously demonstrated spraying fixative products at the hot cell mockup facility at FIU-ARC in November 2008. Based on the initial FIU demonstration and specific technical requirements identified at the DOE facilities, DOE requested that the follow-up demonstration be expanded to include strippable coatings and decontamination gels. This follow-up demonstration took place on June 24-25, 2010.

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 (Instacote CC Strip, Carboline ALARA 1146, and CBI Polymers DeconGel) onto vertical concrete and metal surfaces. ICM climbers are remote-controlled climbing machines that weigh approximately 30 pounds and have a pull off strength of over 225 pounds. Held to the surface by vacuum force, the machines adhere to essentially any hard surface such as metal, concrete, or brick. The ICM climbing machines are remotely controlled by an operator from a control station, allowing the machine to access areas unsafe for manual D&D activities. For the purposes of this technology demonstration, the ICM climber was modified with a spray applicator. The experimental set-up of the ICM climber is shown in Figure 5.

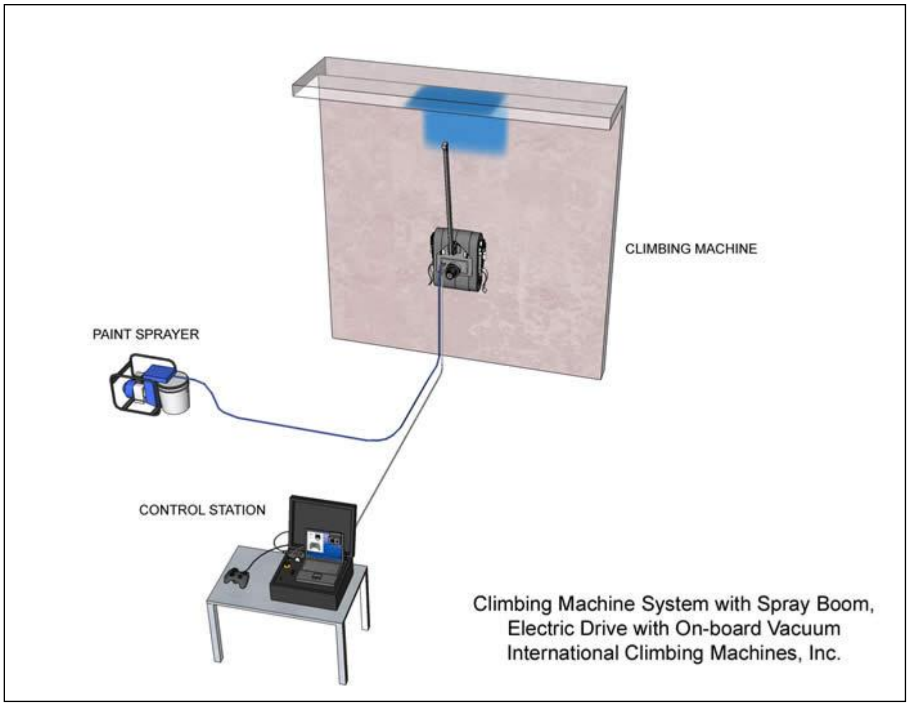


Figure 5. ICM System with Spray Boom.

The selected technology was demonstrated at the ICM facility in Ithaca, NY, under a contract with Florida International University's Applied Research Center. The technology was able to travel across the floor of the building module and climb 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 (Figure 6). Overall, the three products sprayed well and were relatively easy to strip, once dry, from the stainless steel and concrete panels.

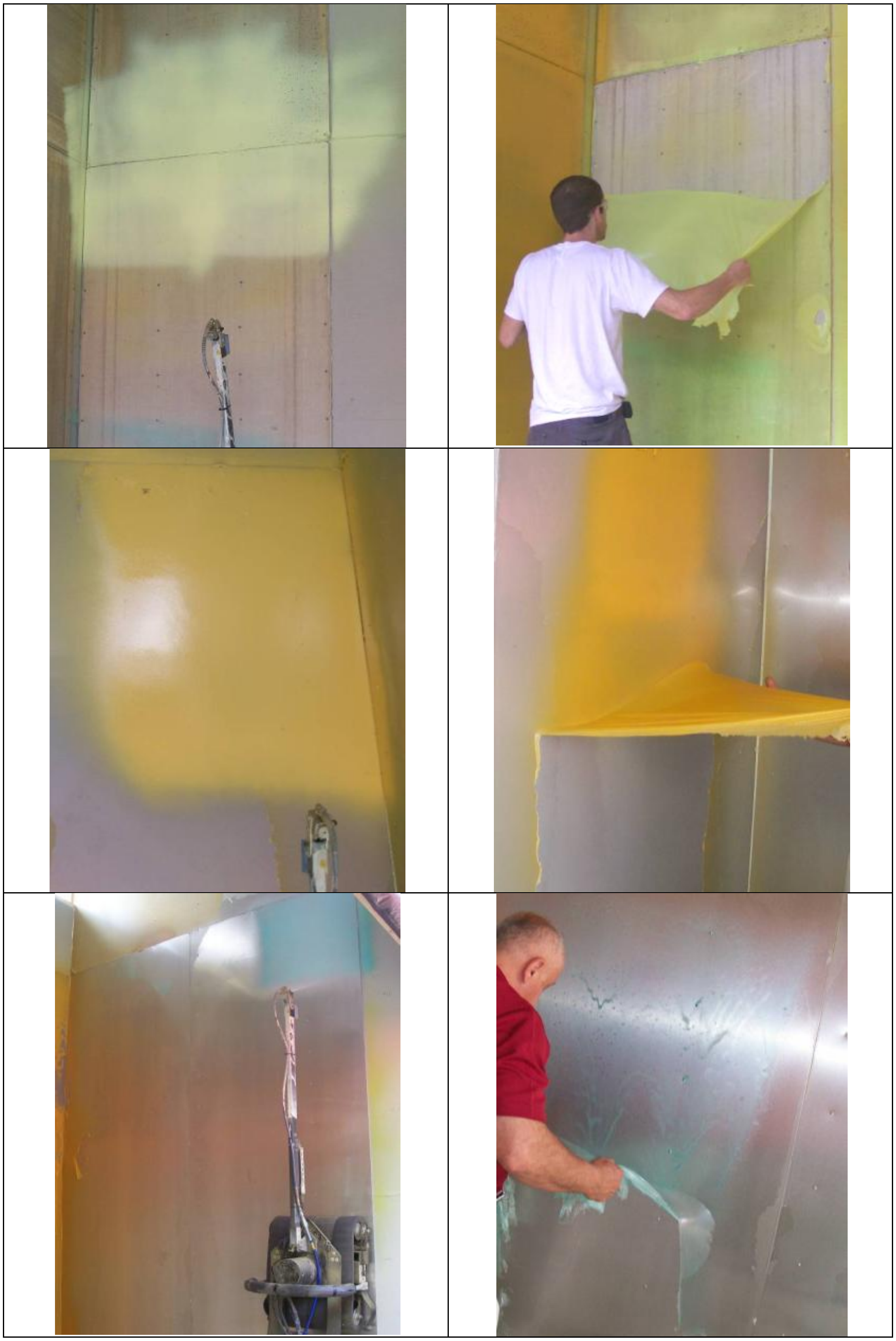


Figure 6. Wet coatings being applied remotely by sprayer (left) and dry coatings being stripped manually (right): CC Strip on concrete panel (top), ALARA 1146 on steel panel (middle), and DeconGel on steel panel (bottom).

Table 1 provides the product coverage achieved during the technology demonstration. It should be noted that maximizing the coverage per gallon was not an objective of the demonstration. Instead, remotely achieving a coating capable of being readily stripped from the surface once dry and minimizing missed or thinly coated surfaces was an overriding factor. The custom spraying attachment to the remote control climber was successful in achieving this goal. Table X also provides a comparison of the spraying rate of the 3 products used during the demonstration. The surface area coated with each product was divided by the total time that product was being sprayed to calculate the spraying rate. These spraying rates do not include break times and so illustrate the rate during active spraying. The rates do include the time required by the technology to position itself and climb the walls.

Table 1. Coverage and Production Rate

Product	Total Surface Area Coated	Product Consumed	Wet Film Thickness	Actual Coverage	Total Spraying Time	Spraying Rate
CC Strip	65 sq ft	1.5 gal	10-30 mil	43 sq ft/gal	21 min	3.1 sq ft/min
ALARA 1146	65 sq ft	1.25 gal	10-20 mil	52 sq ft/gal	13 min	5.0 sq ft/min
DeconGel	80 sq ft	2 gal	16-35 mil	40 sq ft/gal	21 min	3.8 sq ft/min

Table 2 provides a comparison of the strippable coating/decontamination gel products used during the demonstration. Overall, the three products sprayed well and were relatively easy to strip, once dry, from the stainless steel and sealed concrete panels. In addition, drying time affects the ease with which the products strip away from the surface. Areas of product that were still damp after 24 hours of drying time continued to adhere to the surface, creating holes in the dry product that was stripped away. On the other hand, leaving the product to cure for a week caused the DeconGel to become more brittle and papery, leading to tearing of the coating at thin sections. Finally, for all three products, areas of product overspray were difficult to remove.

Table 2. Comparison of Product Characteristics

Product	Product Description and Consistency (wet)	Result after spraying (wet)	Result after spraying (dry)
CC Strip – HV Green	Yellow, consistency of thin whipped cream	Applied with fair uniformity, ~ 10 mil in thin areas and ~25 mil in thick areas	Peeled very easily in one continuous sheet from the metal panel. Peeled in one mostly continuous sheet from the sealed concrete panel; requires more force to remove from concrete than metal. Some heavy drips were not cured after 24 hours and did not form the film.
ALARA 1146	Orange, consistency of liquid plastic	Very uniform application on metal panel (~20 mil). Good application on concrete panel (mostly ~10-13 mil with some thin areas ~7 mil).	Peeled very easily from the metal panel, even discontinuities and bare spots did not cause the film to rip. Harder to remove off concrete, mostly peeled as a uniform sheet except for thin areas which had some rips.
DeconGel	Blue, consistency of liquid gel	Varying application on metal panel, ~16 to 35 mil. More difficult to judge thickness while spraying due to the clear appearance of the gel. ~20-35 mil thickness on concrete panel.	Removed easily from the metal panel; ripped at thinnest sections. Peeled fairly easily from concrete, harder to remove than from metal, tearing at thin sections.

A final report was prepared to document the findings of this technology demonstration and a DOE Tech Sheet was developed. In addition, information, photographs, and video were gathered and incorporated into the web-based D&D Knowledge Management Information Tool (D&D KM-IT) for complex wide distribution.

In Situ Decommissioning Experiment #1: Thermal Analysis of a Special Grout Mixture

Savannah River National Laboratory (SRNL) is implementing in situ decommissioning (ISD) at two reactor facilities by filling all subsurface areas with Zero-Bleed-Flowable-Fill-Gravel No.8-Diutan Gum (ZB-FF-8-D) grout and placing a water resistant concrete slab over the filled area. The 105-R Reactor Disassembly Basin D & E Canal was one of these below grade areas that were filled with the special grout.

The heat generated by the mixture as it cures is known as the heat of hydration. Temperature differences can affect the curing 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 ARC 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 experimental set-up consisted of two reinforced concrete pipes (RCP), each measuring 3 feet in diameter and 8 feet in height (Figure 7). For support, a unistrut system was placed around the pipes to prevent any movement and a crack-filler was applied to the bottom of the RCPs to prevent grout from leaking out. A thermocouple tree was placed in the center of each pipe to measure the axial and radial temperatures.

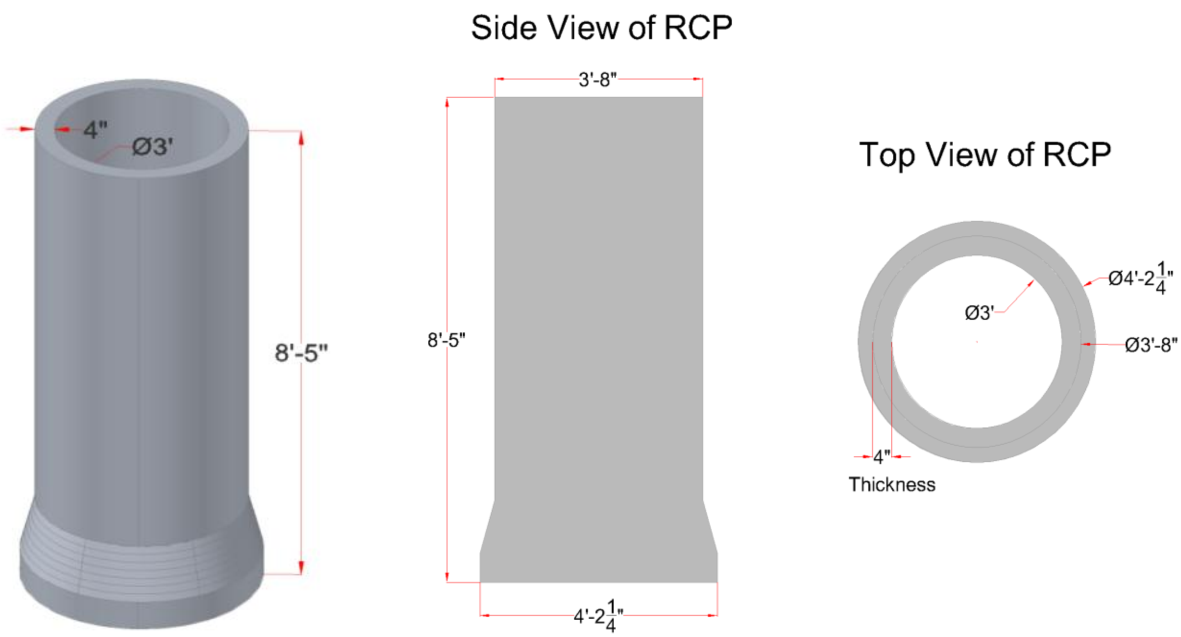


Figure 7. 3-D, side, and top view of the reinforced concrete pipe.

The thermocouples were placed at 4 different vertical levels: 1.5, 3.5, 6, and 7 feet from the base. At each vertical level, the thermocouples were placed at 4 different radial distances: 3, 7, 11, and 15 inches from the center of the RCP (Figure 8). In total, 16 thermocouples per RCP were used, each connected to a data acquisition system.

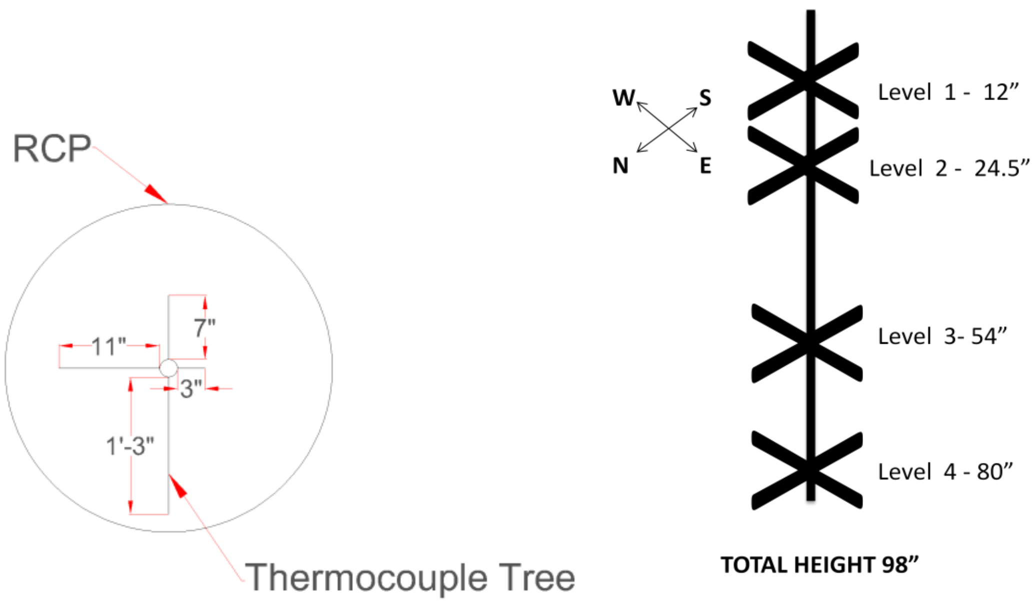


Figure 8. Vertical and radial distribution of thermocouples.

On July 26, 2010, the ZB-FF-8-D grout mixture was delivered and placed by Cemex. The grout mixture formulation had been provided by SRNL and is displayed in Table #.

Table 3. ZB-FF-8-D Grout for Uncongested Dry Areas Mix

Material	Amount	Total (for 2.09 cu yd per RCP)
Portland Cement Type I/II	150 lbs/yd^3	315 lbs/yd^3
Fly Ash Type F	500 lbs/yd^3	1050 lbs/yd^3
Sand (Silica) C-33	1850 lbs/yd^3	3885 lbs/yd^3
Gravel (Granite) No. 8	800 lbs/yd^3	1680 lbs/yd^3
*ADVA CAST 575	79 fl. oz/ yd^3	165.90 fl. oz/ yd^3
*V-MAR 3	205 fl. oz/ yd^3	430.50 fl. oz/ yd^3
Water	50 gal/ yd^3	105 gal/ yd^3

*ADVA CAST 575 replaced Viscocrete 2100, V-MAR 3 replaced Diutan Gum.

The grout was placed in the RCPs via a pump and 2-inch hose. A series of fresh and cured tests were conducted using American Society of Testing and Materials (ASTM) standards to determine the quality of the grout. The results of the fresh and cured property testing are displayed in Table #.

Table 4. Results for Fresh/Cured Grout Property Testing

Test	Day 1	Day 2
Temperature	90.8ºF	89.0ºF
Spread	19 inches	21-23 inches
Air Content	0.5%	0.3%
Solid Unit Weight	143.30 lb/ft^3	141.70 lb/ft^3
7-Day Compressive Strength	366 psi	343 psi
28-Day Compressive Strength	828 psi	789 psi

The grout’s 28-day compressive strength values of 828 psi and 789 psi surpassed the material compressive strength requirement of 50 psi as set by SRNL. These values provide evidence that the grout was curing correctly.

After the RCPs were filled with grout, the temperatures measured by the thermocouples were recorded every minute. Figures 9 and 10 display the temperature fluctuation over time recorded for RCP 1 and RCP 2 for Day 1, Day 2, Day 6-7, Day 32-35, Day 90, and Day 180. Figures 11 and 12 display the radial temperatures for RCP 1 and RCP 2 for Day 1, Day 2, Day 90, and Day 180. Identified temperature peaks were found to occur on a weekly basis. Despite the fact that peaks were expected to occur due to the reaction of fly ash with lime, the pattern of the highest peaks observed was consistently taking place early morning on Mondays. It is believed that such behavior may be directly related to the FIU facility management practice of shutting off the air conditioning Friday evening to Monday morning.

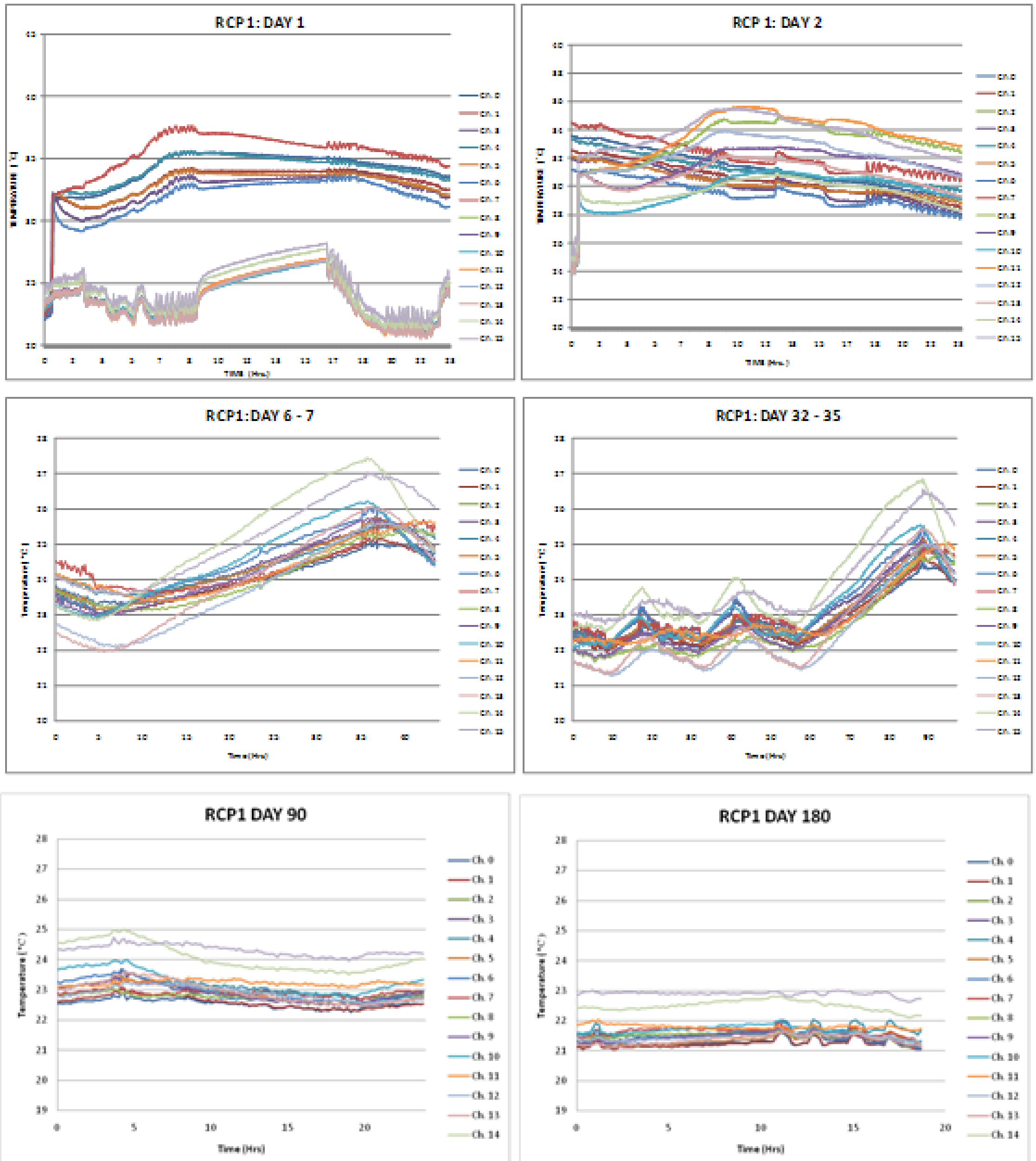


Figure 9. Temperature fluctuations over time for RCP 1.

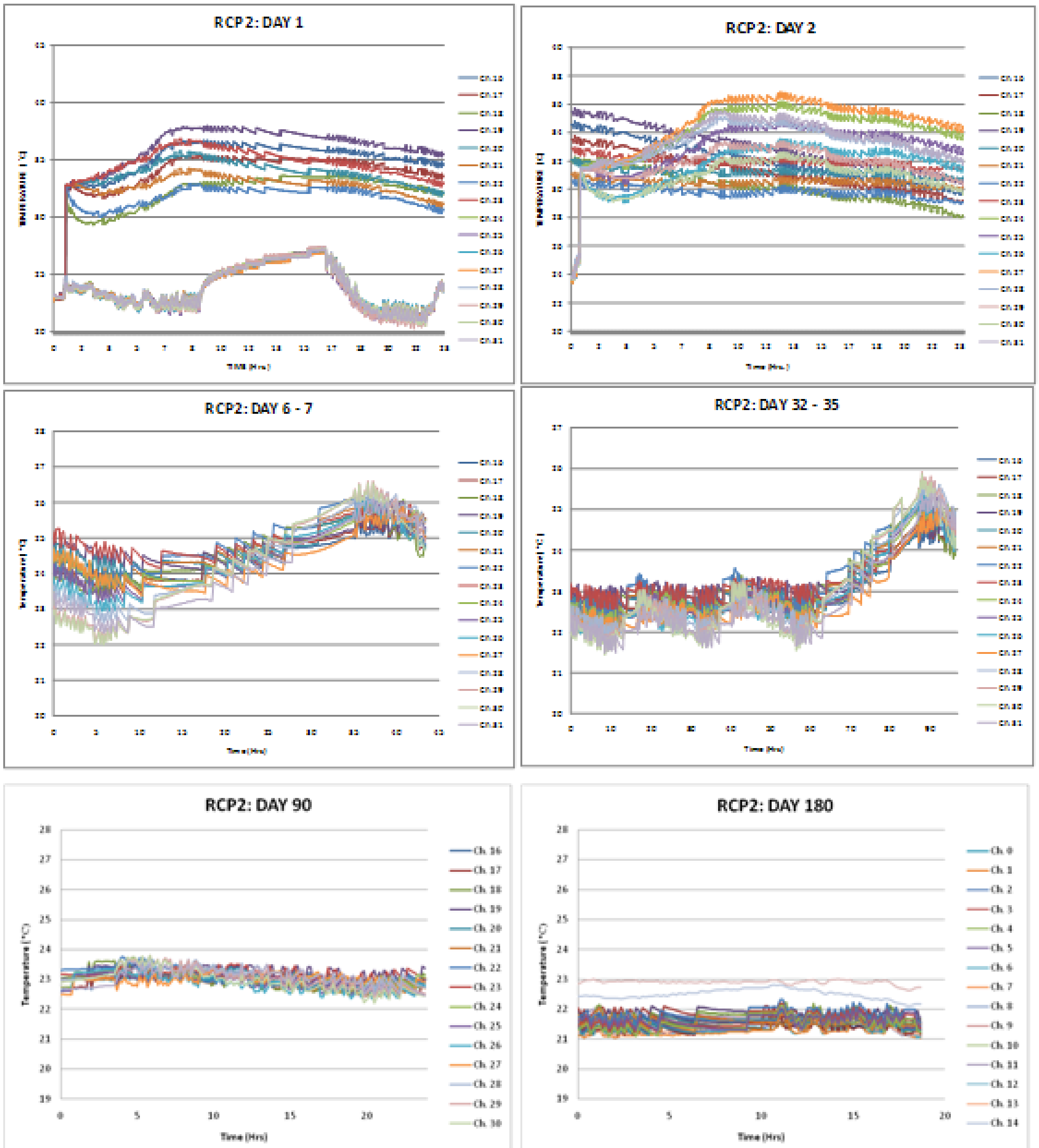


Figure 10. Temperature fluctuations over time for RCP 2.

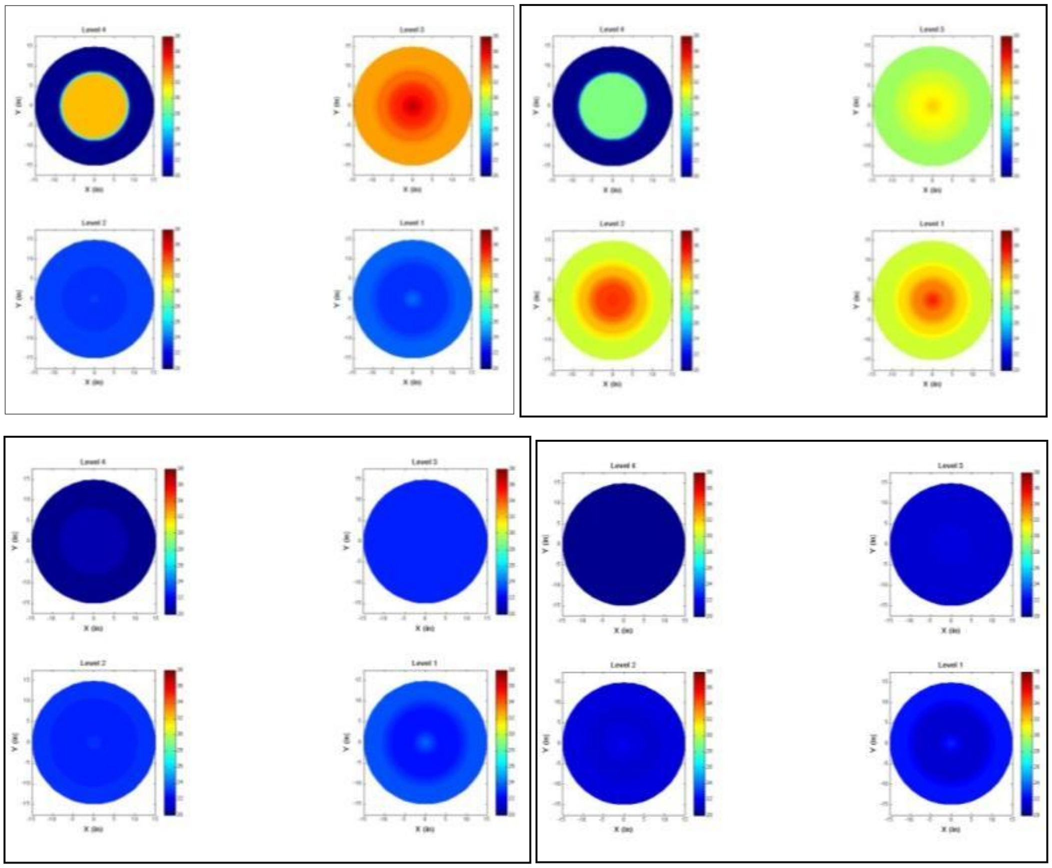


Figure 11. Radial Temperatures for RCP 1 on Day 1, 2, 90 and 180.

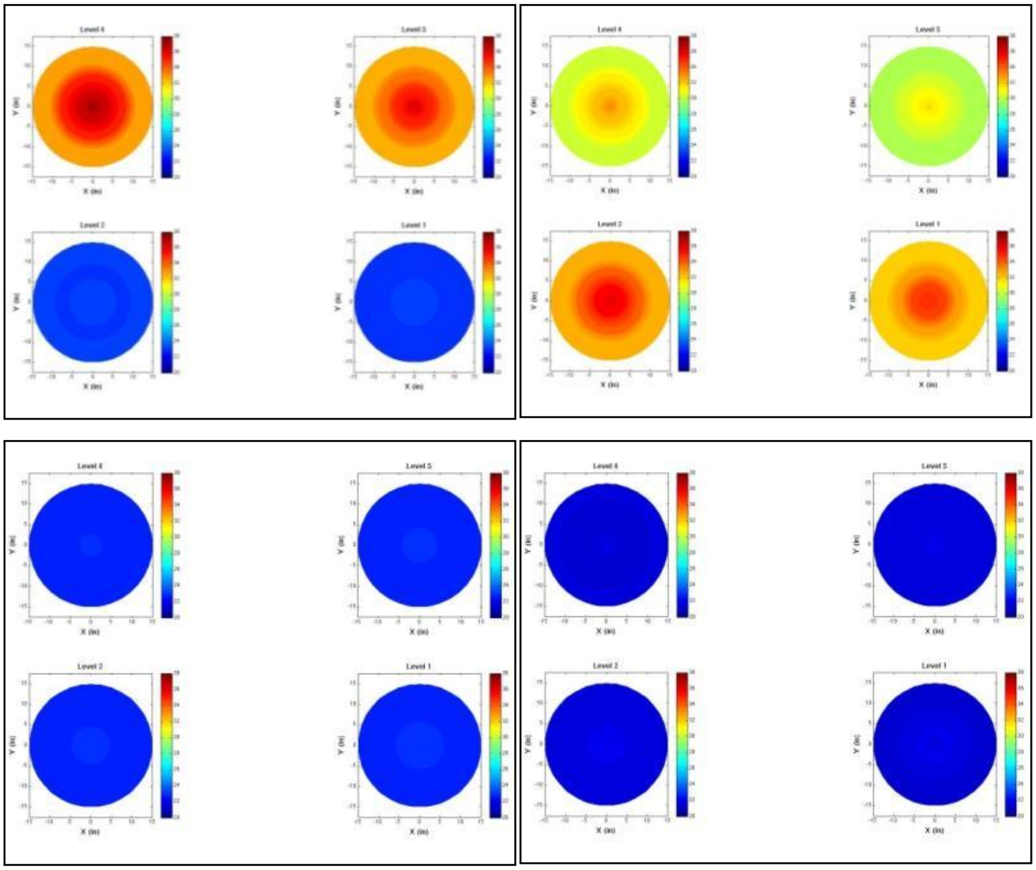


Figure 12. Radial Temperatures for RCP 2 on Day 1, 2, 90 and 180.

The experiment was successfully conducted and met the proposed objectives. 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 100ºF, with subsequent lower peaks occurring after the first 24 hours. The maximum temperature found at SRNL was lower than that at FIU ARC due to the time of year the experiments were conducted. The pouring at SRNL took place between February and March when the ambient temperature was approximately 20-30ºF, while at FIU ARC the ambient temperature was around 85-100ºF. In addition, the presence of water was another factor that affected the behavior of the grout at SRS. These two factors (ambient temperature differences, and the presence of water), have an effect on the temperature behavior of the grout. 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.

In Situ Decommissioning Experiment #2: Heat of Hydration Experimental Mock Up and Heat Transfer Analysis Using Cellular Grout

DOE has identified 84 facilities in the complex that are considered potential candidates for in situ decommissioning closures, representing a footprint of about 1.8 million square feet. Considering facilities that have not yet been placed out of operation and other factors, ISD closure could be beneficial for 100-125 facilities across the complex. With this in mind, FIU continued to work with SRS on this subtask to gain a better understanding on the performance of various cementitious materials that could be used during the process of ISD. For this second in situ decommissioning experiment, FIU used a similar experimental set-up with a cellular grout mixture.

SRS is implementing ISD by placing a modified cellular concrete/grout into a section of the 105-P Reactor Disassembly Basin D & E Canal. The section filled is on top of an underlying cavity (Figure 13) and needed to be filled with a light-weight/low-density concrete in order to avoid collapsing of the cavity. Cellular grout was the lead candidate for filling this space because of its light weight. Cellular concrete/grout is an innovative material to be used for in situ decommissioning. Cellular grout, otherwise known as foam grout, is a lightweight material containing gas cells. These gas cells are created by adding a foaming agent to the neat cement, which in turn decreases its density. The end product is a lightweight material with a density range of 15-120 lbs/ft^3. The selection of cellular grout was based upon its low density, thermal conductivity, and excellent flow properties. These characteristics were ideal for filling the area.

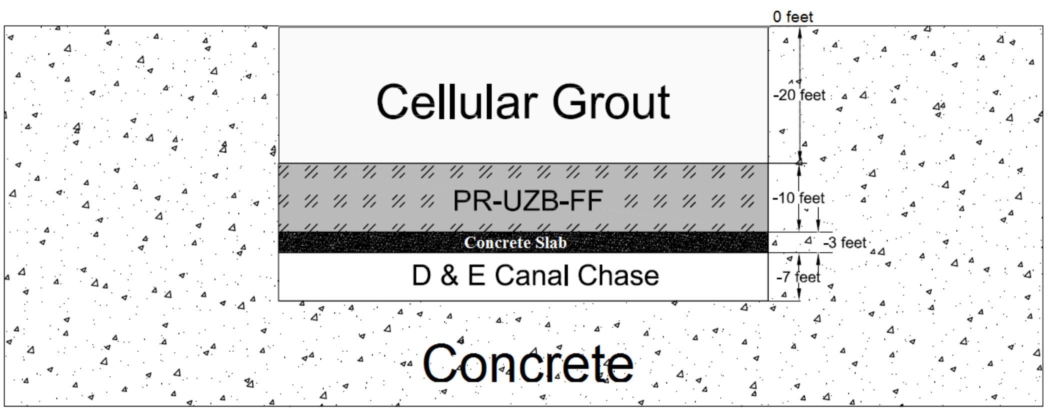


Figure 13. 105-P Reactor Disassembly Basin D & E Canal Cross Section.

As explained in the previous experiment, once the grout is poured, heat is anticipated due to the hydration of the mix and these temperature values need to be quantified. Therefore, a thermocouple tree and concrete maturity logger (CML) were developed to acquire the temperature data and strength of the grout as it cures. The second experimental setup was designed and developed by FIU-ARC in Miami, Florida, to investigate the temperature distribution and strength generated by this grout. The temperature and strength data obtained will be compared with the temperature data modeled by SRS. This experiment will validate the performance of the cellular concrete grout mix. In addition, FIU-ARC will develop a summary report providing the results and conclusions obtained from the experiment.

Similar to the first experiment, this set-up utilized an 8-ft tall by 36-inch diameter reinforced concrete pipe (Figure 7). However, the cellular grout mixture was poured in one continuous lift on a single day.

The two RCPs used for the second experiment were purchased from U.S. Precast located in West Palm Beach, Florida. Both RCPs were enclosed with trusses to support moments from lateral loads. Similarly, the flow of the grout was not fast enough to make the RCPs move. In addition, Crack-Stix Permanent Crack Filler was applied to the bottom of the RCPs to prevent grout from leaking out.

For support, the PVC pipe forming the skeleton for the thermocouples was attached perpendicularly to a 44 in. long 2x4 lumber resting on the top of the RCP. At each end of the 2x4, two smaller cuts of lumber were added to prevent slippage on the rim of the RCP. The smaller cuts had a 4.5 in. gap between them within which the rim of the RCP was held.

The experimental set-up consisted of two RCPs, each with a thermocouple tree at their center along with two concrete maturity loggers. The RCPs were filled with cellular concrete/grout (formulation provided by SRS). The temperatures generated by the cellular grout are currently being recorded for a period of 180 days. At the same time, the CMLs are recording the in-place strength of the grout. Compressive strength analysis was analyzed at days 3, 7, 14, 28. The data will be analyzed and compared to the tested values obtained by SRS. Figure 14 shows the setup of the experiment.

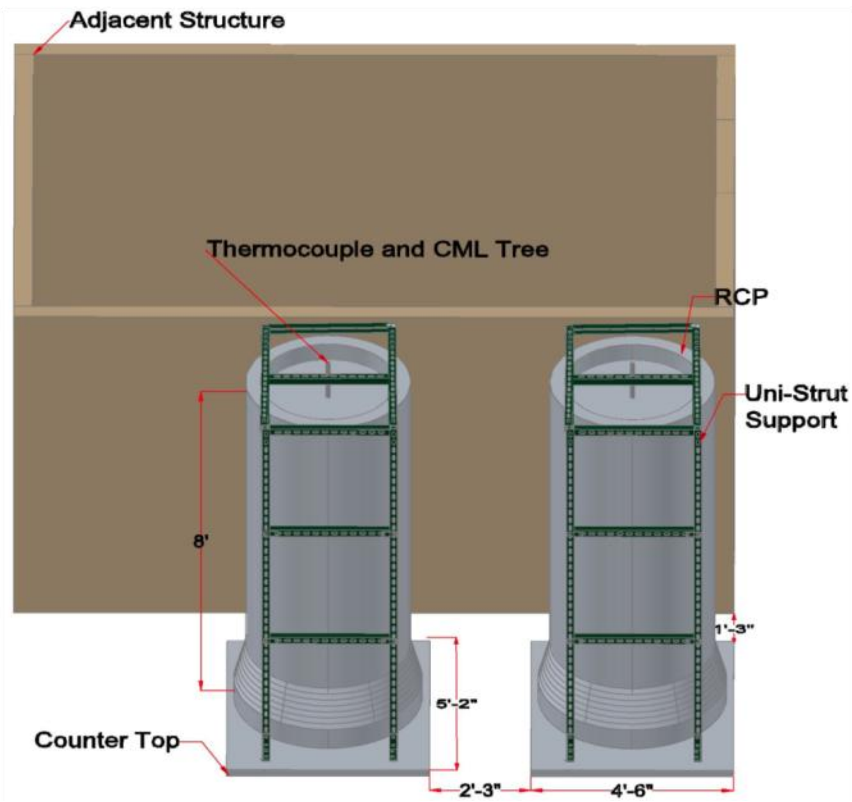


Figure 14. Design of the experimental test bed.

The experimental steps included the following (Figure 15):

1. RCPs were set up on epoxy resin countertops (used as the base).
2. The thermocouples were calibrated using a known temperature measured by a thermometer.
3. After thermocouple calibration, the thermocouple and CML trees were placed and secured at the center of each RCP.
4. The CMLs were calibrated once the concrete mixing truck arrived on site following ASTM C 1074.
5. Gibson's Pressure Grouting Service, Inc. arrived with Central Concrete Supermix (subcontractors that provided the slurry).
6. Gibson's Pressure Grouting Service, Inc. prepared the liquid foam using a Viper Turbo-Air 50-1.0 Foam Generator.
7. The cellular concrete grout was mixed onsite using a mixing truck.
8. A grout hose was placed carefully inside of the RCPs so as not to damage the thermocouple tree.
9. Pouring took place at a rate of 3 ft/hr, until the RCPs were filled. The thermocouples recorded the initial temperature of the grout every minute as it entered the RCP. The CMLs recorded the in-place strength of the grout every hour.
10. The data acquisition will run for a period of 180 days.

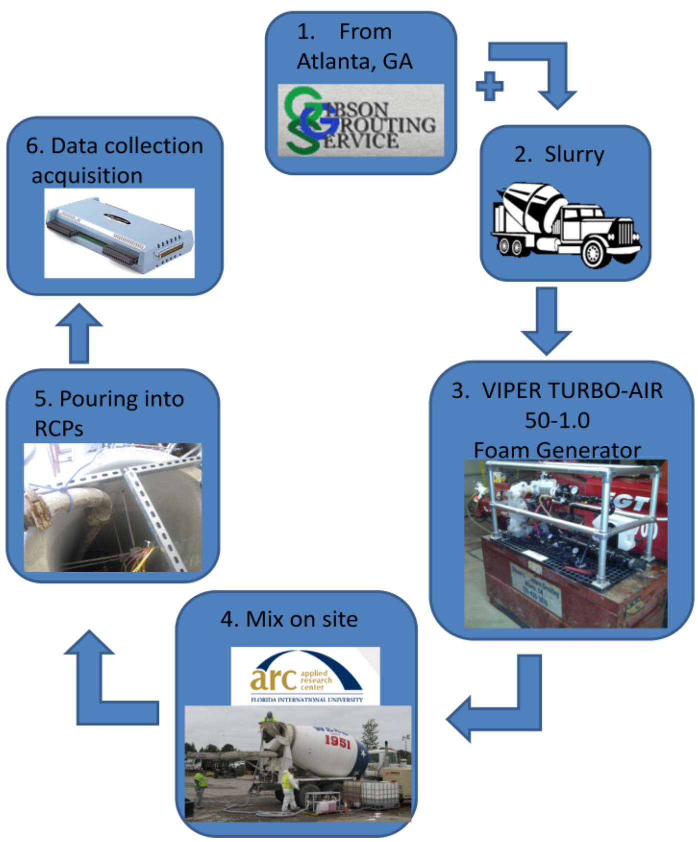


Figure 15. Steps of second ISD grout experiment.

Quality analysis testing of the grout was conducted as fresh and cured tests. Table 5 displays the results for temperature, unit weight, air content, and spread.

Table 5. Results from Quality Analysis Testing

Property	Grout	Grout with Foam
Temperature	90.5°F	84.5°F
Unit Weight	110 lb/ft^3	25 lb/ft^3
Air Content	0.22%	81-83%
Spread	N/A	37 inches

The compressive strength of the grout was also tested at Days 1, 3, 7, 14, 28, and 90. Figure 16 displays the maturity collected by the maturity sensors vs the compressive strength data collected during the compressive strength quality analysis tests.

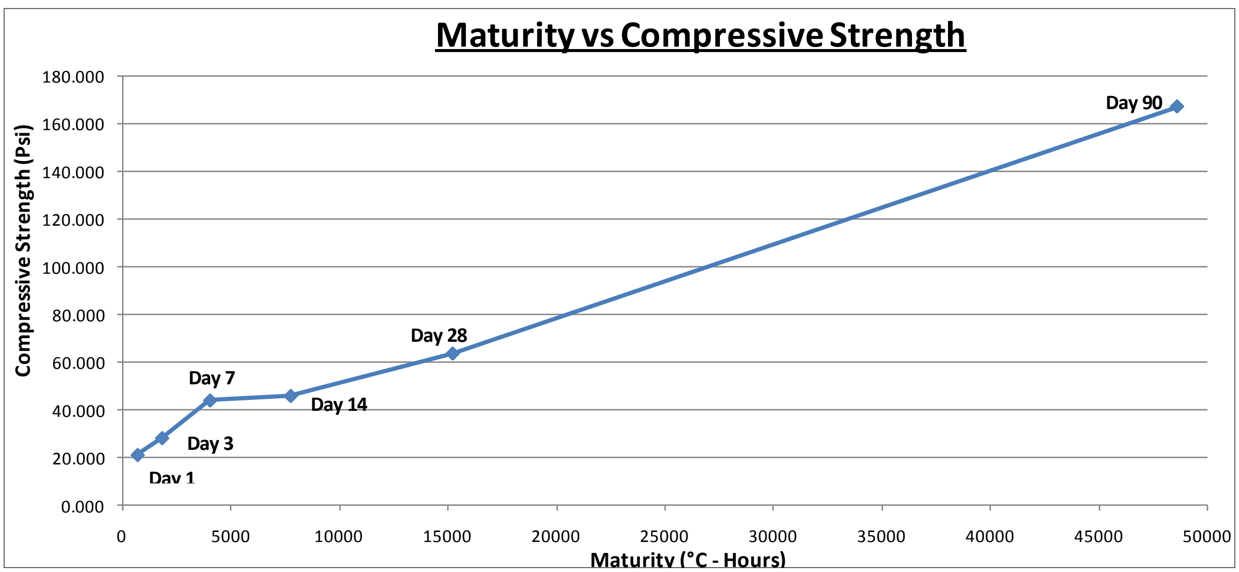


Figure 16. Maturity vs Compressive Strength.

Temperature data collection is in progress. Figures 17 through 20 depict temperature fluctuations for Day 1 and Week 1 for RCP 1 and RCP 2.

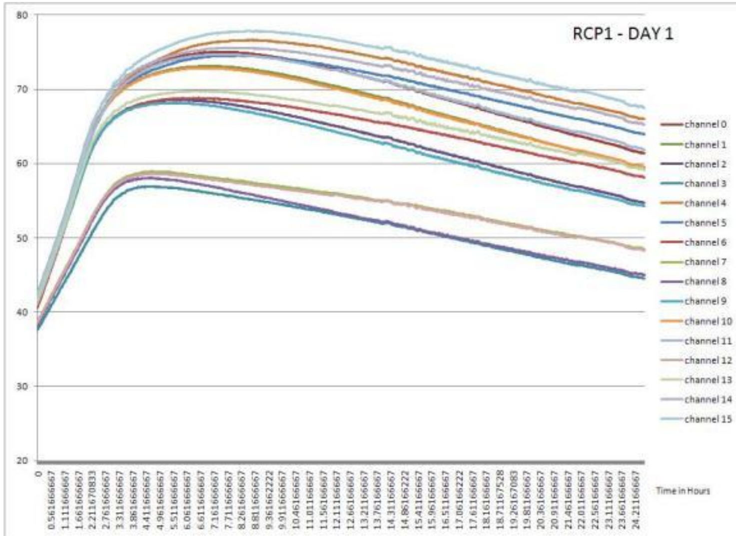


Figure 17. Day 1 RCP 1 Temperature vs Time.

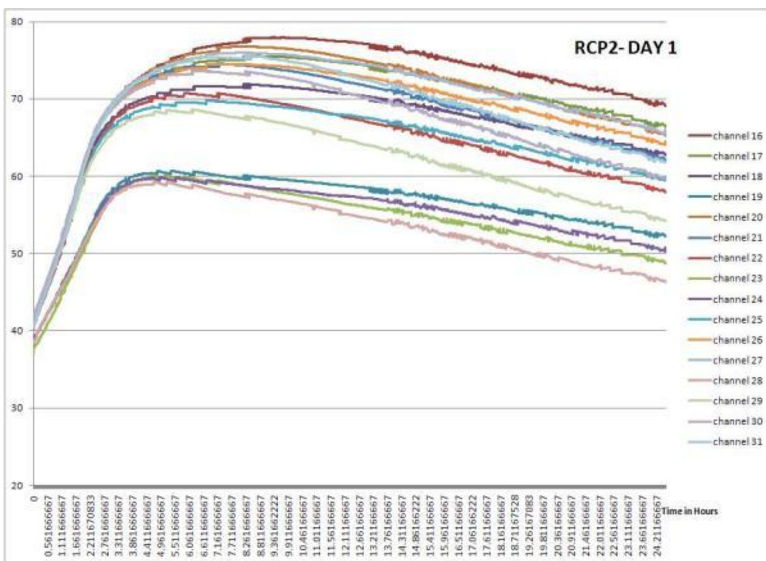


Figure 18. Day 1 RCP 2 Temperature vs Time.

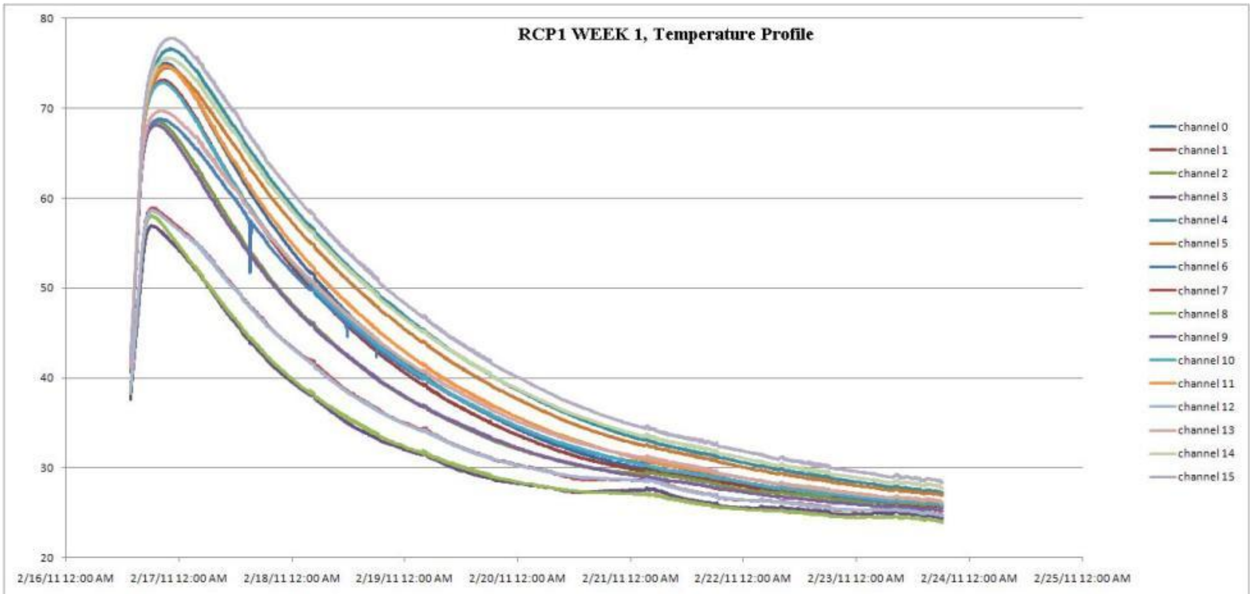


Figure 19. Week 1 RCP 1 Temperature vs Time.

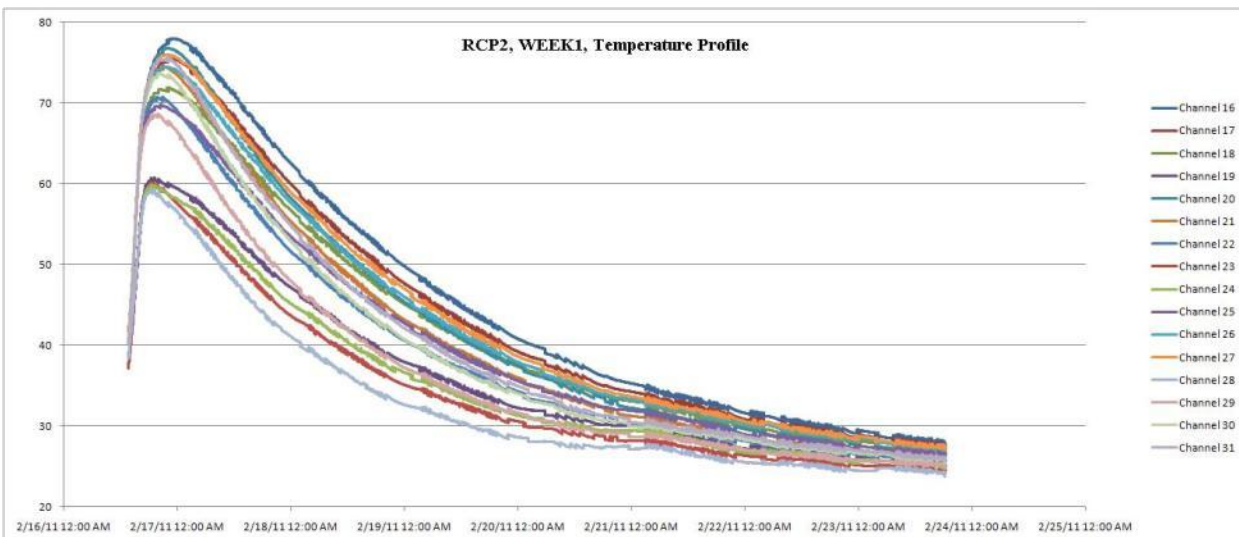


Figure 20. Week 1 RCP 2 Temperature vs Time.

At the end of the data acquisition period, FIU will analyze and report the data in a final report.

Stack Characterization System

The Central Campus Closure Project at ORNL focuses on demolishing a large number of facilities including off-gas stacks. The stacks are located in a densely populated area of ORNL, next to currently active operating facilities. Before demolition of the stacks, the stack must be characterized. However, it is hazardous to place workers in close proximity to or inside stacks with unknown structural integrity. Typical alternatives are to sample just around the top of the stack and at access points near the bottom of the stack. Characterization coverage is thus limited to available areas and these areas are not necessarily the ones most likely to be contaminated.

The Stack Characterization System (SCS) is a collaborative project between the Robotics and Energetic Systems Group (RESG) at Oak Ridge National Laboratory (ORNL) and ARC at FIU. The SCS is 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. Data collection targets the pre-demolition survey needs for structural, health physics and waste management analysis. The system will deploy into the top of stacks via an external overhead crane. The SCS consists of two stages of tripod sections connected in line by a rotating positional joint. The upper tripod is used for stabilization against the stack walls. The lower bipod section, controlled independently from the upper section, is used to position survey instruments against the inside stack walls. Survey instruments include alpha/beta/gamma radiological detectors, smear sampling, and core sampling. Position information, depth in the stack and rotation within the stack, is recorded and identified for each survey position. An array of real-time video cameras provides guidance for remote systems operators for entrance and egress in the stack and for targeting areas of interest inside the stack for inspection and survey

Two DOE Fellows completed summer internships at ORNL in 2010 during which conceptual designs for the SCS were created for a deployable radiation detector and core drill capable of retrieving multiple core samples. Upon their return to FIU, they continued to work on the system, including the development of conceptual designs for a containment system that will be capable of protecting 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. The DOE Fellows presented the overall system at two conferences, the DD&R 2010 and WM2011, and technical papers were submitted to each.

Radiation Detector System Design

FIU performed work on the conceptual design for the radiation detector deployment mechanism. The radiation detector head must be deployed from the instrument bay to the stack wall at a distance of 6.35 mm (¼ inch) with a tolerance of ± 3.17 mm (± 1/8 inch). However, it must be retracted and protected during movement of the SCS. The detector positioning assembly is shown in Figure 21. A small linear actuator is used to move the detector in and out. A limit switch manages the standoff distance from the wall.

The radiation sensor bay deploys both of the radiation detectors. The dedicated rad sensor bay PLC controls deployment of the radiation detectors to the stack wall after the SCS bipod has deployed. Limit switches act as feelers to control the detector standoff distance during measurement. The detector is powered during the entire stack entry. One of two detectors can be deployed: a RadEye SX head with a Ludlum 43-1-1 detector to discriminate alpha from beta-gamma or a RadEye GX head with a Ludlum 44-88 detector for alpha-beta-gamma. Procurement of the detectors has been coordinated with ORNL Health Physics. Data is acquired through the Ethernet network using an USB to Ethernet converter tied to the detector head.

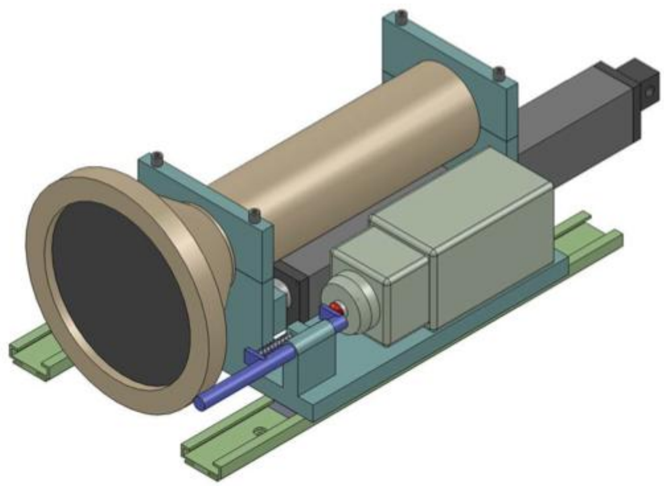


Figure 21. Detector positioning system, assembly view.

Smear Sampling System Design

The “smear” sampler is an automated mechanism capable of deploying 20 individual sample pads to collect removable contamination at a target location. The sampler uses an adhesive pad approach validated by FIU to be at least as effective as smear wipes at collecting removable contamination. The size and form factor of the pads is the same as currently used so that it will fit in the same Health Physics analytical equipment. The sample pads are arranged radially around the outer edge of a carrousel and actuated in a manner such that only two actuators are required: one to rotate the drum and one to actuate the plunger. The design limits the pressure of the sample pad to the target to 3 lbs. There are detents in the plungers to permit the sample pad to sacrificially break away if it becomes accidentally attached to the wall. The same mechanism will be used to remove the samples from the plungers for analysis. The tray of 20 will be removed for analysis after the SCS is retrieved from the stack. The cover and shutter window protect the samples and minimizes cross contamination concerns. The controls are external to the sampler itself but are contained in the bipod bay for the radiation instrumentation. Figure 22 shows the automated smear sampler mechanism with its cover and shutter window installed and also shows the shutter window opened and the sample plunger deployed to take a sample. The detail design phase for the automated samples has been completed. The prototype has been tested and final fabrication is in progress.

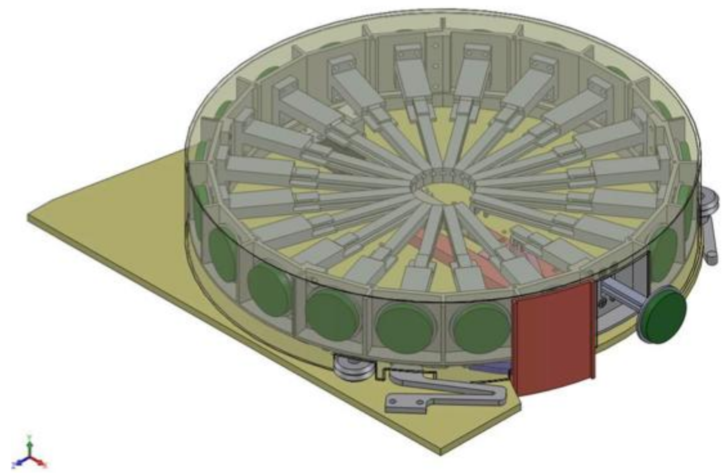


Figure 22. Smear sampling system.

The DOE Fellows performed tests at ORNL with the smear sampler. The first physical smear sampler was prototyped by the Robotics and Energetic Systems Group. Upgrades were made to the original prototype by FIU under the supervision of ORNL staff. Instead of using a rotational geared motor to rotate the carousel, another linear actuator was added. The actuator is located below the base. A detent was added at the base of the carousel as shown in the lower end of Figure 23. A detent is a mechanical component that prevents rotation. The detent was added to keep the carousel from rotating in the opposite direction and to allow it to rotate forward only when the bottom actuator is energized. Testing of the prototype took place after the collection medium was added to it. The collection medium, the double-sided adhesive foam tape, was added to the end of the push rods. For the preliminary testing, the adhesive sides of the pads were kept covered until it would be used for collection. The sampler and its base were mounted on a cart along with its voltage supply and the controller hardware (OPTO 22 PAC Controller), for preliminary testing of the design on outdoor surfaces. The original smear sampler prototype was tested on the same outdoor surfaces that the collection medium materials were tested on. Large grain particles were collected during the testing. One of the main objectives of the outdoor testing with the sampler was to observe if the actuator that extends the push rods with the pads would stall. The concrete block had enough surface particles to be collected by the sampler. As expected, the sampler did not stall when taking samples from the concrete block. The limit switch was tested during preliminary lab testing but was also tested again with the concrete block. Instead of allowing the push rod to extend out fully, an obstruction was set in front of it and the limit switch tripped the actuator to retract the rod as soon as it touched the obstruction. A semi-rough outside concrete wall was tested next; the outside wall did not have large particles but had much finer dust particles on it. The semi-rough surfaces also had enough particles to be collected by the sampler. Afterwards, the sampler was tested on a smoother concrete wall, the same results were yielded. The qualitative results yielded from the sampler testing proved that if there are any loose particles on the surface selected for sampling that:

- The adhesive pads would be able to collect it.
- The linear actuator would not stall.
- The limit switch would retract the push rod if the full stroke of the actuator could not be accomplished.

The carousel on the sampler is transportable and an independent component of the sampler. The carousel is removed from the base when the campaign is over and a new one is added for the next campaign. The sample pads will be removed from the carousel and analyzed for characterization. Because the carousel will be moved around, all the push rod stems need to be in their retracted position before it can be added to the base. The original carousel design was not able to keep the rods retracted while the carousel was being transported. Also, the rods have a circular cross section that allows the rods to rotate, making it harder for the linear actuator to extend the rod. It was also noticed that the carousel itself did not have a location for the technician to pick up the carousel. The carousel design was the main objective to be completed during the summer internship as set by FIU and the Robotics and Energetic Systems Group. The first change made to the carousel was the cross section of the push rods. The circular rods were prone to rotating in place while the carousel was being moved. The new rods used a rectangular cross section. A support was also added to guide the rod and the rod has a slot on each side so that the support can act as rail for the rod. The rod also has a groove on the top surface; the support has an extruded circular section on it, the detent that fits into the groove on the rod. The detent prevents the rod from sliding out when the carousel is being moved. The support has a flexible cantilever end that is able to flex up and down as the groove on the support passed by it. If the detent is in the groove, the rod is not able to slide out until it is pushed forward by the actuator. The detent allows the rods to stay in their retracted position at all times until they are pushed forward by the actuator. The detent facilitates the transportation of the carousel. At the end of the stem, there is a cut out rectangular section. That cut out section allows the actuator to engage the stem when the stem is rotated in front of it and it also allows the actuator to push and pull on the stem. On the opposite end of the stem, there is a disk that the adhesive pad sticks to. The adhesive pad is protected from cross contamination by the arced sections that make up the circle of the carousel.

Changes were also made to the disk pads but these changes were minor. The original rod design had a circular cross section; the new design uses a square cross section that reduces any rotation of the pad while a sample is taken. Because there is a change to the rod design, the disk pad design also needed to change. The new design has a detent built into it. The detents main purpose is to replace the pin that is currently being used to hold the disk to the rod. Previous testing of the adhesive pads with varying concrete surfaces showed that if a smooth clean surface is used, the adhesive pad could not be removed. The previous design of the carousel did not prevent the sample pad from remaining adhered to a surface. In other words, the linear actuator provides 3.4 lb of pushing and pulling force and the pads are so adhesive that they will remain adhered to a dust-free surface, requiring more than 13.34 N (3 lb) of force to detach. The new rod and disk design does not require a connecting pin and will snap off if more than 11.12 N (2.5 lb) of force are required to detach the pad from the surface.

Containment Package Design

The SCS containment concept consists of a flexible collapsible bag in the shape of a cylinder with a base and top cover. The base is designed so that it centers on the top of the stack. The bottom of the SCS includes a disk that fits into the base of the bottom of the SCS containment to provide a bottom seal. The top of the SCS containment structure will be made of fiberglass to permit wireless communications through the structure. While the crane cable penetrates the fiberglass top, the opening is kept to a minimum to minimize the possibility of contamination outside of the containment package. As part of cold testing, ORNL will work with LANCS Industries to adapt the material used in their containment tents to the SCS containment task based on actual hardware. The focus and order of priorities will be on functional containment, durability, and minimum cost. Hot deployment of the SCS will require a trailer for transport and storage before and after each stack campaign. The trailer can also double as the operator station if it were divided into two sections.

There are no specific requirements that dictate the trailer design. The ORNL Work Plan system and ORNL Radiological Work Permit system will drive final design criteria. Consultation with ORNL personnel indicate that the primary concern is the ability to access the SCS while it is in its trailer for survey, decontamination, and sample recovery. A request was made that the interior surfaces of the trailer consist of smooth metal for decontamination ability. Constraints such as maintenance, equipment checkout, and post survey access to sampling equipment dictate that the SCS be stored and transported in a vertical position. The SCS is approximately 3.66 m (12 ft) high in its folded position. This places unusual constraints on the transportation trailer. Addressing the need to minimize permitting concerns for movement on site and/or public roads, the ORNL Transportation Management Organization recommended that the SCS trailer be no more than 2.6 m (8.5 ft) wide and less than 4.57 m (15 ft) high. Anything over 4.11 m (13.5 ft) tall will still require a special permit. To maintain these dimensions, a custom “low boy” trailer with a high ceiling in one section may be suitable. The top will have to open to lower the SCS in from the crane. The operator station portion of the trailer would be at normal height. If additional metal needs to be added to aid decontamination ability, it may increase the trailer weight substantially.

The conceptual and preliminary designs for the containment package must be sufficiently mature to address and analyze the projected safety systems. In order to properly seal off the surrounding environment near the stacks, the containment system needs to be able to provide a holding compartment for the robotic system before and after each deployment. In order to avoid strong wind forces encountered at the top of the stack, the containment system will collapse as the robot is lowered into the stack. The forces in the containment system will be analyzed as the robot and the containment system are held in the air on the end of a crane cable. Failure theory will be implemented as part of the validation for designs being evaluated. Failure can mean a part has separated into two or more pieces, become permanently distorted ruining its original geometry, had its reliability downgraded or had its function compromised.

Core Drill Design

A core from the inside of the stacks may be needed. The SCS will have several cameras and a radiation detector located inside its instrument bays. The detectors and cameras will provide real time data back to the operators; if a location is found to have a high level of radiation, a core sample will be taken from the wall. Also, if the onsite HP decides that a particular location needs to be cored, a sample will be taken.

Current core drills are motorized units that are able to core to a certain distance. Almost all core drills are operated by workers and are able to take one core at a time. A core sample within the stack needs to be taken remotely; no unit has been found that is able to take samples remotely or able to take more than one sample. During the summer 2010 internship, much of the work was designing a core drill mechanism capable of retrieving six core samples. A total of eight core drill designs were created. After the first design, a second better design was created; that process continued until the eighth and final design was completed.

Preliminary components for the core drill were provided by the group at the beginning of the internship. The core drill design needs to be modeled using initial dimensions for the components that will be used. The entire drill assembly needs to be 24 inches long and the bits need to core 6 inches into the concrete.

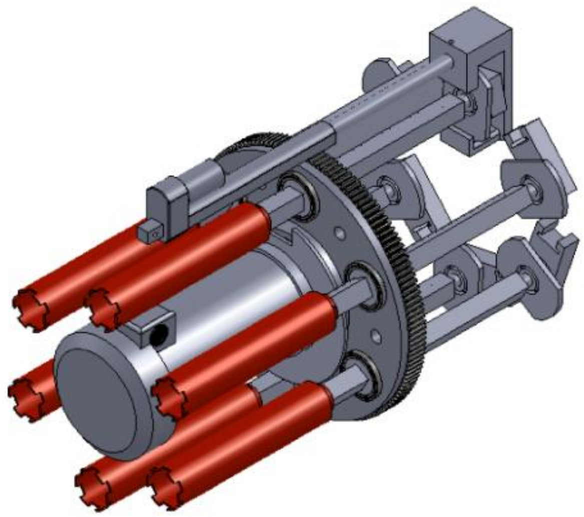


Figure 23. Core drill.

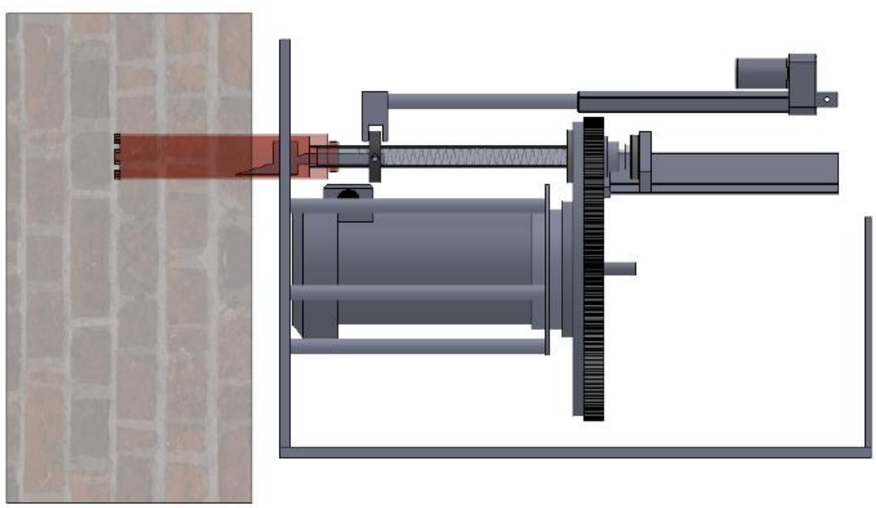


Figure 24. Wall core.

After the core drill reaches its 8 inch depth into the concrete, the core sample needs to be removed from the wall. Because the drill is coring in the horizontal direction, the core needs to be broken off and held in the core bit while the bit is being retracted to its initial position. In order to achieve the needed outcome, a combination of a break-off tool and a vacuum will be used. The vacuum will ensure that the dust created from the drilling is not allowed to spread inside the stack and further contaminate the SCS or cross contaminate the other core samples. The break-off tool is a stainless steel wedge that will be actuated in order to break the end of the core sample from the wall (Figures 23 and 24).

SCS Conclusion

The summer internship provided a chance to assist an in-progress project that requires the work of different engineers and engineering disciplines. 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 currently designed 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 was created, modeled in a 3D CAD software and actual fabrication and assembly of the carousel took place. 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. The work currently being done on the containment system will be evaluated by the group once completed and will be re-designed if needed. Final designs of the system will be given back to the RESG at which time they will determine best implementation uses.

Technical D&D support to DOE-EM International Program & EFCOG

Under this subtask, FIU-ARC provided support to the DOE EM-30 international partnerships and support the DOE Bi-Lateral Agreement by providing D&D expertise, knowledge and support. In addition, FIU-ARC continued active support to DOE's Energy Facility Contractor's Group (EFCOG) by collaborating in the development of Lessons Learned and Best Practices, and other activities as identified and agreed by EFCOG and FIU-ARC. In addition, FIU-ARC participates in monthly conference calls and Fall, Spring and Annual EFCOG meetings and presentations.

EFCOG Participation

FIU participated in the EFCOG Human Capital Working Group Meeting on June 21-22, 2010 as well as the EFCOG D&D and Facility Engineering Working Group that met in Idaho Falls, Idaho on September 1, 2010. The topics covered at the latter included FIU's draft D&D promotional video, status of the working group's lessons learned to be published, gathering comments for a draft guidance document to help clarify D&D requirements for structural and electrical codes, and review of a field-generated list of D&D issues for the working group to consider taking action. Also, Dr. Lagos participated and presented at the EFCOG Chair Meeting held in Washington, DC, on December 7, 2010. Dr. Lagos provided an update for the D&D and Facility Engineering working group and reported on the progress of the Lessons Learned and Best Practices documents being developed by FIU.

EFCOG Lessons Learned and Best Practices

This subtask focused on capturing the manager experience through the EFCOG points-of-contact. In an effort to capture the lessons learned and best practices acquired at DOE sites, FIU worked with EFCOG to establish a data collection process where Subject Matter Specialists (SMS) from various sites were able to share their experiences and lessons learned with the EM D&D community. The development of each lessons learned and best practice was conducted with a similar standardized process, as shown in Figure 25.

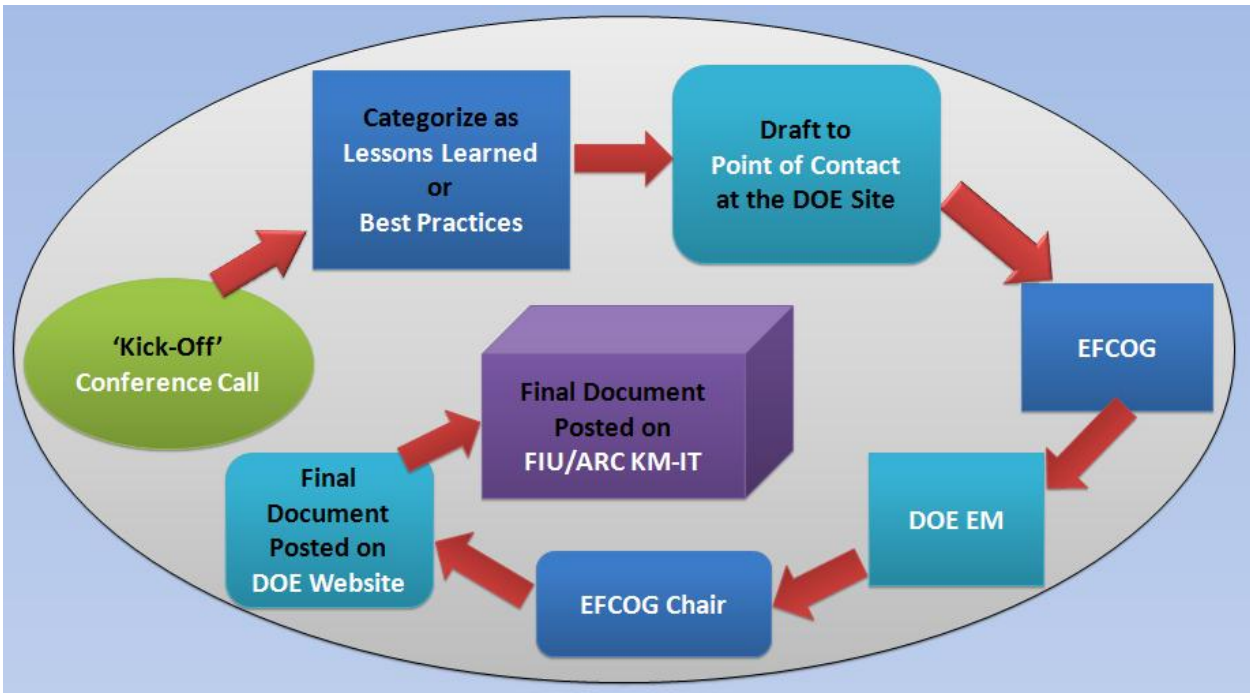


Figure 25. Process for developing Best Practice and Lessons Learned documents.

FIU completed the development, review, and approval for 2 best practice documents and developed an additional 2 best practices and 1 lesson learned that are in the review and approval stages. 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 lessons learned and best practices developed by FIU in FY10 included:

1. Washington Closure Hanford Site Explosive Demolition of Buildings 337 and 337B Best Practice
2. Lawrence Livermore National Laboratory Open Air Demolition of Asbestos Gunite by Using Track Mounted Wet Cutting Saw Best Practice
3. Savannah River Site 185-3K Cooling Tower Demolition Best Practice
4. Lawrence Livermore National Laboratory Historical Hazard Identification Process for D&D Best Practice

5. Closure of the Reactor Maintenance, Assembly, and Disassembly Facility and the Pluto Disassembly Facility at the Nevada National Security Site: American Recovery and Reinvestment Act-Funded Acceleration of Demolition and Lessons Learned – 11157

The first four of these Best Practices and Lessons Learned are attached to this report in Appendix B. The first two have been finalized and the second two are in draft form. The fifth document is in progress and being drafted and reviewed internally by FIU.

<u>The Washington Closure Hanford Site Explosive Demolition of Buildings 337 and 337B Best Practice</u>

The 337 facility and adjacent buildings were built in the early 1970s to support the Fast Flux Test Facility and the Liquid Metal Fast Breeder Reactor Program at Hanford. On October 9, 2010, Buildings 337, 337B, and the 309 Exhaust Stack located in the 300 Area at the Hanford Site, were safely razed by explosive demolition (Figure 26). The best practice was chosen because it provided industrial safety, height of the building, and because of the concrete construction techniques (cast in place and per cast). The problems/issues associated with the best practice included the utilization of hazard controls, providing guidance for the workforce to safely perform the work, the demolition preparation activities and the final implosion. The facilities came down exactly as planned and there were no safety issues, for example, with dust control limits, flying debris, heavy equipment incidents, or uncontrolled releases. The benefits of the best practice included the safety of the workers, easy access on-site, and cost effectiveness.

Figure 26. Explosive demolition of Buildings 337 and 337B at the Hanford Site.

<u>The Lawrence Livermore National Laboratory Open Air Demolition of Asbestos Gunite by Using Track Mounted Wet Cutting Saw Best Practice</u>

To size reduce the structure and prevent exposure of personnel to asbestos material, a track mounted wet cutting saw with a diamond blade was used (Figure 27). First, the roof was cut off and lifted off the building using a crane. Once the roof was at ground level it was cut into smaller sections. When the wet saw became too cumbersome, a hydraulic wet chainsaw was used for the final cut. The best practice allowed controlling, containing, and the preventing the asbestos from becoming airborne. Problems and issues associated with the best practice included long horizontal cuts that were difficult to execute as the building structure would flex and the saw would bind under the weight of the wall. The success was measured by the safety of the workers. The benefits include the containment of the asbestos between the gunite and metal layer of the building during demolition.

Figure 27. Track mounted wet cutting saw at LLNL.with a diamond blade used at LLNL.

<u>The Savannah River Site 185-3K Cooling Tower Demolition Best Practice</u>

SRS's massive K Cooling Tower was safely demolished on May 25, 2010 as part of the Site-wide Footprint Reduction Initiative funded by the American Recovery and Reinvestment Act (Figure 28). The cooling tower became obsolete and no other economical use was available due to its unique and dedicated design and location. In 2003, the DOE selected implosion as the safest approach to ensure the fewest number of man hours at risk for demolishing this unique structure at one of the DOE's premier facilities. Problems/issues associated with the best practice include the height of the building not allowing for typical self-propelled man-lifts to be utilized for drilling at all of the explosives locations, health concerns with the potential carcinogenic effects of silica, and air monitoring noise. The success of the project was measured by clocking 7,000 man hours without a lost time accident and achieving a zero incident rating. The benefits of the best practice was measured by safety, schedule, and the controlled and efficient demolition of the 185-3K Cooling Tower.

Figure 28. Implosion demolition of cooling tower at SRS.

Lawrence Livermore National Laboratory Historical Hazard Identification Process for D&D Best Practice

Facility hazard identification is the critical first step in the D&D) process. The hazard identification process presented in this best practice is the result of eight years of refinements at the Lawrence Livermore National Laboratory (LLNL). The process is not presented as a one-size-fits-all solution. The current process at LLNL can be used as either a starting point for applicability to other U.S. Department of Energy (DOE) sites without a process in place, or as a benchmark for other sites to evaluate their current processes. It is similar to all planning processes in that it is a living document, changing with the experience of use, new requirements, and lessons learned. The existing process identifies four broad categories of information resources including: facility information, hazard information, environmental information, and general information related to the facility.

The use of this process at LLNL has led to both a level of confidence in hazard identification and a defensible level of due diligence, without excessive sampling and characterization. The hazard identification map has also proven to be an efficient and effective way to communicate existing conditions, potential areas of contamination, and a guide for both sampling and project plans.

Closure of the Reactor Maintenance, Assembly, and Disassembly Facility and the Pluto Disassembly Facility at the Nevada National Security Site: American Recovery and Reinvestment Act-Funded Acceleration of Demolition and Lessons Learned

The EFCOG point-of-contact with National Security Technologies, NSTec, provided FIU with a paper entitled *Closure of the Reactor Maintenance, Assembly, and Disassembly Facility and the Pluto Disassembly Facility at the Nevada National Security Site: American Recovery and Reinvestment Act-Funded Acceleration of Demolition and Lessons Learned*. FIU is in the process of drafting the lessons learned document from this paper before it undergoes review and approval.

DOE EM International Programs

DOE Fellows, Denisse Aranda and Edgard Espinosa, supported the DOE EM-30 International Program during this past fiscal year. Denisse and Edgard directly supported Ms. Ana Han (DOE EM-30) and Mr. Laurie Judd (Nuvision Engineering) by participating in conference calls with Bi-Lateral Agreement participants (United Kingdom's Nuclear Decommissioning Authority (NDA)). Denisse Aranda also conducted a one-week training/working session at DOE HQ during the summer of 2010. During this time, Denisse worked side by side with Ms. Han and was exposed to the daily workload and activities under the International Program at DOE EM. In addition, Edgard supported Mr. Laurie Judd by participating in over 10 bi-weekly teleconferences with the NDA and provided the minutes for these Bilateral Agreement scheduled calls. Edgard also participated in the UK-USA Bilateral Agreement meeting at Waste Management 2011. Edgard's support to the EM International Program continued as part of Edgard's Student Career Experience Program (SCEP) where he is currently supporting DOE EM on a full-time basis.

D&D Technology/Methodology Impacts from DDFA Activities

At the request of and in direct support of EM-44, FIU DOE Fellows began this task in FY10 and will complete the work in FY11. The objective of this task is to investigate the number of subsequent successful deployments of technologies and methodologies that were demonstrated under the Deactivation and Decommissioning Focus Area (DDFA) programs, including the Large-Scale Demonstration and Deployment Program (LSDDP) and the Accelerated Site Technology Deployment (ASTD) Program. The subtasks include the following:

1. Review the documents provided by DOE and compile a spreadsheet of the technologies and methodologies demonstrated under LSDDP and ASTD.
2. Contact personnel associated with each demonstration as well as the technology vendor, when feasible, to collect information on deployments of the technology/methodology subsequent to the demonstration under LSDDP or ASTD.
3. Information gathered during subtask 2 will be compiled into the spreadsheet developed during sub-task 1. A brief summary of the information gathered will be written and sent to DOE along with the completed spreadsheet.

FIU completed subtask 1 on May 13, 2011, and sent the draft spreadsheet of 171 technologies/methodologies to DOE. Subtasks 2 and 3 will be completed in FY11 and submitted to DOE for review and input. The task will also be reported in detail in the FY11 Year End Report.

Workshops, Conferences, and Outreach

Under this subtask, FIU-ARC provided support to the DOE EM-44 D&D program by participating in D&D workshops, conferences and serving as subject matter experts.

FIU participated in the Hanford ALARA Workshop on August 3 - 4, 2010 in Richland, WA. FIU co-presented the D&D Knowledge Management Information Tool (D&D KM-IT) with Mr. Jeff Hunter of the Hanford ALARA Center. The presentation included a live demonstration of the D&D KM-IT and a discussion of the system's capabilities.

FIU participated in and helped coordinate Session 1, "The Development of Innovative and Transformational Technologies in DOE's Deactivation and Decommissioning (D&D) Work," hosted by Yvette Collazo (DOE EM-30) and Dr. Rich Abitz (Savannah River National Laboratory) at the Decommissioning, Decontamination & Reutilization (DD&R) Conference from August 29 to September 2, 2010 at Idaho Falls, ID. This meeting is a forum for the discussion of the social, regulatory, scientific, and technical aspects of decontamination, decommissioning, and reutilization, and waste management. The 2010 conference program included lessons learned derived from commercial, government, and international project updates and technology developments in the areas of decommissioning, waste management, site closure and legacy management. A list of presenters for Session 1 "The Development of Innovative and Transformational Technologies in DOE's Deactivations and Decommissioning (D&D) Work," is presented below:

NAME	EMAIL	TOPIC
Mr. Sam Maggio	sam@icm.cc	Remote Application of Strippable Coatings with Climbing Machines
Dr. Richard J. Abitz	Richard.Abitz@srs.gov	Savannah River Site – Decon Gel
Mr. Mike Serrato	michael.serrato@srnl.doe.gov	In Situ D&D
Dr. Jim Clarke	james.h.clarke@vanderbilt.edu	CRESP Study on D&D Risks
Dr. Leonel Lagos	lagosl@fiu.edu	Florida International University – D&D KM-IT
Dr. Charlie Waggoner	waggoner@icet.MsState.edu	LaBr3 Technology for D&D Characterization

FIU also participated in the Waste Management 2011 Conference. FIU presented the remote sprayer technology demonstration at WM11:

Technology Demonstration of Decontamination Gel and Strippable Coatings Applied via Remote Sprayer Platform

Authors: Leonel Lagos, Peggy Shoffner (FIU)
Sam Maggio (International Climbing Machine)
Presenter: Leonel Lagos

In addition, the DOE Fellows made a professional presentation at WM11 for the Stack Characterization System development:

Remote System for Characterizing, Monitoring and Inspecting the Inside of Contaminated Nuclear Stacks

Authors: Mario Vargas, William Mendez, Leonel Lagos (FIU)
Mark Noakes, Randall Lind, Peter Lloyd, Francois Pin (ORNL)
Presenter: Mario Vargas

Also at WM11, DOE Fellows made a professional presentation on research to support in-situ decommissioning at SRS:

Thermal Analysis of a Special Grout Mixture for In-Situ Decomissioning

Authors: Nadia Lima, Cristian Acevedo, Denisse Aranda, Jose Rivera, Givens Cherilus, Sainath Munavalli, Leonel Lagos

Presenters: Nadia Lima, Cristian Acevedo

Two student poster presentations by DOE Fellows were also given at the WM11 Conference on research to support in-situ decommissioning at SRS:

Cellular Concrete/Grout: An Innovative Material for In-Situ Decommissioning

Presenter: Alessandra Monetti (DOE Fellow)

Feasibility of Using Embedded Wireless Sensors for In-Situ Decommissioning Tasks and Environmental Monitoring

Presenter: Elicek Delgado-Cepero (DOE Fellow)

A DOE Fellow also presented the best practices and lessons learned data mining activities in a student poster session (Figure 29):

EFCOG Lessons Learned and Best Practices

Presenter: Heidi Henderson

Figure 29. EFCOG Lessons Learned and Best Practices Poster presented by DOE Fellow Heidi Henderson at the Waste Management 2011 Conference.

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

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TASK 3.
D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL

TASK 3: EXECUTIVE SUMMARY

For Task 3, 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 FY10, FIU performed several subtasks, including certification and accreditation (C&A) readiness, application development, system/database/network administration, data mining, and outreach and training.

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 (EM44 & EM72), the ALARA centers at Hanford and Savannah River, and with the active collaboration and support of 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

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. During FY10, FIU continued to work closely with DOE EM, EFCOG, and the ALARA Centers at Hanford and Savannah River in the development of this system. The primary subtasks for FY10 included certification and accreditation (C&A) readiness, application development, system/database/network administration, data mining, and outreach and training.

TASK 3: RESULTS AND DISCUSSION

Certification and Accreditation (C&A) Readiness

FIU continued preparations towards meeting the guidelines and technical requirements of the DOE certification and accreditation (C&A) process. The C&A process and guidelines were used to develop the infrastructure and documentation needed to achieve this objective.

Secure server room

One requirement of the C&A is a secure and controlled server room. The room requires certain capabilities like easy access to a power generator, air conditioning, and security surveillance. FIU selected several rooms that meet these conditions and after review selected an existing lab. FIU then designed a floor plan and the security surveillance required by C&A. The security surveillance plan is now in place and currently being implemented. The system will monitor inside the server room and the entry into the room. The system repository will be located in a separate room under controlled access to meet C&A requirements.

The existing ARC lab has been converted into a controlled server room. The servers have been installed with UPS's and a power generator with central air and a backup portable AC unit have been installed. The room has an electronic door lock that records and monitors who enters the room. There are only 4 people that currently have access to the server room. A server room visitor form was developed that will have to be signed and approved by the Information System Contingency Plan (ISCP) Director before a visitor can access the server room. In addition, anyone who enters the server room must sign in and out and this logbook is given to the ISCP Director on a monthly schedule. A camera surveillance system will also be installed.

The D&D KM-IT server will be set up based on the C&A process which will include configuring the server and developing the server infrastructure for housing the D&D KM-IT servers. The server room is currently in an initial operation phase; some of the servers have been moved to the location and are currently online. An Active Directory Security Policy to enhance login security has been developed, implemented, and tested.

Deployment of the monitoring server

During FY10, FIU configured and deployed a D&D KM-IT monitoring server. This server is responsible for network, infrastructure, and general reporting as well as for monitoring for virus attacks, hackers or other internet intrusions, web traffic, and application requests. FIU will research available applications for the system monitoring server in FY11 in order to optimize the functions of this server.

The reporting server will generate both real-time and historical reports to offer a complete view of all activity through the firewall network security appliances. FIU is currently using a Google application to generate statistics on the website hits and usage. FIU began providing DOE with sample statistics from data collected from the KM-IT website during FY10. The data gives general information about users visiting the website, like: number of visits, origin of visit, page views, amount of time spent on the website, popular pages, referral pages and search terms used to reach the site.

Disaster recovery system

As another requirement of the C&A process, FIU finalized a disaster recovery system for D&D KM-IT. This system will take over the D&D KM-IT application in emergencies.

The failover system plan is now finalized and ARC is currently working with FIU's main contact in Tallahassee to allocate the space for the system and finalize other technical details. The failover site will be setup to replicate a scaled down version of the main facilities at FIU. The failover will consist of a Windows 2008 R2 server standard edition running SQL 2008 services. The KM-IT website will have the same file structure as the current site with SSL. The files and database will be synched to the main site on a scheduled basis. The backup server will also be syncing copies of the backups that are taken from the main site to a directory on the failover server for off-site storage.

In a DR situation (oncoming hurricane, long term power outage, etc.), all the current files will be forced to synch to the failover server in Tallahassee and the GSS will be ready when any of the servers go down. The GSS is an automated application that redirects the DNS server to the failover servers in Tallahassee if it detects the server is offline and the end users will never know they were re-directed. As mentioned before, the backup server makes a copy of the backup files and then uploads the files to the server in Tallahassee on a daily basis. The retention will be for 4 weeks from the time the backup job ran and then are removed and rotated. Figure 30 shows the basic layout of the failover system and Figure 31 shows the basic layout of the backup system.

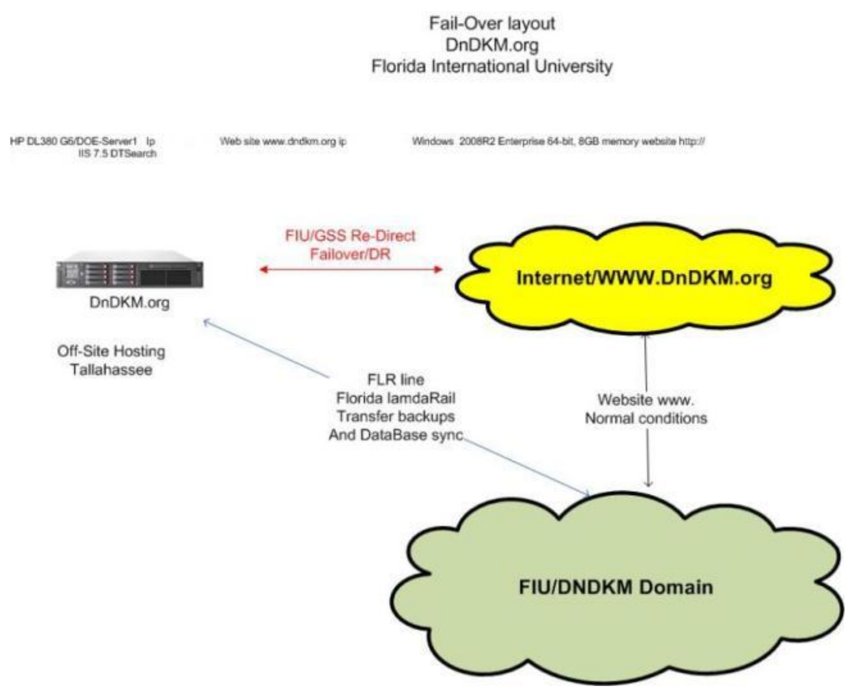

Figure 30. Basic layout of the failover system.

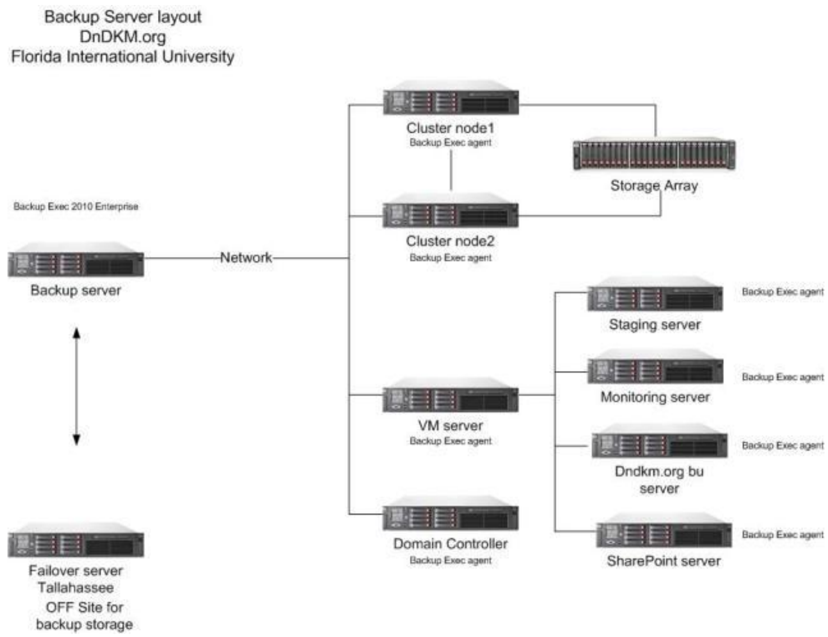

Figure 31. Basic Layout of the backup system.

System and security documentation

FIU also prepared to meet the C&A requirements by developing security documents, awareness training, control management, security policies and documents, and access control. During FY10, FIU completed drafts of the following documents:

- Business Risk Assessment – Awareness and Training
- System Risk Assessment
- Contingency Plan
- Self Assessment
- System Security Change Management
- Maintenance for Physical Environment
- Maintenance for the Server Environment
- Network Diagram and Data Flows
- Software and Hardware Inventory
- Baseline Configurations
- System Description with System Boundaries Notes

An additional document, for Security System Access Control, is currently being developed.

Application Development

During FY10, FIU continued the development of the D&D KM-IT application and made the system officially live to the D&D community at http://www.dndkm.org.

Web crawler module

The D&D web crawler development and deployment was complete in FY10. This module will search and retrieve information from the web through customized web sites or links specified by the D&D KM-IT system (e.g., Science.gov, NRC, ORAU, ORISE, IAEA, etc.).

Cyber security testing

An initial cyber security penetration testing of the KM-IT system by EM-72 was completed and FIU received the Security Assessment Report on June 29, 2010. FIU evaluated the results of the cyber security testing, developed proposed security solutions, and drafted a document response to the cyber security testing findings. The security solutions were then implemented into the KM-IT system and completed by September 17, 2010.

EM-72 performed a validation security test to confirm FIU's solutions to the findings of the initial cyber security penetration testing. FIU received the Security Assessment Report on January 24, 2011, developed and implemented the proposed security solutions, and sent a final response to EM-72 on February 4, 2011.

FIU then integrated and deployed the additional KM-IT modules from the pilot system, and EM-72 again performed a security test of the website. The Security Assessment Report was received by FIU on February 22, 2011. FIU then developed and implemented the proposed security solutions and sent a final response to EM-72 on March 14, 2011. EM-72 confirmed that all findings had been successfully resolved.

Integration, testing, and deployment of D&D KM-IT development modules on the pilot system

A number of D&D KM-IT modules were deployed on the development system for DOE's review during FY09. These modules, including Technology, Lessons Learned, Best Practices, and International Registration, were integrated into D&D KM-IT system in December 2010.

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

EFCOG Lessons Learned and Best Practices

The data mining task for FY10 focused on capturing the manager experience through the EFCOG points-of-contact. In an effort to capture the lessons learned and best practices acquired at DOE sites, FIU worked with EFCOG to establish a data collection process where Subject Matter Specialists (SMS) from various sites were able to share their experiences and lessons learned with the EM D&D community. This subtask is discussed in detail under Task 2. Once the lessons learned and best practices receive final approval, they will be made available to the D&D community on the KM-IT website.

System development QA

DOE Fellows from FIU continued to assist with system development QA especially in the Lessons Learned and Best Practices modules. These modules will accept only PDF documents to upload. Test scenarios were created to simulate the upload of different types of files to determine the system integrity. These tests were also conducted on the test environment running a Firewall with Secure Socket Layer (SSL) encryption to detect potential harmful files.

Hanford ALARA reports

DOE Fellows from FIU compiled and integrated recent ALARA Reports into the D&D KM-IT to archive the information and make it available to the entire D&D community. In addition, the historical ALARA reports already in the system were reviewed, standardized, and converted to PDF. FIU also began development of a search feature that will allow the user to search all compiled ALARA reports for specific words or phrases.

Relevant information from the ALARA reports were also collected and published in the applicable module of the D&D KM-IT. For example, D&D related problems and solutions from the ALARA Reports were collected and published in the Hotline module of the D&D KM-IT. Similarly, technology and vendor information collected from the reports were published in the Technology module of the system.

Outreach and Training

FIU participated in relevant meetings and conferences in support of this project. The D&D KM-IT system was demonstrated at the Hanford ALARA Workshop (August 3 - 4, 2010 in Richland, WA) and the DD&R Conference (August 29 to September 2, 2010 in Idaho, ID).

FIU also presented the KM-IT system to the WM11 Conference via a professional oral session and via live demonstrations of the system to conference participants (Figure 32). FIU promoted the D&D KM-IT system at the FIU vendor booth and at D&D related technical sessions (Figure 33).

***D&D Knowledge Management Tool* - 2011**

Authors: Himanshu Upadhyay, Walter Quintero, Leonel Lagos, and Peggy Shoffner (FIU), Jeff Hunter (Hanford ALARA Center), John De Gregory (DOE HQ)
Presenter: Himanshu Upadhyay

Figure 32. Himanshu Upadhyay presenting the D&D KM-IT system at Waste Management 2011.

Figure 33. D&D KM IT Postcards handed out at the Waste Management 2011 Symposium.

TASK 3: CONCLUSIONS

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

TASK 3: REFERENCES

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

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OVERALL PROJECT CONCLUSIONS

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

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 (EM20), EFCOG, and the ALARA Centers at Hanford and 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, EFCOG, the ALARA Centers, and the D&D community to ensure that the KM-IT system meets their needs for accurate and timely D&D information.

APPENDIX A: REMOTE SPRAYER PLATFORM

This appendix includes the final demonstration report on the remote sprayer platform: *Strippable Coatings and Decontamination Gel Applied via Remote Sprayer Platform.*

TECHNOLOGY DEMONSTRATION REPORT

July 21, 2010

Strippable Coatings and Decontamination Gel Applied via Remote Sprayer Platform

Project Manager:

Leonel Lagos, Ph.D., PMP®

Florida International University Collaborators:

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ABSTRACT

The objective of the US Department of Energy Office of Environmental Management's (DOE-EM's) D&D Toolbox Project is to use an integrated systems approach to develop a suite of decontamination & decommissioning (D&D) technologies, a D&D toolbox, that can be readily used across the DOE complex to improve safety, reduce technical risks, and limit uncertainty within D&D operations. Florida International University's Applied Research Center (FIU-ARC) is supporting this initiative by identifying technologies suitable to meet specific facility D&D requirements, assessing the readiness of those technologies for field deployment, and conducting technology demonstrations of selected technologies. To meet the technology gap challenge for a technology to remotely apply strippable coatings, FIU-ARC identified and demonstrated a remote sprayer platform.

FIU-ARC selected the International Climbing Machines' (ICM's) robotic climber to perform this technology demonstration. The selected technology was previously demonstrated spraying fixative products at the hot cell mockup facility at FIU-ARC in November 2008 [1]. Based on the initial FIU demonstration and specific technical requirements identified at the DOE facilities, DOE requested that the follow-up demonstration be expanded to include strippable coatings and decontamination gels. FIU-ARC conducted a demonstration of the technology in coordination with ICM to evaluate the remote crawler machine's ability to spray strippable coatings and a decontamination gel on vertical surfaces of concrete and steel.

The technology evaluation documented the ability of the remote system to spray three different strippable coating products, including one decontamination gel, on vertical concrete and stainless steel surfaces. The technology performance, cost, and health & safety issues were evaluated during this technology demonstration.

TABLE OF CONTENTS

LIST OF FIGURES iii
LIST OF TABLES iv
INTRODUCTION 1
EXPERIMENTAL 2
RESULTS AND DISCUSSION 8
CONCLUSIONS 13
REFERENCES 14
ATTACHMENT A. FIELD DATA TABLES A-1
ATTACHMENT B. PHOTOGRAPHS FROM DEMONSTRATION B-1

LIST OF FIGURES

Figure 1. 3-dimension diagram of the building module mockup design 3
Figure 2. Building module at ICM facility 4
Figure 3. ICM climber set-up... 6
Figure 4. CC Strip being sprayed onto concrete panel (left) and being removed from concrete panel after drying (right) 9
Figure 5. ALARA 1146 being sprayed onto a steel panel (left) and dry ALARA 1146 being removed from a steel panel (right)... 10
Figure 6. DeconGel being sprayed onto a steel panel (left) and dry DeconGel being removed from a steel panel (right).. 11

LIST OF TABLES

Table 1. Module Building Surfaces Sprayed With Strippable Coatings 2
Table 2. ICM Climber Specifications 5
Table 3. Manufacturer Information for Strippable Coatings and Decon Gel 6
Table 4. Strippable Coatings Used During the Technology Demonstration 8
Table 5. Coverage of Strippable Coatings 12
Table 6. Spraying Production Rate Achieved During Demonstration...9
Table 7. Comparison of Product Characteristics 13

INTRODUCTION

Many facilities slated for decontamination and decommissioning (D&D) across the Department of Energy (DOE) complex pose hazards (radiological, chemical, and structural) which limit, and in many instances prevent, the use of traditional manual techniques. Efficient and safe D&D of the facilities will require the use of remotely operated technologies. In addition, the D&D of a radioactively contaminated facility normally requires that the surfaces be cleaned and stabilized to allow demolition to occur while maintaining worker radiation exposure as-low-as-reasonably-achievable (ALARA) and without spreading radioactive contamination. One decontamination step typically consists of applying a strippable coating (or similar material) to all contaminated surfaces to allow the removal of loose contamination prior to demolition. A study on available remote technologies for D&D activities, performed by Florida International University (FIU) and NuVision Engineering (NVE) [2], indicated that there was no remotely operated technology available to meet the need for the remote application of strippable coatings. This gap between the identified needs and the available technologies is especially critical for highly radioactively contaminated facilities, where physical access is typically very limited and where ALARA and other safety hazards may preclude human entry.

The objective of the D&D Toolbox Project is to use an integrated systems approach to develop a suite of D&D technologies (D&D toolbox) that can be readily used across the DOE complex to reduce technical risks, improve safety, and limit uncertainty within D&D operations. FIU is identifying technologies suitable to meet specific facility D&D requirements, assessing the readiness of those technologies for field deployment, and conducting technology demonstrations of selected technologies.

To meet the technology gap challenge for a technology to remotely apply strippable coatings, FIU identified and demonstrated a remote sprayer platform. FIU-ARC selected the International Climbing Machines' (ICM's) Robotic Climber to perform this technology demonstration. The selected technology was previously demonstrated spraying fixative products at the hot cell mockup facility at FIU-ARC in November 2008 [1]. Based on the initial FIU demonstration and specific technical requirements identified at the DOE facilities, DOE requested that the follow-up demonstration be expanded to include strippable coatings and decontamination gels. FIU-ARC conducted a demonstration of the technology in coordination with ICM to evaluate the remote crawler machine ability to spray strippable coatings and a decontamination gel on vertical surfaces of concrete and steel.

The selected technology was demonstrated at the ICM facility in Ithaca, NY under a contract with Florida International University's Applied Research Center. The technology evaluation documented the ability of the remote system to spray three different strippable coating products (Instacote CC Strip, Carboline ALARA 1146, and CBI Polymers DeconGel) on vertical concrete and stainless steel surfaces. The technology performance, cost, and health & safety issues were evaluated during this technology demonstration.

EXPERIMENTAL

Testing of the ICM climber technology with a custom spray applicator was conducted to demonstrate "proof-of-concept" to remotely spray various strippable coatings and decontamination gels on concrete and metal substrates at the ICM facility.

An FIU-ARC evaluator was present for the duration of the technology demonstration to record performance data and take photographs during the technology's operation. In addition, ICM captured videos during the technology's operation. During the demonstration, the FIU-ARC evaluator gathered data concerning the technology's operation, performance, maintenance, health and safety aspects, cost, benefits, and limitations, and the ability of the technology to be decontaminated. Data tables [Appendix A] were prepared containing a list of specific data that was collected and evaluated.

The technology vendor was responsible for providing the operators for the technology equipment and the same operators were available throughout the duration of the demonstration to ensure continuity of operation and consistency of comments and feedback. The vendor was also responsible for maintenance of the technology equipment.

The testing protocol included the following:

1. Demonstration of the technology utilizing the custom spraying attachment in the building module. The operators and observers were just outside the building module, under a shade canopy. The surfaces sprayed included concrete and stainless steel panels installed on 3 walls within the building module. Table 1 describes the surfaces sprayed and Figure 1 provides a 3-dimension diagram of the building module design. Each of the three products (CC strip, ALARA 1146, and DeconGel) was applied to both concrete and stainless steel panels up to a height of 10 feet.

Table 1. Module Building Surfaces Sprayed With Strippable Coatings

Surface	Description	Panels	Dimensions
Wall A	Left wall (facing opening from outside module)	Concrete	10' x 12'
Wall B	Back wall (facing opening from outside module)	Concrete and stainless steel	10' x 12'
Wall C	Right wall (facing opening from outside module)	Stainless steel	10' x 14'

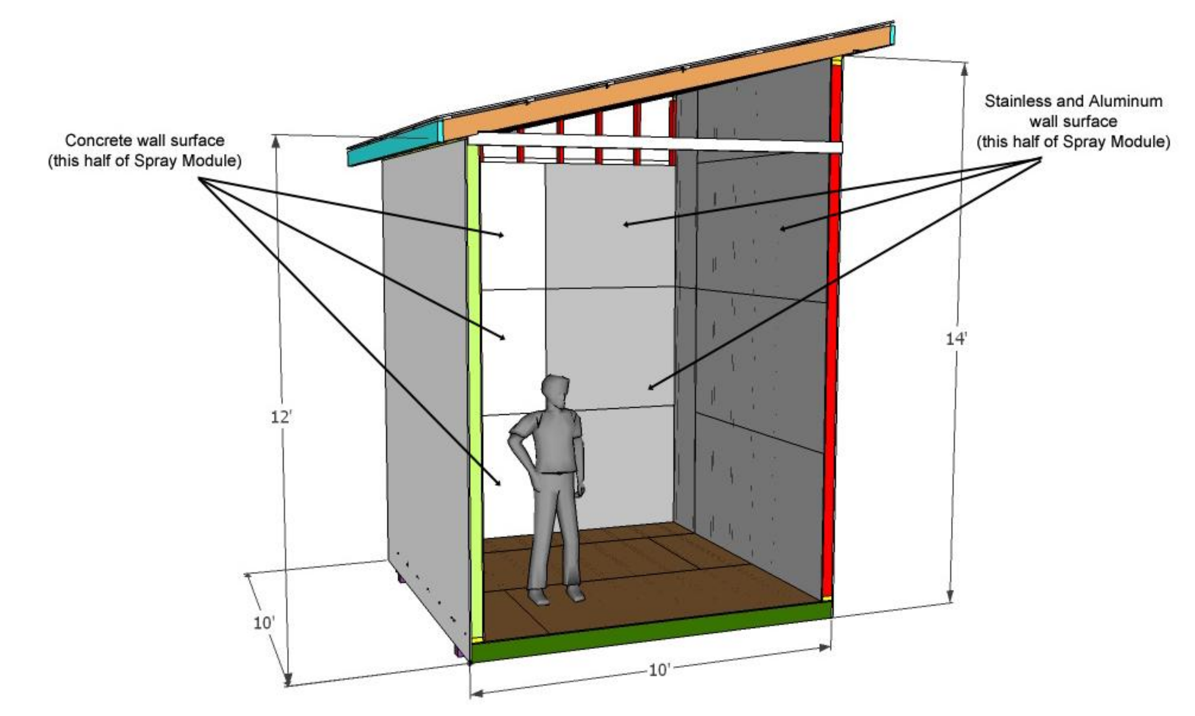


Figure 1. 3-dimension diagram of the building module mockup design

2. At the conclusion of the technology demonstration, the equipment was taken apart to document which parts are removable and what can not be reached for cleaning (decontamination).

   a. The need for equipment and personnel decontamination is highly field site – specific and requires consideration of the following factors:
      i. types of onsite contaminants
      ii. levels of contamination
      iii. personal protection levels utilized
      iv. work activities performed
      v. evaluation/testing parameters

   b. The test “decontamination” procedures were performed on all equipment and accessories that entered the building module.

   c. The decontamination consisted of the following:
      i. overall equipment clean up steps
      ii. equipment disassembly steps
      iii. equipment and accessories clean up
      iv. equipment’s cable removal & clean up
      v. collection/disposal of waste and consumables
      vi. PPE disposal/cleanup
      vii. clean up material collection/disposal

TEST SITE DESCRIPTION

The ICM facility is located at 630 Elmira Road in Ithaca, NY. ICM constructed an outdoor building module as shown in Figure 1 and installed panels of concrete and stainless steel on the interior walls. The building module is 10-ft wide x 10-ft deep x 12-14-ft high and has one side open for observation (Figure 2). The technology demonstration was conducted under standard non-nuclear conditions.

ICM provided all utilities and services, such as water, power, phone, and sanitation services at the work location. Specifically, ICM provided the following for the technology demonstration:

1) Compressed air - 375 CFM at 110 PSI
2) Electric - 110 volts 20 amp service to operate:
   a. Climber with onboard vacuum and control station
   b. Sprayer
3) Trash disposal of items generated during demonstration
4) Collection and disposal of secondary waste generated by the technology
5) Strippable coating products for the demonstration

Figure 2. Building module at ICM facility

TECHNOLOGY DESCRIPTION

ICM climbers are small, remote-controlled, easily deployable, lightweight climbing machines with big payload capabilities. The machines can climb walls, ceilings or rounded surfaces. The inherent benefit is the patented seal that allows these lightweight climbers to climb over surface obstacles, uneven surfaces and surface contours, making them unlike any other climber. The machines weigh approx 30 pounds yet have a pull off strength of over 225 pounds. Plus, the machines are reliable, robust and easy to operate. The climbers also have interchangeable attachments so the same climber can be used for an array of missions. Held to the surface by vacuum force, the machines adhere to essentially any hard surface: metal, concrete, brick, etc. The patented, highly flexible seal ensures the machine is securely adhered as it moves the machine over surface obstacles such as bolt heads, plates, weld seams or virtually any surface irregularity.

The ICM climbing machines are remotely controlled by an operator from a control station, allowing the machine to access areas unsafe for manual D&D activities. For the purposes of this technology demonstration, the ICM climber was modified with a spray applicator. The following technology description of the climber, the technical specifications shown in Table 2, and Figure 3 were obtained from the ICM Climbing Machine operations manual and the ICM website at http://www.icm.cc [3 and 4].

Table 2. ICM Climber Specifications [3,4]

Primary Materials of Construction:	Carbon fiber / advanced composites
Climbing Machine Weight:	30 lbs
Width of Climber:	24 inches
Length of Climber:	24 inches
Height of Climber:	8 inches
Rate of travel:	2.5 - 3 inches/second
Pull-Off Strength:	225 lbs
Power (Adhesion Vacuum):	24 Volt DC/110 Volt AC/15 amp

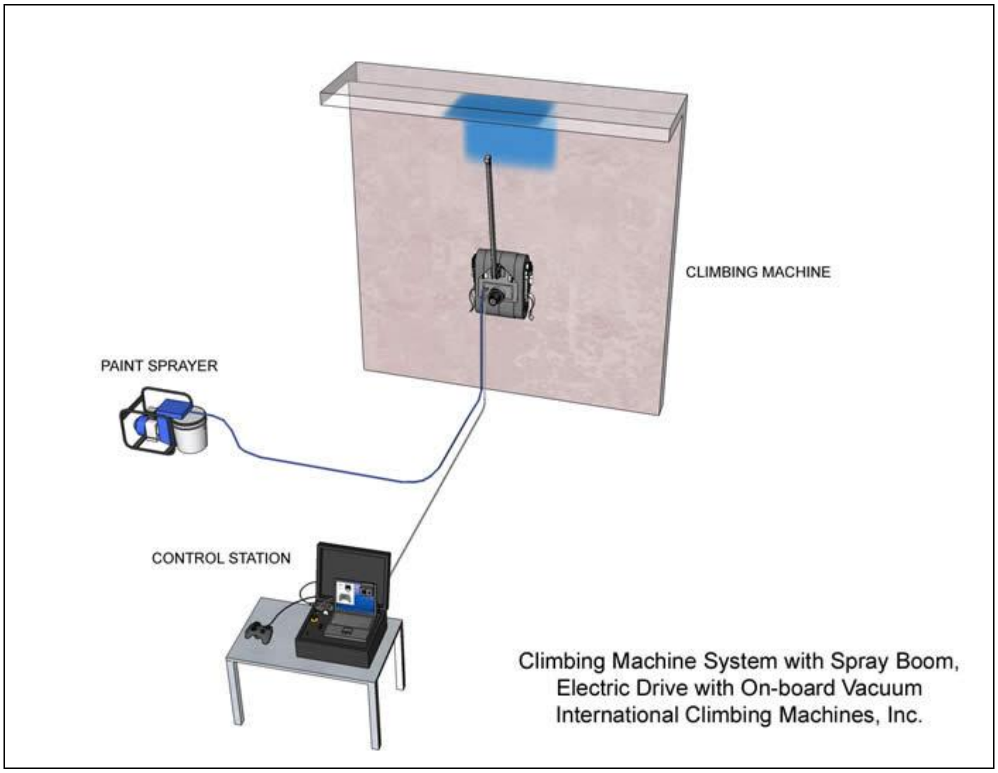


Figure 3. ICM climber set-up [3,4]

The products sprayed include CC Strip (InstaCote Inc.), ALARA 1146 (Carboline), and DeconGel (CBI Polymers). Table 3 provides the manufacturer information for each product [5, 6, and 7].

Table 3. Manufacturer Information for Strippable Coatings and Decontamination Gel

Product Manufacturer	Product Brand	Name of Product	Coverage (ft^2/gal)	Cost ($/gal)
Instacote Inc.	InstaCote	CC Strip	320	99
Williams Power Co.	Carboline	ALARA 1146	26 at 25 mils	105
CBI Polymers	DeconGel	1121 Spray	25-75	170

CC Strip is described by its manufacturer as a removable high solids, latex based product designed for application to surfaces contaminated with beryllium, asbestos, radiological nucleotides (plutonium, uranium) or any other toxic or problematic particulate. CC Strip is applied as a liquid (brushed, rolled, or sprayed), cures to a clear, highly elastic coating which is removed by peeling. Loose contamination is encapsulated in the CC Strip and removed when it is peeled off. CC Strip is water-based, non-toxic, non-hazardous, non-flammable and will not support biological growth [5].

ALARA 1146 is a waterborne vinyl-based strippable decontamination coating. According to the manufacturer, it may be applied to a contaminated surface and the product will attract and bind with surface contaminants. Upon curing, the product mechanically locks the contaminants into a polymer matrix. Removal of the film decontaminates the substrates and produces a solid waste [6].

DeconGel 1121 Spray is a one component, water-based, sprayable, and peelable decontamination hydrogel. It is recommended by the manufacturer for decontamination of radioisotopes as well as particulates, heavy metals, water-soluble and insoluble organic compounds. The hydrogel coating can be applied to most surfaces and when dry, the product locks the contaminants into a polymer matrix. The film containing the encapsulated contamination can then be peeled and disposed [7].

RESULTS AND DISCUSSION

The technology demonstration was performed from June 24 to June 25, 2010. The technology was evaluated on its ability to apply three different strippable coatings to concrete and stainless steel panels. The products sprayed include CC Strip (InstaCote Inc.), ALARA 1146 (Carboline), and DeconGel (CBI Polymers). The field data tables are provided in Appendix A.

The technology evaluation demonstrated the ability of the remote system to spray strippable coatings and decontamination gels on vertical concrete and stainless steel surfaces. Table 4 lists the products used during the demonstration along with the surfaces and area coated with each. With the climbing machine positioned on the wall, the 4-foot boom attachment was capable of spraying to a height of 10-feet with no additional fall protection measures. The climbing machine sprayed the top approximately 4 feet of the wall while positioned on the wall. From the floor, the climbing machine was then able to coat the lower 6-feet of wall.

Table 4. Strippable Coatings Used During the Technology Demonstration

Product Brand	Name of Product	Surface Coated	Surface Area Coated (sq ft)
InstaCote	CC Strip	Concrete panel	40
InstaCote	CC Strip	Stainless steel panel	25
Carboline	ALARA 1146	Concrete panel	25
Carboline	ALARA 1146	Stainless steel panel	40
DeconGel	1121 Spray	Concrete panel	40
DeconGel	1121 Spray	Stainless steel panel	40

Table 5 below provides the product coverage achieved during the technology demonstration. It should be noted that maximizing the coverage per gallon was not an objective of the demonstration. Instead, remotely achieving a coating capable of being readily stripped from the surface once dry and minimizing missed or thinly coated surfaces was an overriding factor. The custom spraying attachment to the remote control climber was successful in achieving this goal.

Table 5. Coverage of Strippable Coatings

Product	Total Surface Area Coated	Product Consumed	Wet Film Thickness	Actual Coverage
CC Strip	65 sq ft	1.5 gal	10-30 mil	43 sq ft/gal
ALARA 1146	65 sq ft	1.25 gal	10-20 mil	52 sq ft/gal
DeconGel	80 sq ft	2 gal	16-35 mil	40 sq ft/gal

Table 6 provides a comparison of the spraying rate of the 3 products used during the demonstration. The surface area coated with each product was divided by the total time that product was being sprayed to calculate the spraying rate. These spraying rates do not include break times and so illustrate the rate during active spraying. The rates do include the time required by the technology to position itself and climb the walls. Figures 4 through 6 show the ICM climber as it sprays each of the three products to the building module walls as well as the products being stripped away from the wall surfaces once dry. Additional photographs taken during the demonstration are shown in Appendix B.

Table 6. Spraying Production Rate Achieved During Demonstration

Product	Surface Area Coated	Total Spraying Time	Spraying Rate
CC Strip	65 sq ft	21 min	3.1 sq ft/min
ALARA 1146	65 sq ft	13 min	5.0 sq ft/min
DeconGel	80 sq ft	21 min	3.8 sq ft/min

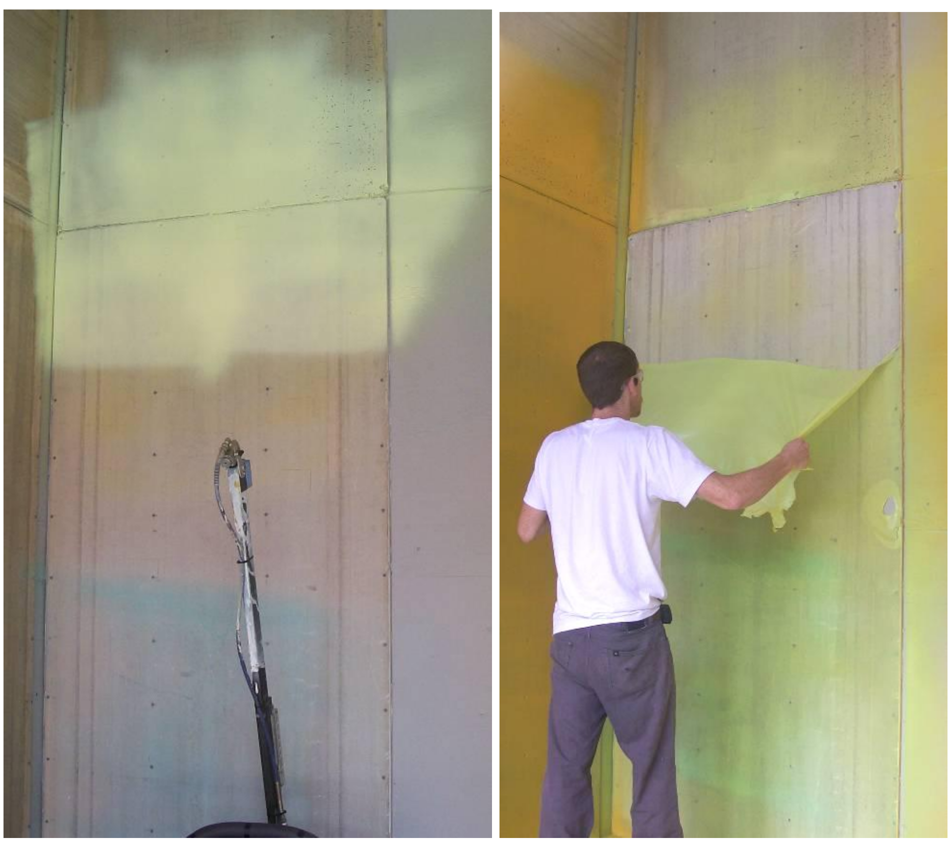


Figure 4. CC Strip being sprayed onto concrete panel (left) and being removed from concrete panel after drying (right)

Figure 5. ALARA 1146 being sprayed onto a steel panel (left) and dry ALARA 1146 being removed from a steel panel (right)

Figure 6. DeconGel being sprayed onto a steel panel (left) and dry DeconGel being removed from a steel panel (right)

Table 7 provides a comparison of the strippable coating/decontamination gel products used during the demonstration. Overall, the three products sprayed well and were relatively easy to strip, once dry, from the stainless steel and concrete panels. Drying time affects the ease with which the products strip away from the surface. Areas of product that were still damp after 24 hours of drying time continued to adhere to the surface, creating holes in the dry product that was stripped away. On the other hand, leaving the product to cure for a week caused the DeconGel to become more brittle and papery, leading to tearing of the coating at thin sections. Finally, for all three products, areas of product overspray were difficult to remove.

Table 7. Comparison of Product Characteristics

Product	Product Description and Consistency (wet)	Result after spraying (wet)	Result after spraying (dry)
CC Strip – HV Green	Yellow, consistency of thin whipped cream	Applied with fair uniformity, ~ 10 mil in thin areas and ~25 mil in thick areas	Peeled very easily in one continuous sheet from the metal panel. Peeled in one mostly continuous sheet from the concrete panel; requires more force to remove from concrete than metal. Some heavy drips were not cured after 24 hours and did not form the film.
ALARA 1146	Orange, consistency of liquid plastic	Very uniform application on metal panel (~20 mil). Good application on concrete panel (mostly ~10-13 mil with some thin areas ~7 mil).	Peeled very easily from the metal panel, even discontinuities and bare spots did not cause the film to rip. Harder to remove off concrete, mostly peeled as a uniform sheet except for thin areas which had some rips.
DeconGel	Blue, consistency of liquid gel	Varying application on metal panel, ~16 to 35 mil. More difficult to judge thickness while spraying due to the clear appearance of the gel. ~20-35 mil thickness on concrete panel.	Removed easily from the metal panel; ripped at thinnest sections. Peeled fairly easily from concrete, harder to remove than from metal, tearing at thin sections.

At the conclusion of the demonstration, the equipment was taken apart to document which parts are removable and what can not be reached for cleaning/decontamination. Photographs were taken to document the cleaning/decontamination step (Appendix B). If used in a radioactively contaminated environment, the rollers and tracks would be cut off and disposed since the foam material is not conducive to decontamination. The cables and hoses in the tether (e.g., electronic input line, main air hose, and retrieval cable) could be wiped/ decontaminated as an alternative to disposing of the entire tether. The two climbing machine drive chains would be difficult to confirm as clean and would likely be disposed. The main body of the climber consists of a carbon fiber chassis, aluminum or resin drive shafts and spindles, an onboard vacuum, a vacuum chamber, and an internal box for electronics. The body could be wiped/ decontaminated but may be difficult to free-release due to the difficulty in confirming that the contamination did not enter the climber through the openings for the drive shafts and spindles, air hose, etc.

CONCLUSIONS

Overall, the technology was capable of successfully achieving the objectives of this demonstration. It was able to travel across the floor and climb the walls unassisted while being controlled remotely by the operator. The technology sprayed strippable coatings and a decontamination gel to the vertical wall surfaces of concrete and stainless steel. A sufficient thickness of each product was achieved to promote the ability of the product to be stripped from the surface once dry.

The technology was evaluated for 16 health and safety categories and a risk rating was applied to each (Appendix A). Twelve of the categories were either not applicable to this technology or received a risk rating of 1, hazard may be present but not expected over background levels. The remaining categories received a rating of 2, some level of hazard above background level known to be present. These categories included pressure hazards, tripping and falling (from the trailing tether), noise (from accessory equipment – air compressor, and airless sprayer), and inhalation (from the product being sprayed).

A few challenges were encountered during the demonstration. The new smooth surfaces of the metal panels had a tendency to allow extra thick coatings to pull away from the surface before it dried. The coating would run down the wall, leaving gaps of coverage on the wall. Aged surfaces exhibiting normal wear is not expected to have this problem. This only occurred where multiple spraying passes were made (overlapping passes with the sprayer).

In addition, line of sight is needed to operate the technology. Where direct line-of-sight by the operator is not possible, at least two cameras spaced apart would be needed to adequately view and operate the technology.

Minimal tether management was needed during the demonstration (providing more tether and removing excess tether) and was achieved from outside the module. In addition, no clogging was encountered during the demonstration although the operator reported that clogging of the spray tip can occur if there is significant down time with no spraying.

ICM performed preliminary testing using the strippable coating/decontamination gel products with varying nozzles, sprayer models, and sprayer pressures to optimize spraying performance. It is recommended that any new product be tested thoroughly with the equipment prior to being used in a radioactive environment.

The results of this demonstration, including this technology demonstration report and additional photographs and videos taken during the demonstration will be made available to the general D&D community through the FIU/DOE D&D Knowledge Management Information Tool located on the web at www.dndkm.org.

Approximate cost per gallon for the products used are as follows: $99/gal for CC Strip, $105/gal for ALARA 1146, and $170/gal for DeconGel. The ICM climber technology can be purchased for approximately $110K or rented for approximately $15K/month.

REFERENCES

[1] Florida International University, *Fixatives Applied to Hot Cell Facilities via Remote Sprayer Platform*, Technology Demonstration Report, January 22, 2009.

[2] AEA Technology Engineering Services, Inc., *ORNL Remote Operations for D&D Activities Final Report*, March 2007.

[3] International Climbing Machine. Retrieved July 14, 2010 from ICM website: http://www.icm.cc/.

[4] International Climbing Machine, *ICM Climbing Machine Operations Manual for Fixative Sprayer Platform*, June 22, 2010.

[5] Instacote, Inc., *Contamination Control Strippable (CC Strip) Technical Data Sheet*, March 8, 2002.

[6] Carboline, *ALARA 1146 Cavity Decon Product Data Sheet*, October 2009.

[7] Cellular Bioengineering, *DeconGel 1120/1121 Spray Product Data Sheet*, March 18, 2009.

ATTACHMENT A.
FIELD DATA TABLES

SPRAYER PLATFORM TECHNOLOGIES

Field Data Tables

DATA	DESCRIPTION	UNITS
The following sections can be completed prior to the demonstration:		
GENERAL INFORMATION ABOUT TECHNOLOGY **To be supplied by the vendor.**		
Technology Name	The generic name of the technology (i.e., remote climbing machine)	No units
	Remote control climbing machine with sprayer modification	
Technology Model Number	Unique identifier for the technology model, where applicable. Typically supplied by the manufacturer.	No units
	ICM-D-E01	
Technology Model Description	Technical description of the technology including basic principle(s) and operational parameters and conditions. Discuss all pieces of equipment required by the original manufacturer for this technology model. Include dimensions, weight, and schematic of technology model.	No units
	The **climbing machine** has three main parts: the main body, the paint boom on the front end, and the transition bar on the back. The main body is responsible for locomotion, protection of vital electronics and control components, and for attaching to wall surfaces. The main body consists of a carbon fiber chassis, aluminum or resin drive shafts and spindles, a vacuum chamber and an internal box for electronics. The climbing machine rides on four rollers and two tracks. The transition bar allows the climbing machine to move from floor to wall. At the end of the transition bar is the umbilical support bar to support the umbilical components (air input hoses, adhesion vacuum hose, and electronic cable) and gives the machine room to maneuver. Dimensions: 24"L x 24"W x 18"H Weight: 30 lbs The **control station** is used to monitor and control the machine movement and the operation of accessories. The control station includes the hand controller, a laptop computer with software, and the vacuum adhesion indicator. Dimensions: 18" x 14" x 24" Weight: 12 lbs The **junction box** supplies the climbing machine with operational air from the compressor and it sends command signals to the climber. It also sets the maximum pressures and has shutoff and filter features. The system is designed to run on source air that is	

DATA	DESCRIPTION	UNITS
	a maximum of 115 psi. Two regulators control the pressure of air flowing to the rest of the system. Dimensions: 24” x 14” x 24” Weight: 12 lbs The spray function of the climbing machine is provided by a Graco 695 **sprayer**. Dimensions: INSERT Weight: 93 lbs Schematics of each part of the system can be found in the ICM operations manual.	
Maturity of Technology	The maturity of the technology at the time of the demonstration. Choose from: • Commercially available • Prototype	No units
	Commercially available	
Utility Requirements for Technology model	Energy and material requirements. Includes compressed air and water requirements.	No units
	Climbing machine Power: 24 V DC <4 amp supply Air: 40 psi 10 scfm compressed air Control station Power: 24 V AC single phase 60 Hz 5 amp Junction box Power: 24 V DC <4 amp supply Air: 40 psi 10 scfm compressed air Airless sprayer	

DATA	DESCRIPTION	UNITS
	Power: 120V 15 amp minimum	
Technology Model Capital Costs (Rental and Service also)	The vendor's current list price for the entire technology model. Include cost of all pieces that are part of the technology model. Include current prices for rental of equipment or as service provider.	$
	Sale - $110K Rental - $15K/mo Service - $190K	
Useful Life Expectancy	The number of hours that the technology model can possibly be used for its specified purpose.	Hrs
	Thousands of hours barring any misuse	
Applicable Media	List all possible surface types to which the technology model can be applied.	No units
	Anything non-porous, including wood, metal (ferrous and non-ferrous), plastic, concrete, brick, block, glass, etc.	
Applicable Geometries	List all possible surface geometries to which the technology model can be applied.	No units
	Any reasonably sized geometry including flat, sphere, cylinder, etc. Reasonable size includes geometries of 4' radius and up, although the technology could be scaled down for smaller geometries.	
Equipment portability	Select one or more ways that are ways for removing the technology model from the transportation vehicle once it arrives at the facility where the demonstration is to be performed. Options include: • 1 person needed – the technology model is small/light and easily carried by one person • 2 people needed – the technology model is not as small/light and requires two people to carry • Forklift needed – the technology model is large/heavy and requires a forklift to remove it from the vehicle • Truck/trailer mounted – the major pieces of the technology model are not removed from the truck/trailer but instead are operated from this location	No units
	1 person	
Coating Cost per Unit	Type of coating used by the technology model for the demonstration and its cost per unit.	$/User Defined

SPRAYER PLATFORM TECHNOLOGIES

Field Data Tables

DATA	DESCRIPTION	UNITS
	Instacote CC Strip (Instacote) - $99/gallon ALARA 1146 (Carboline) - $105/gallon DeconGel (CBI Polymers) - $170/gallon	
Required Personnel for Operation	Manpower requirements for operation of this technology. Distinguish between number of equipment operators and number of technicians required.	No units
	1 operator and 1 technician/assistant	
Level of training required	The level of training and the skills that are supposed to be provided to the operators of the technology.	No units
	5-day training course	
Technology Availability	Average expected delay between order placement and vendor delivery.	No units
	6 weeks	
Scale-up Requirements	Provide a description of what enhancements (equipment/personnel/procedures) would be changed or added by the vendor if the size of the job was greater.	No units
	Technology itself wouldn't be scaled up (the climber size would not increase) but more units and personnel would be added to meet the need of time constraints.	
Maintenance Requirements	Listing of the maintenance requirements for the technology model. Include time frames to perform maintenance. Examples include: • change filter every 6 months • add oil motor at end of every day	No units
	• apply talc to climber rollers with each use • replace tracks and rollers when damaged, frequency depends on severity of use • add oil to sprayer with each use • change filter on junction box periodically • no maintenance needed for vacuum or control station	
Total Maintenance Cost	Include total cost of regular maintenance per hour of use.	$/hr

DATA	DESCRIPTION	UNITS
	Minimal	
Technology Support Equipment and Cost for Each Unit	List any required support equipment (not utilities) that are included in the demonstration. Include description of each and associated capital costs.	
	Airless sprayer – Graco 695 sprayer. Air compressor – Jenny	
Consumables and Cost for Each Unit	List additional expendable items and associated costs for each item, used with the technology that are typically discarded at the end of a job. Examples include vacuum hoses, belts, etc.	
	No items are typically discarded at the end of a job from this technology. However, expected expendables when the technology is used in a radioactively contaminated environment include the follows: • Foam tracks and rollers • Drive chains • Air motor behind gear • Vacuum (onboard) Total estimate for replacement of contaminated items would be $15-20K.	

MANUFACTURER INFORMATION		
DATA	DESCRIPTION	UNITS
Name and Address	Information to be collected about company that manufactured the technology model.	No units
	International Climbing Machines, Inc. 630 Elmira Road Ithaca, NY 14850	
Phone Number(s)	Include area code. Include pager number or second phone number (if applicable).	No units
	(607) 288-4001	
Fax Number	Manufacturer’s fax number including area code.	No units
	(607) 288-4004	
Website	Internet web-site location for manufacturer (if applicable).	No units
	www.icm.cc	
E-Mail	E-mail address for the manufacturer where other D&D professionals can request information.	No units
	sam@icm.cc	
Services Available	What services the manufacturer provides. Chosen from one of the following: Service provider, Sells technology model*, Rents technology model* (* When these items are chosen, if the manufacturer will train site personnel, include technology model training time.)	No units
	Any service required to perform the work. Includes service provider, sells technology model, and rents technology model. 5-day training available when selling or renting.	
References	Locations where this technology model has been used previously (especially other DOE or commercial nuclear facilities).	No units

	Exelon Quad Cities Oconee Nuclear Plant Atomic Energy of Canada Boeing Department of Defense Quest Integrated (QI2) in Seattle Demonstration at Hanford, Savannah River Site, Idaho National Lab, and FIU.	
Publications	List of brochures or publications that provide additional information about the technology model and/or the company. Corporate history or profile.	No units
	ICM was incorporated in April of 2000 as a focused R&D effort developing small, remote-controlled devices which could climb vertical surfaces, particularly surfaces with boltheads, weld seams, plates and other obstructions commonly found in "real life" field conditions. With the assistance from three government grants, founder and investor capital, ICM embarked upon a saga of intense exploration. The result: the technology has flourished into its current market-ready climbing machine. Refer to the website for additional information and case histories: www.icm.cc	
Photographs/Video	If photographs or video is received from the manufacturer and sent for inclusion in the database, list which and the number of each sent to FIU.	No units
	Photographs and videos taken during demonstration.	
VENDOR INFORMATION		
Name and Address	Information to be collected about the company that was chosen as the vendor for this particular demonstration.	No units
	International Climbing Machines, Inc. 630 Elmira Road Ithaca, NY 14850	

Phone Number(s)	Include area code. Include pager number or second phone number (if applicable).	No units
	(607) 288-4001	
Fax Number	Vendor's fax number including area code.	No units
	(607) 288-4004	
Website	Internet web-site location for vendor (if applicable).	No units
	www.icm.cc	
E-Mail	E-mail address for the vendor where other D&D professionals can request information.	No units
	sam@icm.cc	
Services Available	What services the vendor provides. Chosen from one of the following: • Service provider Sells technology model * Rents technology model * (* When these items are chosen, if the manufacturer will train site personnel, include technology model training time.)	No units
	Any service required to perform the work. Includes service provider, sells technology model, and rents technology model. 5-day training available when selling or renting.	
References	List of locations where this technology model has been used previously (especially other DOE or commercial nuclear facilities).	No units
	Exelon Quad Cities Oconee Nuclear Plant Atomic Energy of Canada Boing Department of Defense Quest Integrated (QI2) in Seattle Demonstration at Hanford, Savannah River Site, Idaho National Lab, and FIU.	

Publications	List of brochures or publications that provide additional information about the technology and/or the company. Corporate history.	No units
	ICM was incorporated in April of 2000 as a focused R&D effort developing small, remote-controlled devices which could climb vertical surfaces, particularly surfaces with boltheads, weld seams, plates and other obstructions commonly found in “real life” field conditions. With the assistance from three government grants, founder and investor capital, ICM embarked upon a saga of intense exploration. The result: the technology has flourished into its current market-ready climbing machine. Refer to the website for additional information and case histories: www.icm.cc	

GENERAL DEMONSTRATION INFORMATION (To be completed by evaluation team)		
DATA	**DESCRIPTION**	**UNITS**
Demonstration Site Location and Description	Location of demonstration including name of facility and city/state and brief site description.	No units
	International Climbing Machine (ICM), Ithaca, NY Module was built outdoors of the ICM facility in Ithaca, NY. The module was designed to provide surfaces (primarily concrete and steel) that are typical of DOE site facilities. The module is 10' wide, 10' long, and ranges from 12' to 14' high. Three walls were constructed with the fourth wall open and covered with a tarp when not in use. The construction is plywood with concrete and steel panels installed on the interior vertical surfaces and siding installed on the outside. A cloth canopy was set up immediately outside the module to provide protection from the weather (sun, rain, etc.) to the operators and equipment.	
Problem Targeted	A brief description of the specific problem(s) targeted and its importance or critical nature.	No units
	Many facilities slated for D&D across the DOE complex pose hazards (radiological, chemical, and structural) which prevent the use of traditional manual techniques. Efficient and safe D&D of the facilities will require the use of remotely operated technologies. In addition, the D&D of a radioactive facility requires that it be cleaned and stabilized to allow demolition to occur while maintaining worker radiation exposure ALARA and without spreading radioactive contamination. One decontamination step typically consists of applying a fixative or strippable coating (or similar material) to all surfaces to hold (fixative) or remote (strippable coating) loose contamination prior to demolition. A study on available remote technologies for D&D activities, performed by Florida International University (FIU) and NuVision Engineering, indicated that there was no remotely operated technology available to meet the need for the remote application of strippable coatings (ORNL Remote Operations for D&D Activities, March 2007). This gap between the identified needs and the available technologies is especially critical for hot cell facilities, where access is typically very limited and radioactive contamination and dose rates are high.	
Demonstration Start and End Dates	Dates from start to finish for this particular demonstration. Example: October 20-24, 2008	No units
	June 24-25, 2010	
Major Objectives of the Demonstration	Objectives as they relate to DOE environmental requirements.	No units
	To meet the technology gap challenge for a technology to remotely apply strippable coatings to remove loose/removable contamination.	

Major Elements of the Demonstration	Specific operations evaluated during the demonstration.	No units
	1. Technology's ability to remotely enter and maneuver 2. Ability of technology to spray vertical surfaces of concrete and steel 3. Effectiveness of spraying mechanism 4. Ability of technology to transition from horizontal to vertical surfaces 5. Ability of technology to be decontaminated 6. Sufficient coating thickness achieved to promote strippability of coating once dry	
Boundaries of the Demonstration	Specific goals addressed versus not addressed.	No units
	Walls were sprayed to a height of 10 feet. Walls only were sprayed.	
Testing Organization, Contact Name, Phone Number, and E-Mail	• The name of the organization responsible for this demonstration and the information on a contact person who can be reached to gather additional information about all of the demonstrations performed by that organization. Example: FIU ARC, Leo Lagos, phone number, email	No units
	FIU ARC, Leo Lagos, 305-348-1810, lagosl@fiu.edu ICM, Sam Maggio, 607-288-4001, sam@icm.cc	
Test Engineer Name	The name of the person from the test organization in charge of setting up and evaluating this particular demonstration.	No units
	Peggy Shoffner (FIU) and Sam Maggio (ICM)	
Vendor Principal Investigator Name	The name of the vendor personnel that is supervising the demonstration from the demonstration site.	No units
	Sam Maggio	

REGULATORY, PERMITTING, AND SAFETY ISSUES

DATA	DESCRIPTION	UNITS
Patent/licensing Issues	Is the technology patented or licensed. If so, by whom. Technology specific.	No units
	Two U.S. patents and international patent held by ICM.	
Site-specific Regulatory/Permitting Issues	List any regulatory/permitting issues specific to the demonstration site or state. Include any OSHA regulations that should be considered for technology operation.	No units
	Standard industrial/jobsite safety practices.	
Secondary Waste Stream Regulatory Considerations	List any regulations that must be considered for the collection and disposal of the secondary waste. Consider RCRA, DOT, and Waste Acceptance Criteria concerns.	No units
	No waste regulations need to be considered for the crawler technology itself. The spraying mechanism generates a secondary waste from flushing the line and spray nozzle with water. This waste is a mixture of water and the coating being sprayed. RCRA, DOT, and waste acceptance criteria concerns will depend on the coating product chosen.	
CERCLA Criteria	Evaluate the technology against the nine CERCLA evaluation criteria. (Even if CERCLA does not apply.) – See page 8 of ITSR Guidance (May 1998)	No units
	1. Overall protection of human health and the environment • Worker risk reduction - protects workers by performing D&D activity remotely. Dose rates within hot cells can range up to hundreds of R/hr, precluding human entry. • Environment risk reduction - fixes loose/removable contamination which will reduce radiation exposure and reduce risk of spread of contamination. 2. Compliance with ARARs 3. Long-term effectiveness and permanence N/A. Coating is intended to be a short-term treatment prior to D&D. 4. Reduction of toxicity, mobility, or volume through treatment • Effective reduction of mobility by fixing loose/removable contamination. 5. Short-term effectiveness • Excellent short-term effectiveness	

	6. Implementability • Technology is commercially available and able to be implemented. 7. Cost • Costs relatively low compared to other remote technologies. 8. State acceptance • No hurdles to state acceptance 9. Community acceptance • No hurdles to community acceptance	
Worker Safety Issues	Discuss any safety issues for the workers, include possible exposures or liability risks.	No units
	The technology actually mitigates safety issues for the workers by minimizing exposure to radioactivity; the technology can enter the area remotely and spray a coating to fix loose contamination.	
Community Safety/Stakeholder Issues	Discuss safety from the perspective of the community and stakeholders. Are there any stakeholder issues that might preclude the use of this technology at the site?	No units
	No stakeholder issues.	

DATA	DESCRIPTION	UNITS
The following sections are to be completed during or immediately after demonstration:		
DEMONSTRATION STATISTICS		
Information to be completed one time during demonstration:		
Mobilization Time	A measured time for how long it takes to mobilize the technology model prior to performing work. This time measures from the time the vendor arrives at the demonstration site to when the technology model is ready to operate.	hr
	Demonstration was conducted at the vendor facility. Estimated mobilization time = 25 minutes.	
Portability Option Chosen	List of equipment/ personnel used at this particular demonstration to remove the technology model from the vendor vehicle during mobilization/demobilization.	No units
	Demonstration was conducted at the vendor facility. Equipment could be removed by 1 to 2 people. No heavy equipment is required once delivered.	
Required PPE for Demonstration	List the PPE that was required to operate the technology model during the demonstration. If the equipment operator and technicians wore different levels of PPE, describe the most restrictive.	No units
	Operator – no PPE required, safety glasses suggested as needed Technician/assistant – safety glasses	
Demobilization Time	A measured time for how long it takes to demobilize the technology model after demonstration. This time measures from the time the technology model is ready to be decontaminated to when the vendor leaves the demonstration site.	hr
	Demonstration was conducted at the vendor facility. Estimated demobilization time = 1 hr	
Supporting equipment installation/setup	A measure of time for setting up/hooking up supporting equipment (generator, air compressor, etc)	hr
	Demonstration was conducted at the vendor facility. Minimal time required to set up and hook up supporting equipment.	
Information to be completed for each problem set:		

DATA	DESCRIPTION	UNITS
Problem Set	Describe problem set for which data applies.	No units
	Module 10'L x 10' x 12-14' H with concrete and steel panels installed on interior walls. One wall was open to operators. Operator visual contact with technology is necessary, either via direct line-of-sight or remote video feed.	
Technology Model Maneuverability	Discuss maneuverability of the technology model, including horizontal and vertical surfaces. Include examples of ease or difficulty whenever possible.	No units
	Technology maneuvered easily on horizontal surfaces and transitioned routinely to vertical surfaces. Technology can move forwards, backwards, and turns. Technology requires 24" clearance (width) between obstacles to traverse surface and has the ability to push/move non-fixed obstacles on the floor. Technology had no difficulty with concrete and steel vertical surfaces and painted plywood floors.	
Spraying Parameters	Include measurements on the following: • Spraying rate (ft/min) and pressure (psi) • Width of spray coverage for each pass • Thickness of coating on surfaces for each application • Amount of coating consumed • Amount of diesel/gas used by supporting equipment (gallons) Additional information should be collected if relevant.	Various
	• Overall spraying rate (ft^2/min): 3.8 sq ft/min • Pressure (psi): 2800-3200 psi • Width of spray coverage for each pass: 24" at 10" distance • Thickness of coating on surfaces for each application: varied from 10 mils to 35 mils wet • Amount of coating consumed: 1.25 to 2 gal per product tested • Amount of diesel/gas used by supporting equipment (gallons): no diesel or gas used	

SPRAYER PLATFORM TECHNOLOGIES

Field Data Tables

DATA	DESCRIPTION	UNITS
Observation of How Coating is Applied	Describe the motion of the technology during the spraying process. • Is the technology driven on the surfaces at a constant rate? • Is the technology driven through in steps, at each step allowing the technology to spray the coating while stationary before further advancement? • Does the technology adheres to the surfaces (specially vertical surfaces)	No units
	Technology has the ability to move across surfaces at a constant rate or a variable rate while spraying the coating and can also stay stationary and move the boom as needed to thoroughly coat a surface before moving on. The technology uses a vacuum chamber to adhere to vertical surfaces and generally travels across horizontal surfaces without the vacuum.	
Spraying Rate	The measurement of sprayed surfaces (ft^2) divided by the total number of hours of equipment operation required to complete the task. Spraying rate includes only the time the equipment is in operation, and does not include time spent in site specific activities.	ft^2/hr
	2.5 to 6.25 sq ft/min, averaged 3.8 sq ft/min	
Production rate	The measurement of sprayed surfaces (ft^2) divided by the total number of hours required to complete the task at a given site. Site-specific production time begins immediately following equipment mobilization and ends at problem set completion, just prior to equipment demobilization. Production time includes breaks taken by operators, equipment adjustments and maintenance, rigging equipment adjustments (when appropriate), and consultations with test site administrators. Site-specific time does not include extended operator breaks (such as meals), test interruptions resulting from inclement weather, or the time required to correct major equipment failure.	ft^2/hr
	2.6 sq ft/min or 156 sq ft/hr	
Problems encountered	A detailed description of problems encountered during the demonstration.	No units

DATA	DESCRIPTION	UNITS
	The new smooth steel surfaces had a tendency to allow extra thick coatings to pull away from the surface before it dried. The coating would run down the wall, leaving gaps of coverage on the wall. Aged surfaces exhibiting normal wear is not expected to have this problem. This only occurred where multiple spraying passes were made (overlapping passes with the sprayer). Line of sight is needed to operate the technology. Where direct line-of-sight by the operator is not possible, at least two cameras spaced apart would be needed to adequately view and operate the technology. Minimal tether management was needed during the demonstration (providing more tether and removing excess tether) and was achieved from outside the module. In addition, no clogging was encountered during the demonstration although operator reports that clogging of the spray tip can occur if there is significant down time with no spraying. The three different strippable coating products dried at different rates.	
Quality of sprayed surfaces	Quality refers to the nature of the sprayed surfaces, whether they are evenly coated, whether there are surfaces the technology was unable to coat, etc.	No units
	Sprayed surfaces were unevenly coated and the coatings tended to run where spraying passes overlapped. The demonstration objectives prioritized the complete covering of the surfaces over leaving an even coat. The technology effectively sprayed both concrete surfaces and steel surfaces.	
Application rate of coating used	The quantity of coating required per time of operation will be recorded at the test site during the technology demonstration.	(gal/hr)
	Overall: 4 gal/hr	
Waste Volume	The measured volume of primary/secondary waste generated during this particular demonstration with respect to the area of surface coated with coating.	No units

DATA	DESCRIPTION	UNITS
	A total of 210 sq ft of surface was coated. Approximately 6 gallons of coating/water mixture was generated during the demonstration and approximately 10 gallons of loose dry stripped coating.	
Waste Characteristics	The description of primary/secondary waste generated during this particular demonstration.	No units
	6 gallons of coating/water mixture from purging the sprayer, spray nozzle, and tubing 10 gallons of loose dry trash consisted stripped coating	
Technology Model Decontamination Method	The method used to clean and decontaminate the technology model after the demonstration is completed. Examples include: • wiped with damp rags • could not be decontaminated • cleaned using soft media blasting equipment • stainless steel construction makes for easy decontamination by wiping with damp rags.	No units
	Clean tap water was flushed through the sprayer, spray nozzle, and tubing. Climbing technology was disassembled to document which parts are removable and what can not be reached for cleaning (decontamination). If used in a radioactively contaminated environment, the rollers and tracks would be cut off and disposed since the foam material is not conducive to decontamination. The remaining cables and hoses in the tether (e.g., electronic input line, main air hose, and retrieval cable) could be wiped/ decontaminated as an alternative to disposing of the entire tether. The two climbing machine drive chains would be difficult to confirm as clean and would likely be disposed. The main body of the climber consists of a carbon fiber chassis, onboard vacuum, aluminum or resin drive shafts and spindles, a vacuum chamber, and an internal box for electronics. The body could be wiped/ decontaminated but may be difficult to free-release due to the difficulty in confirming that the contamination did not enter the climber through the openings for the drive shafts and spindles, air hose, etc. The onboard vacuum could not be internally decontaminated.	

SPRAYER PLATFORM TECHNOLOGIES

Field Data Tables

OVERALL RATING OF TECHNOLOGY		
Effectiveness of Overall Technology	Qualitative evaluation of how the technology model, spraying mechanism, and coating combination demonstrated achieved the desired effect. Scale of 1-4, with 4 being the highest. Include reason rating was given including whether final outcome of demonstration met site needs, and if not, what needs were not met.	No units
	4 – demonstration fully met the site needs	
Benefits	Technical and economic advantage(s) of the technology over competing technologies (e.g., lower cost, greater degree of cleanup, more stable waste form, increased safety).	No units
	As compared to manual spraying of coating in a radioactive setting, the technology increases worker safety and improves ALARA.	
Limitations	Disadvantages or shortfalls the technologies has (e.g., conditions under which the technology shall not be used at this time). Include any outstanding design issues and/or problems that may have been encountered during the demonstration or post-demonstration. Include needs/recommendations for further development.	No units
	Line-of-sight or high-quality video feed is required between the technology and the operator. Management of tether is also required. Having a second separate remote vehicle to carry a video camera and assist with tether management may be beneficial. It would be difficult for the technology to maneuver in a very cluttered setting as it needs 24” clearance in width to traverse. Careful testing of any new product to be sprayed needs to be performed ahead of time to ensure that clogging of the spray nozzle will not be an issue.	
Potential Markets	Potential markets for the technology (both specific DOE applications/sites and non-DOE applications)	No units
	Aircraft, DOD, spraying hot cells, applying linings on tanks and vessels, inspection/characterization, decontamination, repairs, retrieval	
Data Sensitivities	Description of items that could affect the quality of the data collected. Examples may include: • Vendor statement that the equipment/personnel used at the demonstration is not what would be used in routine decontamination jobs • Vendor statement that demonstration conditions were unlike what would be seen in normal jobs and adversely effected their performance as seen in the statistics • Information about data that was misplaced or unsure of accuracy.	No units

	• New polished steel surface was too smooth. Strippable coatings tended to run when too thick (e.g., where spraying passes on the wall overlapped) and could pull the coating from the wall before drying. The surface area thus uncoated was minimal and it is believed that aged surfaces with normal wear would not have this problem.	
Recommendations for Improvement	Describe any recommendations that should be made to the vendor to improve the technology to make it more safe, efficient, and/or cost effective.	No units
	Where you don't have direct line of sight, add remote cameras (with pan-tilt-zoom capabilities) to a ROV to provide various viewpoints of the technology for easier operating.	

HEALTH AND SAFETY RATINGS		
A risk rating (from 1 to 4) for each health and safety category and a description of the specific hazards associated with this particular technology and/or demonstration. Use NA if not applicable to this technology. 1 = Hazard may be present but not expected over background levels 2 = Some level of hazard above background level known to be present 3 = High hazard potential 4 = Potential for imminent danger to life and health		
DATA	**DESCRIPTION**	**UNITS**
Electrical	1	No units
Fire/Explosion	1	No units
Confined Space Entry	NA	No units
Mechanical Hazards	1	No units
Pressure Hazards	2 – technology uses vacuum pressure to adhere to vertical wall surface, the machine weights approximately 30 lbs and has a pull off strength (when vacuum is being applied) of over 225 lbs	No units
Tripping and Falling	2 – technology requires a trailing tether which could pose a tripping hazard	No units

Moving Vehicles	NA	No units
Protruding Objects	1	No units
Overhead Lifts	NA	No units
Inhalation	2 – inhalation hazard is not applicable to the climber itself; the inhalation hazard for the climber as used as a coating sprayer platform would depend on the product being sprayed	No units
Skin Absorption	1	No units
Heat Stress	NA	No units
Noise	2 – the climber itself operates with little noise but requires the use of an adhesion vacuum, air compressor, and an airless sprayer (when used as a coating sprayer platform), all of which produce noise above background levels	No units
Cold Stress	NA	No units
Ergonomic Hazards	1	No units
Particulate Emissions	1	No units
Other (list)		No units

ATTACHMENT B.
PHOTOGRAPHS FROM DEMONSTRATION

Module constructed at ICM facilities in Ithaca,NY.

Canopy set up to provide shade to operators and equipment.

Stripping ALARA 1146 from steel panel. Coating applied prior to demonstration.

Stripping DeconGel from steel panel. Coating applied prior to demonstration.

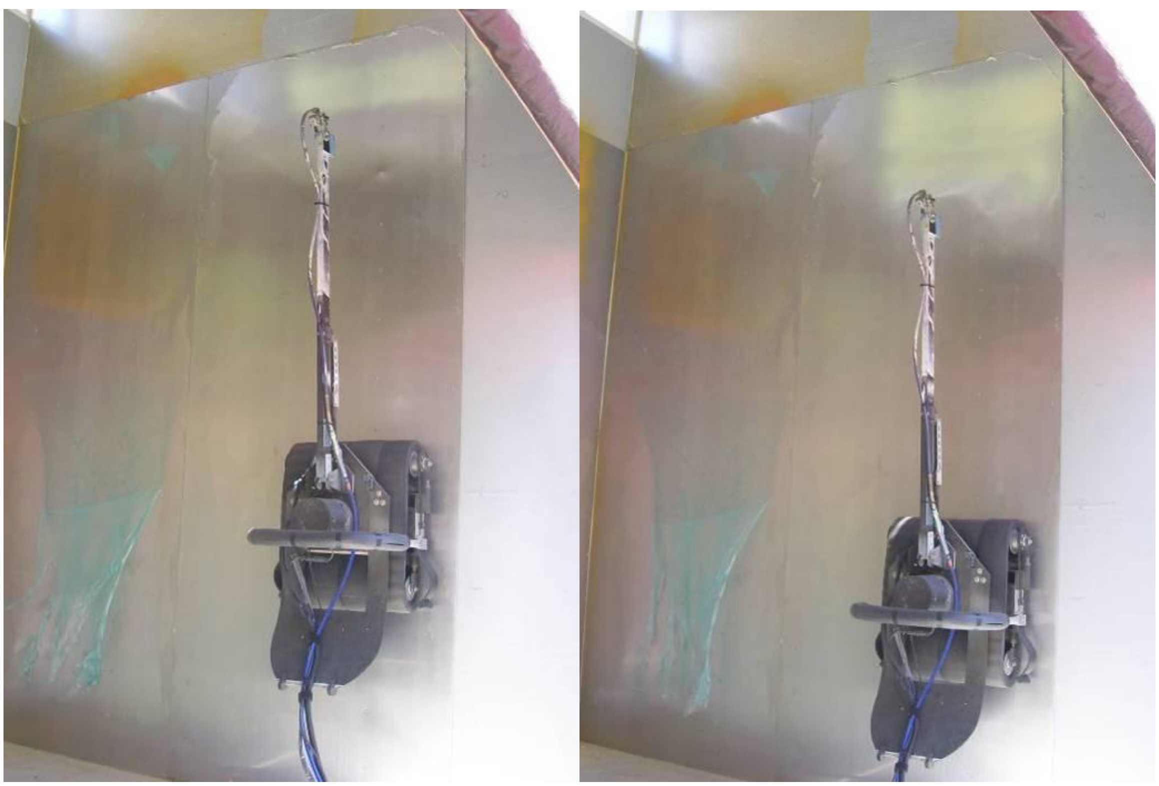
Stripping CC Strip from steel panel. Coating applied prior to demonstration.

Strippable coating products (from top): CC Strip, ALARA 1146, DeconGel

Equipment used (from top): junction box, Jenny air compressor, Graco spray unit

Equipment used (from top): ICM coating sprayer platform, control station

Spraying CC Strip on concrete panel.



Spraying CC Strip on steel panel.

Spraying ALARA 1146 on steel panel.

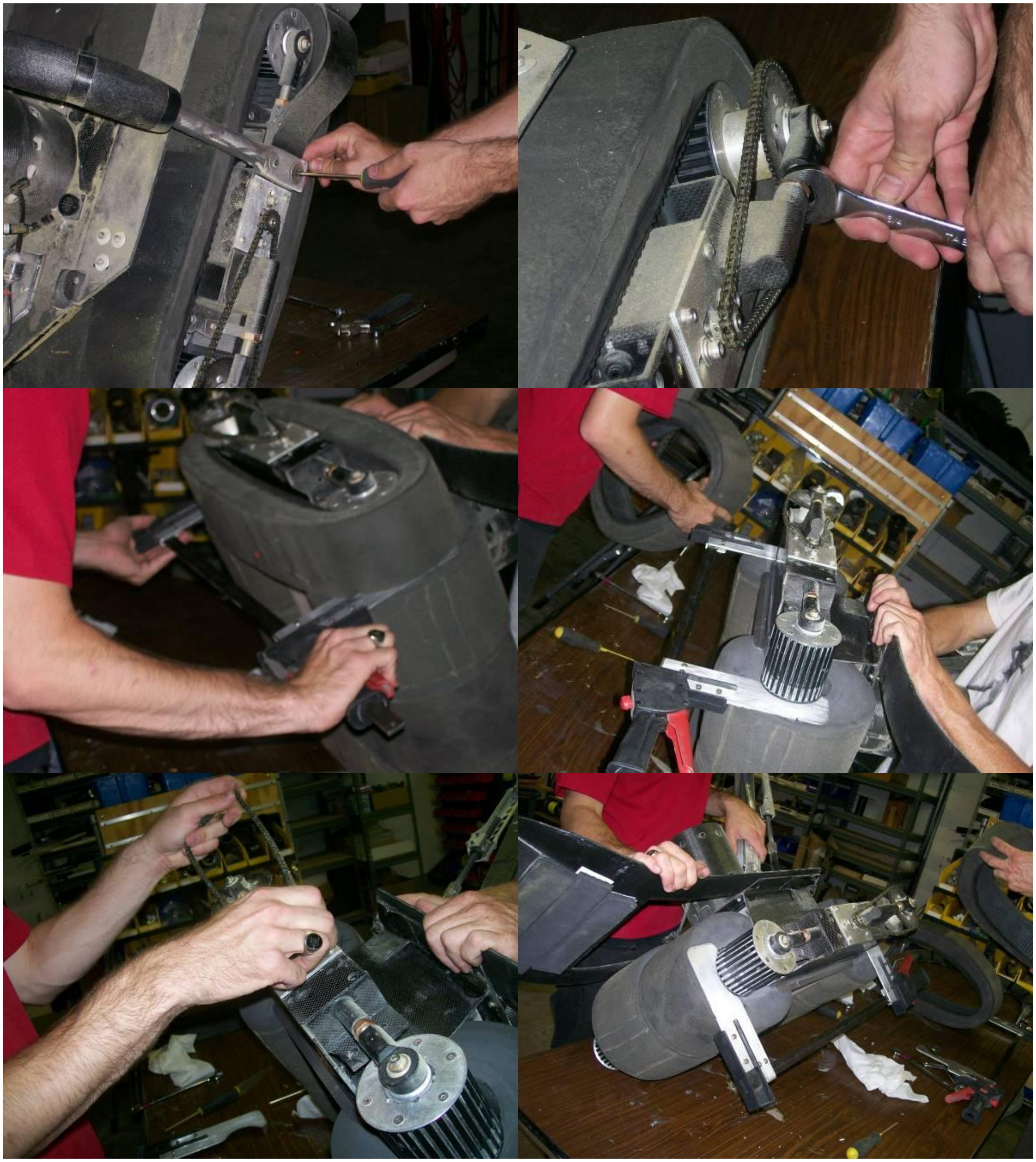
ALARA 1146 sprayed on concrete panel.

Spraying DeconGel on steel panel.

Spraying DeconGel on concrete panel.

Stripping CC Strip from steel panel (applied during demonstration).

Stripping CC Strip from concrete panel (applied during demonstration).



Disassembling the ICM climber.

Disassembling the ICM climber.

APPENDIX B: BEST PRACTICES AND LESSONS LEARNED

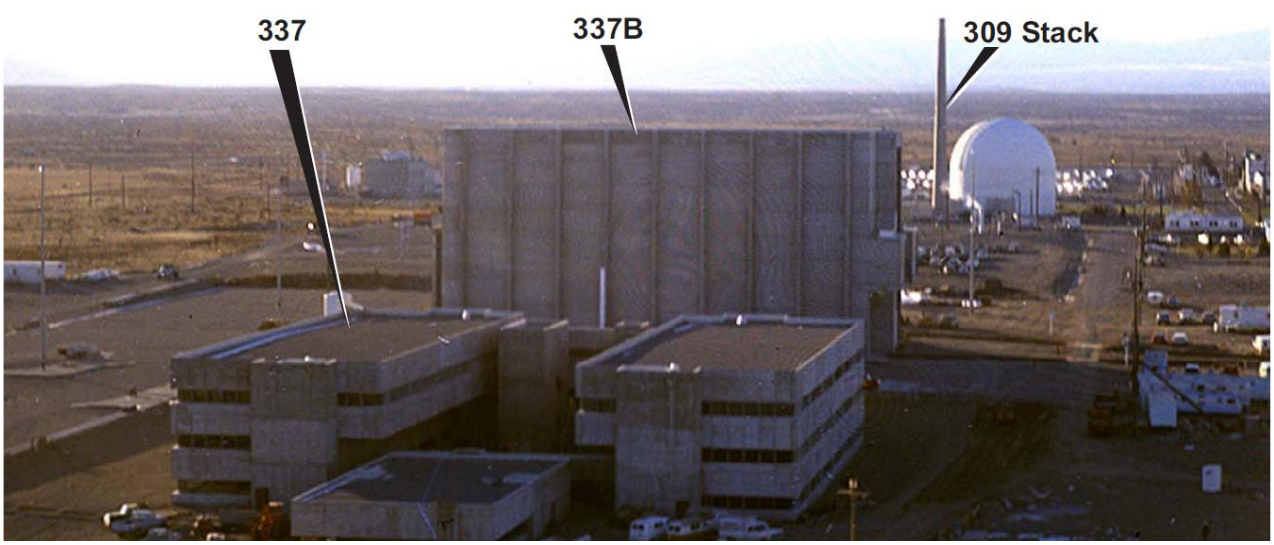
This appendix includes the following best practices and lessons learned developed by FIU in collaboration with EFCOG:

1. Final - Washington Closure Hanford Site Explosive Demolition of Buildings 337 and 337B Best Practice
2. Final - Lawrence Livermore National Laboratory Open Air Demolition of Asbestos Gunite by Using Track Mounted Wet Cutting Saw Best Practice
3. Draft - Savannah River Site 185-3K Cooling Tower Demolition Best Practice
4. Draft - Lawrence Livermore National Laboratory Historical Hazard Identification Process for D&D Best Practice

Best Practice Form

Best Practice Title:	Explosive Demolition of Buildings 337, 337B and the 309 Stack at the Hanford's 300 Area		
DOE Site:	300 Area, Hanford Site	**Facility Name:**	Bldgs. 337, 337B and the 309 Stack
Contact Name:	Bob Smith (D4/ISS Director, Washington Closure Hanford) Daniel Beckworth (WCH, Subcontract Engineer) Thomas Kisenwether (WCH, 300 Area Subcontracts Manager)	**Contact Phone:**	Daniel Beckworth (706) 833-0342
Contact Email:	drbeckwo@wch-rcc.com bdsmith@wch-rcc.com	**Interview Date:**	11/11/2010
Interviewed by:	Leonel Lagos, Peggy Shoffner, Lee Brady	**Transcribed by:**	Heidi Henderson and Leydi Velez

Brief Description of Best Practice:



On October 9, 2010, Buildings 337, 337B, and the 309 Exhaust Stack located in the 300 Area at the Hanford Site, were safely razed by explosive demolition. The 337 facility and adjacent buildings were built in the early 1970s to support the Fast Flux Test Facility and the Liquid Metal Fast Breeder Reactor Program at Hanford. The 309 Exhaust Stack was utilized at the Plutonium Recycle Test Reactor (PRTR) during the 1960's to support development of the plutonium fuel cycle. The proper application of the demolition technique combined with qualified and experienced management, subcontractors and proactive communication with all parties involved contributed to the success of this project.

Summary:

Buildings 337 and 337B were two adjacent facilities built in the early 1970s to support the Fast Flux Test Facility and the Liquid Metal Fast Breeder Reactor Program at Hanford. The 337 Building was an office complex and the 337B Building was a high bay facility used at the 300 area the activities carried out at the Pacific Northwest National Laboratory (PNNL). The 337B Building was decommissioned in the late 1990s and the 337 Building was later vacated in the mid-2000s due to its deteriorating condition.

These buildings were architecturally unique in that they exhibited characteristics of an architectural style called Brutalism (large scale buildings with exposed concrete, piping, ductwork and mechanical systems). The 337 Building was a three-story office complex with two identical office wings (50 feet tall, 165 feet long and 50 feet wide). The building's total square footage was 54,118 feet and was constructed with reinforced cast in place concrete columns ranging from 2 to 3 feet thick and precast concrete panels ranging from 8 to 12 inches thick. The 337B Building had a very unique design: 95 feet tall with a foot print of 176 feet long by 76 feet wide and with a 20-foot deep basement which also contained caissons up to 30-feet deep. It was constructed with reinforced concrete columns that were up to 4 foot thick and slabs that were 12 inches thick. Two large bridge cranes were located at the top of the structure. The 337B Building totaled 23,250 square feet.

The 309 Exhaust Stack was constructed in the 1960s and was 12 feet in diameter at the base, 100 feet tall and 10 feet diameter at the top. The stack was constructed utilizing reinforced cast in place concrete 12' thick at the base and 6" thick at the top. The 309 stack was contaminated with fixed low level radiological contamination.

The Washington Closure Hanford (WCH) subcontracted Controlled Demolition, Inc. (CDI), Cavanagh Services Group, and Clauss Construction to successfully implode both buildings on October 9, 2010. Prior to the demolition, two small test blasts were performed to ensure the structures would behave as predicted. The first test blast used approximately 3½ pounds of dynamite on an external concrete panel at the 337B high bay. A second test blast with 1½ pounds of explosive tested an internal column on the first floor of a 337 office wing. The purpose of the test blasts was to verify the explosive loading density and minimize flying debris.

Why the best practice was used:

Industrial safety was the main criteria for choosing explosive demolition over conventional demolition due to the height of the structures and the concrete construction techniques (cast in place and per cast) utilized for the construction of the 337B Building. The explosive demolition also rubblized some building debris, allowed for easy access to complete size reduction of the debris and ensured that all parts of the building were dismantled. Conventional demolition techniques for this building would have included large excavators and high reach excavators for extended periods exposing personnel to industrial hazards which include; unstable building conditions at the end of a working day, flying debris, equipment maintenance hazards, and extended exposures to heavy equipment. Finally, explosives did not require the use of or the costs associated with special heavy machinery such as high reach excavators.

What problems/issues were associated with the best practice and any lessons learned derived as a result:

As for the demolition itself, there were no issues associated with this technique due to the subcontractor selection/qualification, engineering, work planning, and coordination performed prior to the demolition.

Some of the lessons learned derived from the proper management of the explosive demolition were:

1. Selecting managers and subcontractors with the right background and experience in explosive demolition contributed to the successful completion of this project.

2. Maintain proactive communication with stakeholders, including onsite entities and off site entities such as Federal Aviation Administration (FAA) local businesses, and the local community to keep everyone well informed of the plan and schedule.

3. Designate a specific Radiological Control Technician (RCT) and supervisor to help with the flow of the project and work packages and keep everyone on the same page, without the need to retrain new people. In the middle stages of the project, the coordination between the contractor's RCTs and WCH project directors disrupted the flow of the project because WCH had not designated an RCT supervisor. Once resolved, the project was able to move forward on schedule.

4. Development of a good working relationship between the contractor and subcontractor through the utilization of a Subcontract Technical Representative and Construction Subcontract Engineer to facilitate the interfaces between stakeholders, management, site work force and subcontractor personnel.

5. Utilized a Project Start-up Review (PSR) Process to verify that the implosion was ready to be performed. The PSR identified key items for the implosion to take place and included prerequisites that needed authorization to continue with the project. The PSR process involves senior management from development of the PSR checklist through the completion and approval of the PSR checklist items. A copy of the PSR has been enclosed as Appendix A.

6. Development of a detailed step-by-step process checklist to guide the "day of" implosion activities. This checklist was jointly developed by the explosive demolition expert and the contractor. The checklist incorporated site access control activities, explosive arming and detonation, instrumentation set up and data gathering, and site and building safety/stability inspections post implosion. A copy of the process checklist has been enclosed as Appendix B.

7. Work planning activities instrumental in identifying hazards, utilization of hazard controls and providing guidance for the work force to safely perform the demolition preparation activities and the final implosion.

How the success of the Best Practice was measured:

The success of the project was measured in terms of safety of the personnel and timely completion of the project. At the end, the facilities came down exactly as planned and there were no safety issues, for example, with dust control limits, flying debris, heavy equipment incidents, or uncontrolled releases.

The Project did not perform a detailed cost savings analysis of conventional versus explosive demolition for this project. Explosive demolition was chosen for safety reasons. No first aid, recordable, or lost time incidents occurred. There were no releases and the final debris pile was stable and ready for final debris processing and disposal.

What are the benefits of the best practice:

- Safety – Use of explosives significantly reduces worker exposure to conventional building demolition hazards. The explosives ensured that all parts of the building were dismantled; in turn, there were no unstable debris located within the demolition area that would pose a threat to the workers involved in the clean-up process.
- Easy Access - By using the explosive demolition, the building collapsed into its own footprint which provided easier access on-site during size reduction and the clean-up process.
- Cost Effective - Using explosives did not require the use or the costs associated with special heavy machinery for the demolition, increased equipment maintenance, equipment operation and repair labor itself.

Alternative solutions considered:

Conventional demolition was considered; however, given the height and construction of the facilities, explosive demolition proved to be the safest and most cost effective approach.

Additional Information	
Source Links:	http://www.washingtonclosure.com/documents/E1010034_1.pdf
Pictures:	    
Videos:	Videos of the 337B High Bay and adjacent Office Buildings Demolition http://www.youtube.com/watch?v=1r_WsqIcZIA&feature=related http://www.youtube.com/watch?v=zDdXdeFtmnc
Documents:	The following documents are enclosed below: 1. Appendix A: Project Startup Review Checklist 2. Appendix B: Process Checklist for 337 Facilities and the 309 Stack Implosion
Comments:	

Best Practice Form

Best Practice Title:	**Open Air Demolition of Asbestos Gunite by Using Track Mounted Wet Cutting Saw**		
DOE Site:	Lawrence Livermore National Laboratory (LLNL)	**Facility Name:**	B328 Demolition
Contact Name:	Rob Vellinger	**Contact Phone:**	925-200-3181
Contact Email:	RVellinger@TerranearPMC.com	**Interview Date:**	June 18, 2010
Interviewed by:	Dr. Lagos, L.Brady, L.Velez	**Transcribed by:**	L.Brady

Brief Description of Best Practice:

"LLNL's B328 building is a metal structure with a corrugated metal exterior façade. The walls of the structure consist of a corrugated metal exterior surface, a one & one-half inches (1.5") of Gunite, and four inch (4") thick fire bricks subsurface. In addition, there are 6" x 6"x 1/2" tube steel columns and beams for structural support. In order to size reduce the structure and prevent exposure of personnel to asbestos material, a track mounted wet cutting saw with a diamond blade was used.

The use of a track mounted wet cutting saw reduced the need for respirators and additional PPE during this D&D operation (except for the saw operator) and eliminated Health & Safety (H&S) concerns encountered during typical asbestos removal operations. By using this method, the D&D workers were kept at a safe distance during the size reduction operations since the cutting saw was mounted on tracks on the outside wall of the structure. The saw had a thirty-six inch (36") blade and was operated remotely. The saw has an integral cooling system that prolongs blade life, reduced sparks, and minimized dust. A supplemental shroud was constructed out of PVC and fire retardant plastic to capture any over spray and direct the runoff into a catch basin located around the perimeter of the building. Captured water was filtered and transferred into a holding tank for sampling and disposal."

Summary:

Before dismantlement, sampling of firebrick on a burn-building at LLNL led to the discovery of 8% friable asbestos sandwiched material. The outer skin of the structure was made of metal and corrugated metal that dissipated heat. After considering 3 different methods for dismantlement, it was determined that the best option was to cut the building into sections using a diamond blade track mounted wet saw.

This process consisted of multiple cuts using the wet saw. First, the roof was cut off and lifted off the building using a crane. Once the roof was at ground level it was cut into smaller sections. When the wet saw became too cumbersome a hydraulic wet chainsaw was used for the final cut.

Before the removal of wall sections, the building was structurally supported by welding steel members measuring 6” x 5/8” by 8 to 10 feet onto the building. The welded steel supports restricted the building from flexing and/or crumbling thus preventing the asbestos from dispersing in the air. Rather than scabbling the walls of the building which would break-up asbestos making it disbursable into the air, the asbestos was kept sandwiched between the walls. The wet saw cutting, effectively contained the asbestos between the gunite and metal layer. Other sections, including metal, on the building that did not contain asbestos were torch-cut.

Once the wall sections were removed from the building they were placed on a sheet of plastic on the ground. Then the wall sections were cut into smaller sections measuring no more than 8’ for transportation via roadway to landfill. The sections were then separated and double wrapped in plastic.

Although the minimum requirements were already met by having the sections double-wrapped in plastic, they were also placed in Polytech bags to insure that asbestos was fully contained while transporting the sections to the landfill.

Why the best practice was used:

The wet saw was used as it was the best method to control, contain, and prevent the asbestos from becoming airborne and contaminating surrounding areas and personnel.

What problems/issues were associated with the best practice:

1. Originally the plan was to cut the walls into two sections. However the long horizontal cuts were difficult to execute as the building structure would flex and the saw would bind under the weight of the wall. The solution was to cut the wall in sections after it was moved to the ground thereby minimizing the number of horizontal cuts on the building.
2. Rigging was necessary to remove the wall sections from the building. This entailed special equipment including riggers and a crane. Not only did this process contribute to higher cost but also delayed the cutting process. It is paramount that the riggers and the cutting team collaborate together so that once wall sections are cut they can be removed in a timely manner. Other site priorities had a tendency to divert resources from this process and resulted in slowing down the execution.
3. A wet saw was used as the cutting tool in this operation and due to the characteristics of this tool, overspray was present. The track mounted wet saw, similar to a concrete saw, possessed a diamond tip blade and had been tested on a concrete structure prior to starting this project. The wet saw used in this project had never been tested on this particular sandwich type wall construction before. The wall consisted of metal, gunite and fire brick. Cutting metal was a crucial factor because it caused the wet saw to bind, created sparks and slowed down the process.
   Due to the hazards, proper PPE was used i.e. full rain gear, hearing protection, gloves, hard hat, respirator, and personal air monitor.
   Asbestos particulates mix with the water, although there was no asbestos found in the water after sampling because the water was pumped through a cuno filter system. A custom manufactured PVC frame fitted with a fire retardant blanket material helped to prevent overspray. The spray hit the material then dropped into plastic covered hay bale burms setup to capture water. The plastic and hay were easy to fabricate and easy to move. The residual sediment left over was kept wet to prevent contaminants from being dispersed in the air.
   Water was then pumped from the burms through cuno filters and stored in retention tanks. The cuno filters successfully captured particulates and regulators approved the disposal of water into the sewage drain after reviewing sample results.
4. Although the cumbersome PPE was stressful on the body while performing work on the lift, it was better to make cuts from the outside of the building rather than performing work inside the building and having broken firebricks dislodge and injure workers.
5. The building's metal exterior walls were painted with lead based paint. The lead paint was removed using a paint remover. Because lead is hazardous a respirator was worn while performing the work and added time and cost to the demolition process. It was necessary to remove the paint because the bar stock needed to be welded on the exterior of the building to prevent flexing while being lifted with the crane.
6. When using a track mounted saw there is a track that is mounted to the building. The length of track available was 3', 8' and 10'. There were not enough support brackets for continuous track setup. Unfortunately the brackets weren't commercially available due to the age of the saw. The saw was purchased 15 years ago and the company has since gone out of business. This limited our ability to move the saw around from cut to cut without losing setup time.

How the success of the Best Practice was measured:

Two factors contributed to measurement of this project's success:

1) Time required to complete demolition safely. While this was initially planned as a six week activity, difficulties with the saw and other processes contributed to extending the timeline.
2) Safety of workers was a key consideration throughout the project and these practices resulted in a safe work process, minimizing worker exposure to potential hazards.

What are the benefits of the best practice:

The use of the track mounted wet saw allowed the walls to be cut and removed while keeping the asbestos contained between the gunite and metal layer of the building. This method prevented asbestos contamination to surrounding areas and personnel.

The use of hay bales covered with a plastic sheet to capture water was very effective and a good way to capture overspray water. Once filtered the water could be disposed of through the sanitary sewer system.

Alternative solutions considered:

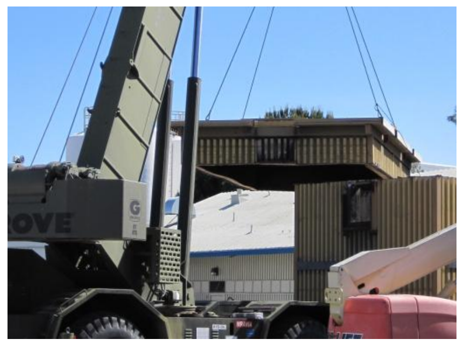
1. Alternative Method 1 was to go inside the building and set-up air hogs then scabble (or chip-out) the firebrick in order to get to and remove the asbestos layer. Once done the metal skin would be demolished as a regular building. However obtaining the Brokk unit was problematic. The Brokk unit was too expensive to purchase and would have to be rented. Obtaining the equipment proved challenging, given the proposed project schedule, and also would require a specialized operator.

   Safety concerns: Although the Brokk unit is remotely operated the bricks on the structure measured 4'x4' and 4" thick weighing approximately 700lbs. If these bricks fell on a person or equipment it would cause extensive damage or personal injury. Another safety concern was that asbestos exposure levels would have required an airline respirator for workers to work safely.

2. Alternative Method 2 was to tent the entire building. This process would require that all equipment be moved inside. There would be an operator inside with a negative environment and the building would be demolished in a sort of bubble created by the tent.

   Building the tent structure would have required a structural engineer to design and approve. How to pull a negative environment and be sure that the tent structure would not implode on itself was questioned. It was also to be noted that the building was in a confined area with other buildings in close vicinity, making it difficult to construct an over-sized structure. Another conflict was the waste that this process would produce as equipment such as the enclosure structure, and excavator would need to be cleaned or it may be deemed as asbestos waste.

Due to the elevated costs and health concerns affiliated with these alternatives it was concluded that the best method was to use a diamond blade track mounted wet saw for cutting the building into pieces and then disposing of the building in sections. This was the safest alternative to both workers and the environment.

Additional Information	
Technology Links:	
Vendor Links:	
Videos Pictures:	   

Comments:

Best Practice Form

Best Practice Title:	**185-3K Cooling Tower Demolition**		
DOE Site:	Savannah River Site	**Facility Name:**	185-3K Cooling Tower
Contact Name:	Bill Schaab	**Contact Phone:**	716-984-7566
Contact Email:	bschaab@americanDND.com	**Interview Date:**	9/16/2010
Interviewed by:	L.Brady (article), DOE Fellow	**Transcribed by:**	L. Brady, DOE Fellow

Brief Description of Best Practice:

Savannah River Site's (SRS) massive K Cooling Tower was safely demolished on May 25, 2010 as part of the site-wide Footprint Reduction Initiative funded by the American Recovery and Reinvestment Act (ARRA). Before the demolition of the cooling tower concrete structure, all pumps, motors, switch gears, and control rooms were removed.

Perfect planning, proper design, flawless execution, and a cooperative team effort from the DOE, Savannah River Nuclear Solutions, Wackenhut Security/Safeguards Personnel, American DND, Inc. and Controlled Demolition, Inc. (CDI) and LVI Services of North Carolina Inc. (LVI) helped ensure a safe, on time and uneventful delivery of the explosive demolition.

Summary:

The 185-3K or "K" Area Cooling Tower, built in 1992 to cool the water from the K Reactor, was no longer needed when the Cold War ended. The cooling tower became obsolete and no other economical use was available due to its unique and dedicated design and location. The DOE decided to demolish the cooling tower to eliminate ongoing carrying costs to taxpayers and reduce the footprint of unnecessary facilities at SRS.

SRNS subcontracted to American DND, Inc. who further subcontracted Controlled Demolition, Inc. (CDI) and LVI Services of North Carolina Inc. (LVI) to successfully implode the second largest cooling tower ever demolished, worldwide, on May 25, 2010. American DND teamed with CDI due to its more than six decades of experience in the handling of explosives. For the debris cleanup effort, American DND teamed with LVI, who brought extensive resources and heavy equipment to perform size reduction and load-out of the resultant debris pile.

Approximately 3,900 holes were drilled in the cooling tower to place explosive charges. Over 50% of the holes were located 120 feet above grade or higher. Over 1300 pounds of explosive were used and 13000 feet of detonating cord was needed.

Why the best practice was used:

The DOE and SRNS selected implosion as the safest approach to ensure the fewest number of man hours at risk for demolishing this unique structure at one of the DOE's premier facilities.

CDI had previously imploded the largest cooling tower ever demolished at the former Trojan Nuclear Station in Rainer, Oregon. CDI's explosive Demolition Plan worked flawlessly for the Trojan Project and CDI brought those lessons learned forward to enhance the design and implosion of the SRS Cooling Tower.

What problems/issues were associated with the best practice:

The use of explosives on any DOE site poses unique challenges for coordination, logistics, permitting, security and safeguards. SRNS's and American DND's onsite Project Managers, coupled with CDI's Management Team, all worked diligently for three months to complete all permitting, submittals, Task Specific Packages, Work Plans, Activity Hazard Assessments, explosives permitting, designs and layout to help ensure flawless project execution.

Due to the height and configuration of the Cooling Tower, typical self-propelled man-lifts could not be utilized for drilling at all of the explosives locations. CDI designed a crane lifted man-basket for the drilling of the holes and placement of explosives and cover materials from elevations 100' to 250' above grade. It was positioned with a 150-ton Linkbelt crane with 300' of boom and jib.

Due to the height of the Tower, the Federal Aviation Administration had to be notified as the strobe lights affixed atop the tower would soon no longer be visible and the tower, which was once a landmark, would no longer exist.

There was a health concern with the potential carcinogenic effects of silica to the workers performing demolition and subsequent load-out activities. To manage this risk, American DND implemented an extensive Silica & Respirable Dust Air Monitoring Program. The Industrial Hygiene & Safety Team of American DND implemented a well designed and comprehensive Respiratory Protection Plan and Personal Air Sampling Monitoring Program to ensure worker protection on this complex multi-employer work site.

In addition to the air monitoring, noise was also a concern. The use of large pneumatic drills, hydraulic hammers, electric drills, grapples and concrete pulverizers on this job site are some of the most extreme and loudest demolition machines in the industry and presented a challenge for the safety team.

How the success of the Best Practice was measured:

Following the principle that "Prior Proper Planning Prevents Poor Performance" paid big dividends in the safe and successful performance of this project.

The controlled failure of the massive cooling tower into its own footprint was textbook and the resultant debris pile was well-fractured and neatly contained as a mere 1% of the tower debris came to rest outside the Cooling Tower Basin footprint. The entire operation went perfectly from every perspective.

The tower took 8 seconds to fall from the time of "fire" to the top ring hitting the ground. The dust cloud was harmless as it passed over unoccupied site areas and was fully dissipated in approximately 12 minutes. The seismic impact was less than 1/5th the allowable limit for 'peak particle velocity.'

The project was also successful due to the 7000 man hours without a Lost Time Accident and achieving a Zero Incident Rating.

What are the benefits of the best practice:

SRNS, American DND, CDI and LVI all contributed their experience and expertise to the successful demolition of the SRS Cooling Tower. The benefits to this best practice are a safe, on schedule, controlled and efficient demolition of the 185-3K Cooling Tower.

Alternative solutions considered:

The American DND options included three different implosion designs with three different blasters and multiple options for recycling the materials as part of an overall approach and comprehensive plan for the work.

Additional Information

Technology Links:	
Vendor Links:	
Videos Pictures:	

CT before reduced CT during reduced

CT after reduced CT aerial after reduced

CT aerial at completion

Comments:

Best Practice Form

Best Practice Title:	**Historical Hazard Identification Process for D&D**		
DOE Site:	LLNL	**Facility Name:**	N/A
Contact Name:	Paul G. Corrado	**Contact Phone:**	925-423-2152
Contact Email:	corrado1@llnl.gov	**Interview Date:**	3/21/2011
Interviewed by:	L. Brady & H. Henderson	**Transcribed by:**	L. Brady & H. Henderson

Brief Description of Best Practice: (Provide a short, "abstract-like" description of the best practice)

Facility hazard identification is the critical first step in the Decontamination and Decommissioning (D&D) process. The hazard identification process presented here is the result of eight years of refinements at the Lawrence Livermore National Laboratory (LLNL). The process is not presented as a one-size-fits-all solution. The current process at LLNL can be used as either a starting point for applicability to other U.S. Department of Energy (DOE) sites without a process in place, or as a benchmark for other sites to evaluate their current processes. It is similar to all planning processes in that it is a living document, changing with the experience of use, new requirements, and lessons learned.

The process does not limit itself to hazard identification since the effort is also intended to provide the technical data and information needed to assist in the production of a D&D project execution plan as well as a facility hazards identification map. This existing process identifies four broad categories of information resources including: facility information, hazard information, environmental information, and general information related to the facility.

The use of this process at LLNL has led to both a level of confidence in hazard identification and a defensible level of due diligence, without excessive sampling and characterization. The hazard identification map has also proven to be an efficient and effective way to communicate existing conditions, potential areas of contamination, and a guide for both sampling and project plans.

Summary:

The Historical Information Process presented here deals first with the justification and elements of the process. The discussion then centers around four major categories of information. How this information is gathered, analyzed, processed, and used is the next phase of the discussion. Examples of the steps in the process and the documents used to gather and organize the data are then shown. The results of this effort are provided to the project manager in two formats. The first is the binder(s) containing the collected information in a systematic format. The second is a hazards map, which summarizes and graphically depicts the hazard information contained in the binders. The project manager uses this information as a baseline to start the project execution plan. Subject matter experts use this information as a starting point for sampling plans.

The Historical Hazards Identification Process for building D&D as detailed in Figure 1 of the Appendix, begins with the D&D Information Manager being given a project with an identified scope and approximate due date. The required data and information is then researched, organized, and placed in binders. Implementation of the Historical Information Process is the first critical step in the demolition of a facility. Many of the other project planning processes cannot take place without this initial research being completed. Potential hazards need to be identified and the potential consequences of their presence evaluated.

Other facility related information must also be collected and organized. These include data related to the management of the facility itself. Facility drain reports, environmental permits, Storm Water Pollution Prevention Plans, and sub-surface information, are examples of each type of data. The building's master equipment list, telecommunications resources, information and data management files must also be taken into account during project planning. Certain specialized facilities may have high-pressure lines and unique cabling and conductors that have been deactivated but not yet flushed and cleaned. Other organizations such as Archives and Security provide unique perspectives, adding to the knowledge base of the project planning data.

Experience has shown that the three most important sources of information are: personnel interviews, historical Incident Analyses and Occurrence Reports, and facility hazard history. Of these three, personnel interviews are by far the most valuable. A more detailed discussion of the personnel interview process is presented in the Appendix.

There are times when the historical research associated with a facility is placed on hold, and a project is held in reserve, or "shelved". It can then be reactivated when/if required. After the project is completed, information in the form of historical information binders, containing both the facility's historical information and the completed project information is taken to LLNL Archives for final disposition. Identifying information sources, documenting the contacts, and implementing a system of cross checks provides a solid basis for a judgment of due diligence.

It should be noted that this process can be automated to some extent by scanning and storing digitally the collected materials. Scanning documents, adding metadata, and storing takes time and resources, but improves the ability to search for specific topics. Digitizing, although a good aid to access, adds significant work and cost down the line for continual migration as electronic media change. Since planning, obtaining funding for and execution of D&D projects can be a long term process, LLNL places an emphasis on use of hard copy documentation.

Why the best practice was used: (Briefly describe the issue/improvement opportunity the best practice was developed to address)

The Historical Hazards Identification Process is a great starting point for applicability to other U.S. Department of Energy (DOE) sites without a process in place, or as a benchmark for other sites to evaluate their current processes. This existing process identifies four broad categories of information resources including: facility information, hazard information, environmental information, and general information related to the facility. The use of this process at LLNL has led to both a level of confidence in hazard identification and a defensible level of due diligence, without excessive sampling and characterization

What problems/issues were associated with the best practice: (Briefly describe the problems/issues experienced with the initial deployment of the best practice that, if avoided, would make the deployment of this best practice easier the" next time".)

It is safe to assume that it is prohibitively expensive to sample and test for all potential hazards in every facility slated to be demolished. The issue then becomes how is the breadth of the sampling plan and characterization study to be rationally limited while meeting the legal and ethical requirements for due diligence? The answer to this question is clear. Have a hazard identification process in place and use that process, not to simply identify the hazards, but to document, categorize and map hazards in a way that can be easily and clearly displayed so that all project personnel can use the information.

How the success of the Best Practice was measured: (What data/operating experience is available to document how successful the best practice has been?)

Hazard identification based on historical data gathering can be critical in ensuring safety and cost-effectiveness. On one project, without this process in place, detonatable quantities of shock sensitive crystallized perchloric acid inside a fume hood would not have been identified. According to an on-site explosives expert, the first 40 feet of the building could have been blown off. This could have resulted in both fatalities and off-site radiological contamination.

The success of the Historical Hazard Identification process is measured by the completion of D&D projects which are safe and cost-effective.

What are the benefits of the best practice: (Briefly describe the benefits derived from implementing the best practice.)

The principal purpose of this effort is to keep people from being injured or killed. Early hazard identification will lead to more efficient, compliant, and cost effective project planning and execution. While there is no set schedule, it is advisable to start facility hazard research early in the scoping process of potential D&D projects. As time passes it becomes more challenging to access records and contact former employees.

Alternative solutions considered: (Other solutions to the issue/improvement opportunity considered prior to implementing the best practice?)

There are no alternative solutions as the Historical Hazard Identification process is similar to all planning processes in that it is a living document, changing with the experience of use, new requirements, and lessons learned.

Additional Information	
Technology Links:	
Vendor Links:	
Videos Pictures:	
Comments:	

Attachment to Historical Hazard Identification Process for D&D Best Practice Form

Facility Designation/Organization File Review

The following sources of information are critical to the identification of a facility's hazards. The first task is to identify the facility's unique designator, both current and historical. At LLNL, facilities are assigned building numbers and these have changed over time. Facilities could have a designation dating back to WWII Naval air station era, or a different number before June 12, 1967, when all the facility numbers were changed. This change renumbered all of the facilities in order to place them in blocks for emergency response purposes.

The second task is to review the previous site plans, using the data from the facility number research as a starting point. The third is a review of the on-site organization files. The salient portions are then copied and placed in 3 ringed binders.

Hazards Information

One of the three most important sources of information is files from an organization that oversees worker safety and health. This organization keeps facility specific hazard information in paper files. Finding the source of this type of information can be a worthwhile exercise. These files include:

- Screening Reports which tell the current hazards associated with the facility
- Non-nuclear safety basis documentation yields a facility hazard classification
- Facility files identify specific facility hazards
- Fire Department files may identify historic hazards
- RAD Survey 10 CFR 835 information
- HEPA filter database information
- Asbestos Report
- High-pressure database identifies high-pressure equipment in the facility

Restricted Database Information

Some of the hazard-related facility information is in restricted databases. Inquiries are made from several sources. The process for accessing this information needs to be done on a site-by-site basis. The following is a partial listing of these sources at LLNL.

- Occurrence Reports
- Incident Analysis
- Classified Programmatic Hazard Information

Environmental Information

The on-site environmental organization provides important information from several internal sources. This information provides the required due diligence effort regarding almost all of the environmental information provided to projects. The balance of the information includes chemical tracking information and the hazardous waste information related to that facility. The environmental organization at LLNL provides information from the following sources:

- Facility Drain Reports
- Operation's files review
- Environmental Operations Group Spill Reports
- Environmental Permits
- Storm Water Pollution Prevention Plan
- Retention Tank Reports
- National Environmental Policy Act information
- Life-cycle chemical tracking
- Subsurface information
- Hazardous Waste Management Records

Facility Information

This information is not always specifically related to hazards. It is, however, required to produce a project execution plan. Finding and documenting the sources of this type of information, can be a significant time saver. Types of sources/information may include:

- Facility Number Designation (current and historical)
- Master Equipment List
- Phone/ Building Alarm Resources
- Information and Data Management facility files
- Floor plans/ Room size/area sheets/Historical Site Plans/ Photogrammetric maps
- Facility Condition Assessment Survey (CAS)
- Facility Photos-recent and historic
- DOE's Facility Information Tracking System (FITS)
- Issues Tracking System (ITS) Deficiency tracking information

General Information

This category of information provides a place for those data that do not readily fit into the other categories. They include:

- Personnel Interviews
- E-mails/project correspondence
- Property Management Database
- Archives
- Security
- Financial History- used to identify past and current facility 'owners' and types of use
- Records Management- organizational information by facility designation

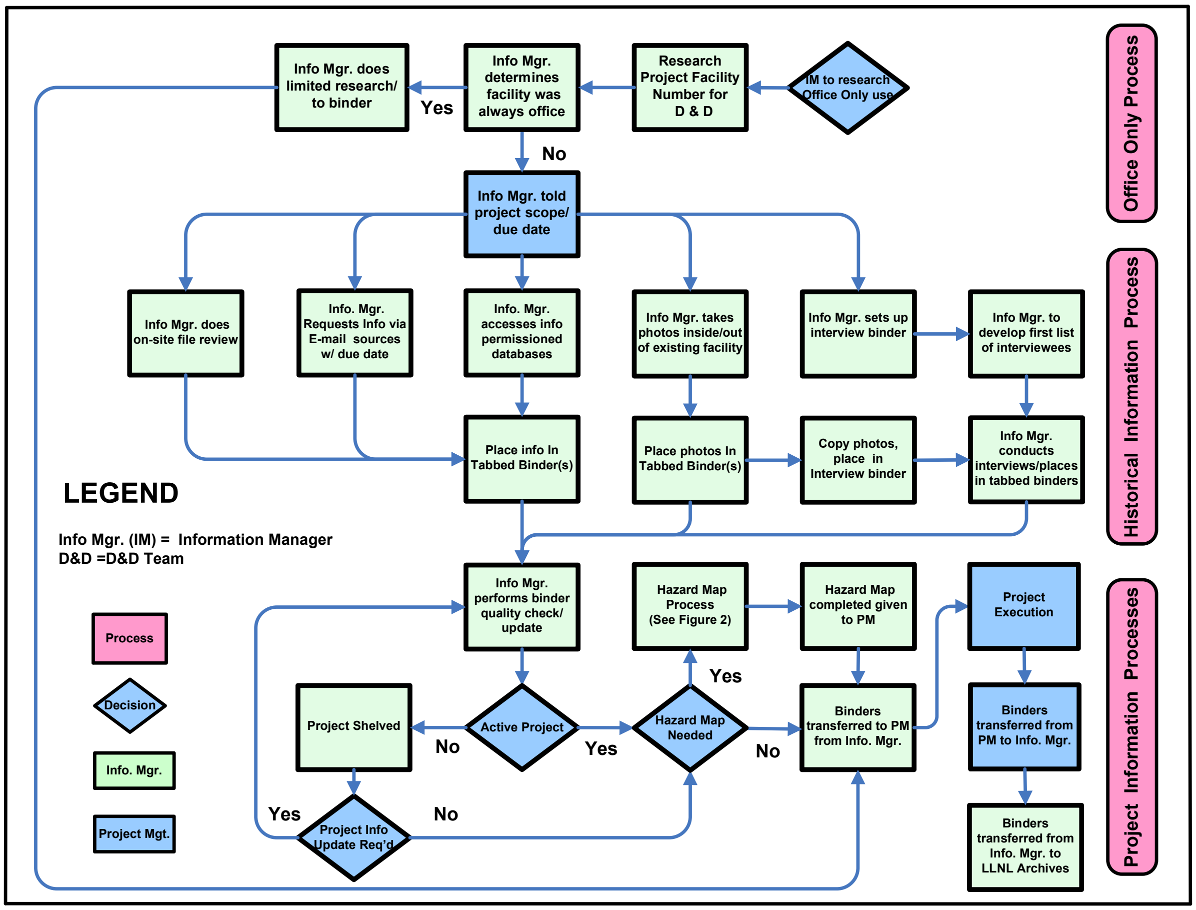


Fig. 1 LLNL Historical Information Process

PERSONAL INTERVIEWS

Personal interviews have been identified as a critical source of facility hazard information. The following guidelines can be used to facilitate the interview process. They are broken down into the following 3 phases:

Phase 1. Pre-Interview Guidelines: Develop interview materials and identify contact information for interviewees.

Phase 2. Guidelines For Conducting Interviews: Conduct interviews, adding additional interviews, when warranted, as the process progresses.

Phase 3. Post Interview Guidelines: Compile the interviews, contact data, and place in tabbed historical information binder(s).

Phase 1. Pre-Interview Guidelines

- The identification of interviewees and the knowledge of how to get in touch with them should be addressed when names are provided.

- Typical inquiries of on-site staff regarding other persons familiar with the facility include:
    - Are they still on-site?
    - Do you know where they live or lived?
    - Do they still work here part-time?
    - If retired, did they move out of state?
    - Are there others who might know where they are?
    - Use "Zabasearch.com" which prompts for name and state of residence to find contact information for retirees.
- Work on having good relations with everyone, especially when identifying contacts at the initial phase of the effort.
- Retirees have some of the best facility hazard knowledge available. If a person is identified repeatedly as someone who knows a lot about a facility, keep calling, and be very polite.
- To identify a persons address use local government land records if you suspect they live in a specific city/county. If they own property, you can generally get important contact information from county/ city clerk's office.
- Be open to doing a "cold call" if the person in question has important and unique knowledge, even if they have "an ax to grind".
- Suggest you bring a floor plan(s) of the facility and other "memory jogger" materials such as a list of typical contaminants (See Figure 3) and especially recent facility photos.
- Multiple copies of floor plans are required so that interviewees can mark directly on them, identifying areas of concern and possible contamination.
- Before the interview make up a contact sheets, documenting the interviewee's personal information, and answers to open-ended questions regarding potential hazards within the facility. Include a question identifying who else might be contacted regarding the facility. (See Figure 2)
- Be willing to go where they live, meet in the middle, whatever it takes to get the interview.
- You may not have a travel budget, and may be forced to conduct phone interviews. If possible, e-mail the questions and related interview material prior to your call. Consider this option only as a last resort. Historically, responses using this approach have been disappointing in both quality and quantity of information.
- Come to the interview with knowledge of the facility after having, for example, taken photos and having researched what went on in the facility over a period of years.
- Bring different color felt-tip pens and hand them to the interviewees so they can mark directly on the documents you bring.
- Be on time and respectful of their time, especially on-site personnel.
- Give both the appearance of being organized and be organized/prepared for the interview.
- A list of typical contaminate types on a single sheet of paper can be a very useful memory jogger. (See Figure 3)
- Consider using a spreadsheet with contact information, date/time contacted, and status/remarks to document calls and allow for follow up.
- Consider setting up a database and asking the interviewee what other facilities he/she has hazard knowledge of.
- Estimate the number of interviews that may be appropriate for this facility. Complexity, size, age, types of contamination, and existing documentation are all relevant issues to address when deciding how many initial sets of questionnaires and graphics to make.

- The identification of interviewees usually starts with the identification of current facility management staff with the greatest familiarity with the building, who, when interviewed, may identify others who have personal knowledge of the potential hazards in the facility.
- These interviews usually start with on-site staff, and as the list develops, often include retirees.

Phase 2. Guidelines For Conducting Interviews

- Show your official credential when visiting retirees off-site as a form of identification and reassurance.
- Demonstrate that you appreciate the fact that they are willing to talk to you. Remember that opinions are formed in the first 30 seconds of the interview that will last a long time.
- Make sure they know you like seniors and value their knowledge, experience, and information.
- Be someone they can trust.
- Briefly explain the steps in the process.
- If they have extensive knowledge of the facility, at the initial contact, ask if the person would be willing to walk through the building. Though this can be a great memory jogger, unless photos and notes can be taken simultaneously, generally with the assistance of a third person, capturing the information this way can be a challenge.
- Listen carefully, and ask leading, open-ended, clarifying and follow-on questions.
- Make friends with interviewees; you may need them again for other facilities.
- If possible, bring a third party to take down the information, so you can be a better listener/interviewer. Trying to write down what is being said while listening is difficult.
- Take down the information for the person who is not at the interview.
- Write so others can read it, easily. Sometimes it means asking the interviewee for just a minute to collect that information.
- When the interview is completed, re-read your notes aloud to the interviewee and verify that you have captured the issues, accurately.

Phase 3. Post Interview Guidelines

- Place all interview documents in a tabbed binder as soon as they are completed.
- If follow-up is needed, schedule it as soon as possible.
- Make sure to write down the names of the other persons to contact when you get back to the office on the contact sheet.
- If more than 2 interviewees have the same person on their, "to be contacted" list, work hard at finding and interviewing that person.
- Consider enough interviews have been done when little or no new information is forthcoming.
- Give them your business card, and ask them to contact you should they think of anything else.
- Send hand written thank you notes the same week as the interview.

Contact Sheet ***(Facility Number)***

Person contacted: ______________________________

Title: ______________ Facility Affiliation from __________ to __________

Org. Representation: ______________________________

Date Interviewed: ___/___/___ by ______________________________

Interview type: Personal_____Phone_____E-Mail_____Site Visit__________

Contact Information:______________________________

What were your job responsibilities?

When? Do you remember any spills, fires, accidents, explosions, and unusual occurrences?

What parts of the building would you be concerned about if you or someone you knew is going to work on this demo?

Who do you think we can contact for more information on the building?

Fig. 2 Interview Contact Sheet

Since it is impossible to list all potentially hazardous substances, the following broad hazard categories and the most prevalent hazardous materials commonly found within each category are listed below. The following form is used as both a memory jogger and a checklist.

Classification of Chemicals/Contaminants

- Organic Chemicals
  - Polychlorobiphenols (PCB)
  - Chloroform
- Solvents (a specific grouping of organic chemicals) (examples)
  - Acetone
  - Toluene
  - Methanol
  - Perchloroethylene (PCE)
  - Trichloroethylene (TCE)
  - Methyl ethyl ketone (MEK)
- Inorganics (examples)
  - Cyanide
  - Boron
  - Silicon
- Heavy Metals (a specific grouping of inorganic chemicals) (examples)
  - Mercury (Hg)
  - Lead (Pb)
  - Arsenic (As)
  - Selenium (Se)
  - Beryllium (Be)
  - Aluminum (Al)
  - Iron (Fe)
  - Lithium (Li)
  - Gold (Au)
  - Silver (Ag)
  - Cobalt (Co)
  - Chromium (Cr)
- Acids (examples)
  - Nitric Acid
  - Hydrochloric Acid
  - Sulfuric Acid
  - Perchloric Acid (if acids were used ask about perchloric, specifically)
- Radionuclides (examples)
  - Uranium-234, 235, 238
  - Thorium-233, 234
  - Plutonium-238
  - Neptunium
  - Cesium-137
  - Cobalt-60
  - Tritium (H3)
  - Strontium-90
  - Europium 152, 154, 154

Fig. 3 Classification of Chemicals / Contaminates

The following Hazard Map process, Figure 4, is typical for the LLNL site. Identifying and tailoring a hazard map process to a specific project can be a useful exercise.

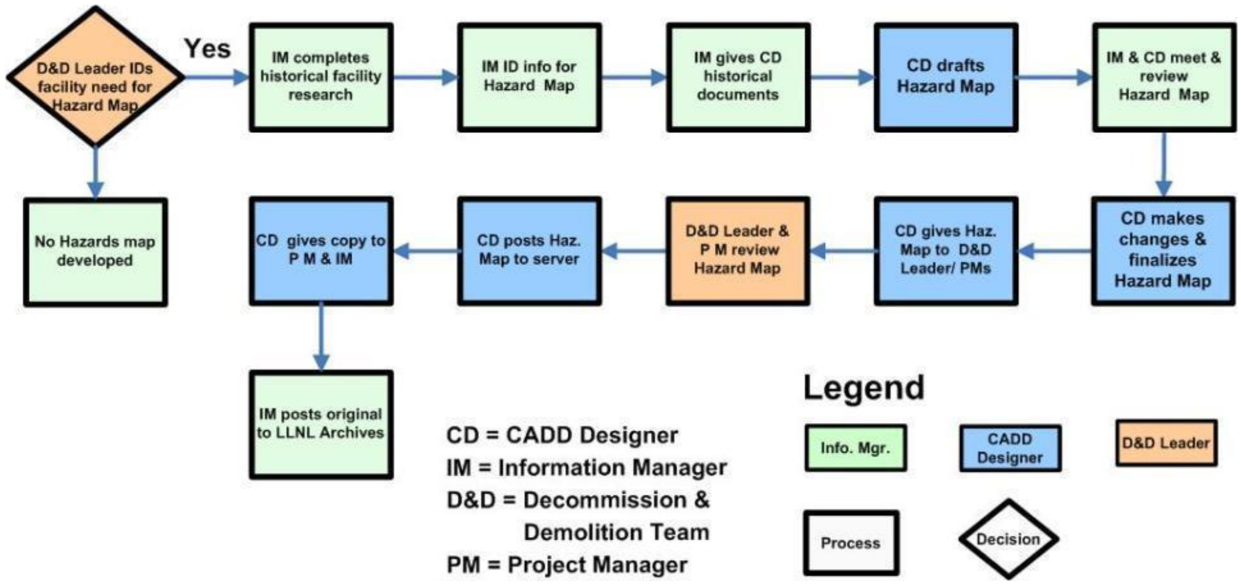


Fig. 4 Hazard Map Process