WM'00 Conference, February 27-March 2, 2000, Tucson, AZ

COST COMPARISON OF COMPETING D&D TECHNOLOGIES

Steven J. Bossart
U.S. Department of Energy
National Energy Technology Laboratory
Morgantown, West Virginia

Richard W. Walker
RIO Technical Services
Morgantown, West Virginia

Abstract

Through the end of October 1999, the DOE's Deactivation and Decommissioning Focus Area (DDFA) has demonstrated 75 improved/innovative decontamination and decommissioning (D&D) technologies in its seven Large-Scale Demonstration and Deployment Projects (LSDDP) and has successfully deployed about 50 of these technologies over 150 times as a result of their benefits compared to competing baseline technologies. These benefits have included reduced cost, improved safety, accelerated schedules, and reduced radiation dose to workers. At least 30 of the improved/innovative D&D technologies showed a cost reduction of greater than 20% compared to the competing baseline technologies. As a result, many of these improved/innovative technologies have become the new baseline technologies at DOE sites. These technologies span a wide range of D&D applications including facility characterization, metal and concrete decontamination, asbestos abatement, waste disposition, facility and equipment dismantlement, and worker safety and health.

Introduction

In 1995, the DOE's Deactivation and Decommissioning Focus Area (DDFA) initiated a new approach called "Large-Scale Demonstration and Deployment Projects (LSDDP)" to demonstrate, evaluate, and deploy innovative and improved D&D technologies within ongoing deactivation or decommissioning projects at DOE sites. For each technology demonstration in an LSDDP, the innovative/improved decontamination and decommissioning (D&D) technology is evaluated side-by-side with a competing baseline technology. During the demonstrations, performance data is collected on the innovative/improved technology and baseline technology, and the data is evaluated to assist D&D project managers and planners in determining whether an improved/innovative technology has cost and other performance advantages over the baseline technology. Typically, five to twenty-five innovative/improved technologies are demonstrated in each LSDDP.

An Integrating Contractor (IC) Team manages the technology demonstration for each of the LSDDPs. Typically, membership of the IC Team includes three or more experienced D&D firms, DOE site contractors, and universities. The management of the LSDDP by multiple D&D organizations provides a balanced project management approach since different firms use different baseline technologies and have different perspectives on the benefits and risks of using improved/innovative technologies. The IC Team screens and selects the innovative/improved technologies for demonstration; identifies the competing baseline technologies; determines the scope and duration of the demonstrations; and evaluates and documents the results of the demonstrations, including preparation of Innovative Technology Summary Reports (ITSR).

An innovative/improved technology is suitable for demonstration in an LSDDP if it is:

- A developed technology that has not been demonstrated at full scale, or
- A new application of an existing technology, or
- A commercial technology that has not been used by DOE for the specific application of the demonstration.

The LSDDP provides realistic technology performance data because the demonstrations occur within DOE's ongoing deactivation and decommissioning projects and accomplish necessary D&D work. The LSDDP has proven to be a sound approach to qualify an innovative/improved D&D technology for further deployment within the facility hosting the LSDDP and throughout the DOE weapons complex.

Large-Scale Demonstration and Deployment Projects

The DDFA has seven LSDDPs in its current portfolio. These LSDDPs span a wide range of types of facilities, types and quantities of contamination, scope of D&D projects, D&D technology needs, and project schedules. The DDFA deliberately selected a diversity of LSDDPs in its portfolio to allow a variety of improved/innovative D&D technologies to be demonstrated in the LSDDPs.

Table 1 lists the seven LSDDPs, current status, and number of improved/innovative technology demonstrations completed or projected to be completed within each LSDDP.

Table 1. Large-Scale Demonstration and Deployment Projects

Facility/Location	**Status**	**No. of Demonstrations**
Chicago Pile 5 Research Reactor **Argonne NL**	Completed demonstrations in 1997	23
Plant 1 Uranium Processing Facility **Fernald**	Completed demonstrations in 1998	13
C-Reactor Plutonium Processing Reactor **Hanford**	Completed demonstrations in 1998	20
321-M Fuel Fabrication Facility **Savannah River**	Completed demonstrations in 1999	5
Underwater Reactor Facilities **INEEL**	Scheduled for completion in 2000	16-18
Plutonium Gloveboxes **Los Alamos NL**	Scheduled for completion in 2001	10-12
Tritium Facilities **Mound**	Scheduled for completion in 2001	15-20

Cost Analysis

In order to create an independent and consistent method to evaluate technology cost, the DDFA established an interagency agreement with the U.S. Army Corps of Engineers (USACE). Through this interagency agreement, the USACE performs cost analyses of the innovative/improved and baseline D&D technologies demonstrated in all seven LSDDPs. The USACE uses Micro Computer Aided Cost Estimating (MCACE) Gold software and the Hazardous, Toxic, and Radioactive Remedial Action Work Breakdown Structure (HTRW) in estimating the cost of the innovative/improved and baseline D&D technologies. The HTRW was developed by the U.S. Department of Energy, U.S. Environmental Protection Agency, USACE, U.S. Navy, and U.S. Air Force and has been adopted by each of these organizations for estimating project and technology costs.

Cost estimates for the improved/innovative and baseline D&D technologies are realistic because the technology demonstrations are conducted as part of DOE's deactivation or decommissioning projects, and are developed by USACE in a consistent and unbiased manner. Demonstration data, such as equipment purchase or rental price, production rates, crew size and labor rates, personal protective equipment, waste generation, and utility usage, is used by the USACE to prepare the technology cost estimates. In calculating the cost estimates, the USACE uses site-specific costs for cost elements such as labor rates, waste disposal costs, and work practices. Some costs were not included in the comparison of the baseline and innovative/improved technology if the cost rates would be applied equally to both technologies. Labor overhead, general and administrative expenses, engineering, quality assurance, and taxes on services and materials are examples of cost elements not included in the cost analyses.

Technology costs are segmented into the following three categories:

- Mobilization Cost which includes transportation of equipment and workers to the site; training requirements; and setup and checkout of equipment. Mobilization Costs are not dependent on the amount of D&D work.

- Unit Cost which is the cost of performing the D&D work. Unit cost is reported in dollars per unit of D&D work (e.g., dollars per square foot of survey area, dollars per cubic foot of concrete demolished).

- Demobilization Cost which includes disassembly and removal of equipment, decontamination and release of equipment, and transportation of workers and equipment from the site. Demobilization Costs are not dependent on the amount of D&D work.

The results of the cost analyses are reported in ITSRs for each technology demonstration. Mobilization cost, unit cost, and demobilization cost are reported in tables within the ITSRs. If applicable, a breakeven point or payback period is presented to indicate the quantity of D&D work at which the cost of innovative/improved technology is equal to the cost of the baseline technology. In many cases, the innovative/improved technology consists of equipment that is more expensive than the equipment comprising the baseline technology, but the increased production rate and reduced labor requirements for the innovative/improved technology cause it to be more cost-effective than the baseline technology if the D&D work is greater than the payback period or breakeven point.

Normally, a D&D technology is provided by the vendor in one of three ways:

- Purchase of equipment
- Rental of equipment
- Vendor provides workers and equipment under a service contract

If the DOE site contractor purchases the equipment, the equipment capital cost is included in the unit cost as an amortized cost by estimating the life of the equipment and a usage rate per year using standard USACE cost estimating procedures. If a vendor provides the technology as a service or as rental equipment, the vendor will recover a portion of the equipment capital cost as part of its quoted rate.

Cost-Effective D&D Technologies

Table 2 shows cost results for 26 of at least 30 improved/innovative D&D technologies that showed greater than 20% cost reduction compared to the competing baseline technologies. This figure is segmented according to the technology categories of characterization, decontamination, dismantlement, waste disposition, worker health and safety, and project management.

Table 2. Cost Comparison of D&D Technologies

Improved Technology	Baseline Technology	Unit Cost Improved	Unit Cost Baseline	% Cost Reduction
Characterization Technologies:				
Surface Contamination Monitor	Manual Survey	$.10 / ft^2	$.36 / ft^2	72
Portable X-Ray Fluorescence Spectrometer	Lab Analysis	$2,600 / facility	$10,600 / facility	75
Airborne Laser Induced Fluorescence Imaging	Swipes, Hand Held	$2.18 / ft^2	$3.22 / ft^2	32
Remote Underwater Characterization System	Camera and Radiation Sensor on Pole	$1,086 / 26 surveys	$1,789/ 26 surveys	39
In-Situ Object Counting System	Sampling, Lab Analysis	$56 / location	$140 / location	30
Lead Paint Analyzer	Sampling, Lab Analysis	$54 / sample	$1,533 / sample	96
Infrared Thermography	Mechanical Opening	$622 /tank	$3,650 /tank	83
2-D Linear Motion System	Manual Rad Survey	$.36 / ft^2	$.80 / ft^2	55
Decontamination Technologies:				
ROTO PEEN Scalar & Vac-Pac System	Mechanical Scabbling	$10.41/ ft^2	$18.05/ ft^2	42
Rotary Peening With Captive Shot	Mechanical Scabbling	$10.43/ ft^2	$22.62/ ft^2	54
Concrete Grinder	Mechanical Scabbling	$2.92 / ft^2	$10.47 / ft^2	72
Concrete Shaver	Pneumatic Scabbling	$1.32 / ft^2	$4.05 / ft^2	67
ALARA 1146 Strippable Coating	Pressurized Water	$4.85 / ft^2	$7.45 / ft^2	35
Soft Media Blast Cleaning	Disposal	$4.60 / ft^2	$18.08 / ft^2	75
Dismantlement Technologies:				
Dual Arm Work Platform	Manual Dismantling	$108 / ft	$154 / ft	30
Oxy-Gasoline Torch	Oxy-Acetylene	$.64 / in for 2"	$1.12 / in for 2" metal	43

Table 2. Cost Comparison of D&D Technologies

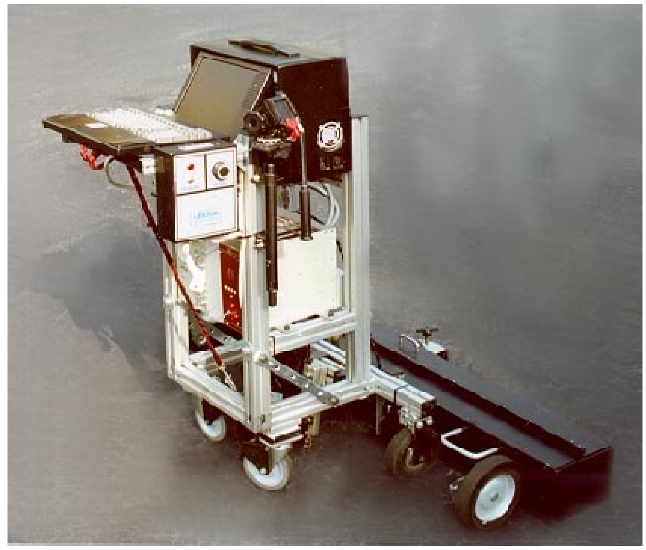
		metal		
Remote Control Concrete Demolition System	Manual Demolition	$17 / ft^3	$254 / ft^3	93
Concrete Dust Suppression System	Fire Hose Spray	$1.70 / ft^3	$8.94 / ft^3	81
RESRAD-Build	Demolition	$133,588 / job	$280,726 / job	52
Diamond Wire, Saw, and Metal Cutting	Plasma Arc Torch	$45,531 / Vessel	$123,391 / Vessel	63
VecLoader HEPA Vacuum Insulation Removal	Manual Removal	$1.32 / ft^2	$2.01 / ft^2	34
Worker Protection Technologies:				
Mobile Integrated Temporary Utility System	Portable Generators	$1.21 / kW hr	$2.00 / kW hr	40
Personal Ice Cooling System	Heat Stress Mgmt PPE w/no cooling	$84 / crew-hour	$243 / crew-hour	65
Automatic Locking Scaffold	Nuts and Bolts Scaffold	$.25 / cf	$.49 / cf	49
Disposition Technologies:				
Alloy Analyzer	Sample, off-site analysis	$19.72 / sample	$1,192 / sample	98
Soft Sided Waste Containers	Metal Boxes	$3.44 / yd^3	$11.20 / yd^3	69

Readers are encouraged to refer to cost details in the ITSRs for each set of technologies in Table 2 to better understand the scope of the demonstration and how costs were determined based on the results. The remainder of this paper will focus on the performance of several improved/innovative D&D technologies that showed greater than 20% cost reduction compared to the competing baseline technology. As a result of the documented cost savings, most of these technologies have been deployed at multiple DOE sites following the LSDDP demonstration.

Surface Contamination Monitor and Survey Information Management System (SCM/SIMS) (6, 11)

The Surface Contamination Monitor (SCM) from Shonka Research Associates can survey horizontal and vertical surfaces for alpha and beta/gamma contamination. The SCM consists of a position-sensitive gas proportional counter mounted on a motorized cart, which can take 400 radiation measurements per square meter. Detector arrays ranging from 0.5 to 5 meters wide are mounted on the cart. The SCM provides the operator with a real-time visual indication of the activity level on a liquid crystal display. Survey data is automatically processed with the Survey Information Management System software. The software combines data from individual strips of detectors to create a uniform grid for the survey area. The data can be analyzed using a wide range of image processing algorithms. Processed survey data can be overlaid on facility drawings. The software automatically generates data reports that meet regulatory requirements for unrestricted release.

The SCM was demonstrated in the Hanford C-Reactor and CP-5 LSDDPs to survey concrete floors for alpha and beta/gamma contamination. Using the SCM to survey the floor and generate reports was approximately 70% less expensive compared to the baseline technology approach of using hand-held instruments. For routine surveys and associated documentation, the SCM was about 5 to 6 times faster for beta/gamma surveys and two times faster for alpha surveys than using hand-held instruments. For free release surveys, the SCM is expected to be at least 16 times faster than hand-held instruments, mainly due to its automated generation of reports.



Personal Ice Cooling System (7, 8, 12)

Delta Temax, Incorporated has developed a Personal Ice Cooling System (PICS), which is a self–contained core body temperature control system that uses ordinary ice water as a coolant and circulates cool water through tubing incorporated into a durable, comfortable full-body garment. Ice is carried in bottles that are worn with anti-contamination suits in a sealed, insulated bag, with a circulating pump attached to a support harness system. An adjustable-rate, battery-powered pump circulates chilled water through the tubing in the suit, enabling the wearer to control the rate of cooling. The ice bottle, pump, and suit weigh only 12 pounds.

During its demonstration in the Fernald Plant 1 LSDDP, workers wore the PICS while scraping paint in Building 68. The temperature inside the building was about 105 °F. The average stay time for workers wearing two layers of Level C protective clothing with respirators under those conditions was about 23 minutes. Stay-time for workers wearing the PICS was about 92 minutes. The capital cost of the PICS with Level C clothing is about $1,600 compared to $210 for one layer of Level C protective clothing. Based on the cost analysis, the increased stay-time for workers using PICS results in a 65% lower cost compared to workers wearing two layers of Level C protective clothing. For each 10-hour shift at Fernald, workers wearing PICS with Level C clothing performed 5.4 hours of productive work in the field compared to only 2.3 hours for workers wearing Level C protective clothing. The increased worker productivity offsets the capital cost of the PICS.

Concrete Shaver (5)

The concrete shaver is a self-propelled, electric–powered, concrete diamond-shaving machine that can remove concrete surfaces with extremely accurate tolerances. The unit has a 10-inch wide shaving drum that is suitable for flat or slightly curved floors. The design for mounting the blades onto the drum results in low vibration levels. Infinitely variable shaving depths from 0.004 inches to 0.5 inches can be achieved. The depth of shaving is set by the use of a manual rotary wheel that is linked to a digital display. The system includes a vacuum extraction unit for dust free operations. The travel rate is also variable, giving a high production rate. The unit weighs 330 pounds and consumes 16 amps of 380-volt to 480-volt, 3-phase power, and has forward and reverse action.

The Concrete Shaver was demonstrated in the Hanford C-Reactor LSDDP to decontaminate a sample room floor. The shaver is more than five times faster than the baseline technology, pneumatic scabbler, for removing contamination from concrete. Because of this increased productivity, the shaver is 67% less costly to operate than the baseline technology. Additionally, the use of the Concrete Shaver reduces worker fatigue compared to pneumatic scabbling due to lower vibration.

Oxy-Gasoline Torch (2, 10)

The Oxy-Gasoline Cutting Torch system from Petrogen International consists of a 2.5 gallon fuel tank with automatic flow shutoff valve, a gasoline supply hose, and a cutting torch. Pressurized oxygen is supplied from standard oxygen bottles commonly used with oxy-acetylene torches. Gasoline is delivered to the tip of the torch as a confined liquid. At the tip of the torch, the gasoline liquid expands to a vapor and is mixed with oxygen to form a combustible mixture. Mixing of gasoline vapor and oxygen in the tip of the torch eliminates back flash in the fuel line, and keeps the torch head cool.

The Oxy-Gasoline cutting torch was demonstrated in the Fernald Plant 1 LSDDP. The Oxy-Gasoline Torch was compared to the baseline technology oxy-acetylene cutting torch, and each torch cut approximately 250 inches of metal components ranging from 0.5 to 4.5 inches thick. One demonstration showed that the Oxy-Gasoline Torch was able to cut through a two-inch thick steel plate in 13 minutes, whereas the oxy-acetylene torch took 27 minutes to cut through the same distance on the same plate. On a four-inch thick plate, the oxy-gasoline torch cut at a rate of 50 inches per hour compared to only 10 inches per hour with an oxy-acetylene torch.

Though the price of the Oxy-Gasoline Torch is approximately $500 to $600 more expensive than the oxy-acetylene torch, it is less expensive to use because it cuts faster and uses less expensive fuel. Independent analysis from the USACE indicates that the oxy-gasoline torch costs about $0.64 per inch and the oxy-acetylene torch costs about $1.12 per inch to cut 2-inch carbon steel. Using the Oxy-Gasoline Torch resulted in approximately a 43% cost savings over the baseline technology.

Portable X-Ray Fluorescence Spectrometer (3, 9)

X-ray fluorescence (XRF) analyzers provide real-time information on the elemental composition of a variety of materials including surfaces, soils, liquids, and thin films. XRF results when atoms of a specific element emit distinguishable x-rays when excited by radiation with an energy slightly greater than the binding energy of the inner shell electrons of the element. Since each element has a different electron shell configuration, the energy spectrum of the x-rays emitted by each element is unique. XRF measures the peak energies of x-rays emitted from samples to identify the elements in the sample. Also, because the intensities of the x-ray emissions are proportional to the number of atoms in the sample, it is possible to determine the concentration of each element.

The TN Lead Analyzer uses a radioactive cadmium-109 source for sample excitation, and it is used to measure lead, arsenic, chromium, iron, copper, zinc, and manganese on surfaces, coatings, and smear samples. The TN Spectrace 9000 uses three radioactive sources and can analyze the elements with atomic numbers between 16 (sulfur) and 92 (uranium), which includes all of the heavy metals regulated under the Resource Conservation and Recovery Act (RCRA).

The TN Lead Analyzer and the TN Spectrace 9000 were used to analyze surfaces, coatings, and smears in the Chicago Pile 5 Research Reactor LSDDP. In this demonstration, the XRF analyzers were compared to the baseline approach of collecting and analyzing samples in a laboratory using acid digestion and atomic spectroscopy. Typically, results are not available for days or even weeks depending on the workload of the laboratory. The portable XRF analyzers are able to provide real-time data in the field. In addition, the cost to analyze samples using the XRF analyzers was only 25% of the cost to analyze samples in the laboratory.

Remote Control Concrete Demolition System (4, 10)

The Brokk Remotely Operated Concrete Demolition System is used to demolish radioactively contaminated concrete during remote D&D operations. The Brokk BM 150 uses a remote-operated articulated hydraulic boom with various tool head attachments. The machine is primarily designed to drive a hammer, has a reach of 15 feet, and can operate up to a 30^{o} gradient. The Brokk can be operated up to 400 feet away via a television monitor. The Brokk was demonstrated at the Janus Research Reactor using a hammer operating at 600 ft-lbs and an excavating bucket.

During the demonstration at the Janus Research Reactor at Argonne National Lab, the Brokk system dismantled about 66 cubic yards of the biological shield wall and the reactor pedestal which are made from reinforced concrete. In 16 days, the Brokk system was able to dismantle the biological shield wall and reactor pedestal with the hydraulic hammer and load it into waste containers with the excavating bucket. This work was projected to take six months to complete with manual jackhammers. Cost analysis by the USACE showed that the Brokk system cost about $17 per cubic foot of removed concrete compared to the manual jackhammer at about $254 per cubic foot. The production rate for the Brokk system was about 12 cubic feet per hour compared to only 0.6 cubic feet per hour for the manual jackhammer. Using the Brokk system resulted in approximately a 93% cost savings over the baseline technology.

Concrete Dust Suppression System (12)

Dust generated during facility demolition must be managed to protect worker health and control the spread of contaminants. In the Hanford C-Reactor LSDDP, an automated water spray system was demonstrated for control of concrete dust generated by a demolition ram fitted onto a Caterpillar excavator. The automated water spray system is mounted on the excavator and consists of a 540-gallon water tank, eight spray nozzles, and controls. The spray nozzles are located slightly behind the ram and directed at the dust source. The baseline approach used at Hanford to control dust generated during concrete demolition work is spraying water with manned fire hoses.

Because water from the automated water spray system is directed at the source of the dust, much less water is needed to control concrete dust compared to the baseline approach using workers with fire hoses. For demolition of a high wall of concrete, the automated water spray system used 1.7 gallons of water per cubic foot of concrete compared to 14 gallons of water per cubic foot of concrete for workers using fire hoses to suppress dust. For demolition of a concrete floor slab, the automated water spray system used 0.12 gallons of water per cubic foot of concrete compared to one gallon of water per cubic foot for workers using fire hoses. Thus, the automated water spray system generated eight times less wastewater to achieve the same level of dust suppression as workers using fire hoses. To demolish a high-wall room with about 14,600 cubic feet of concrete, the automated water spray system would cost about $24,700 compared to $130,400 using the baseline approach of manned fire hoses. This represents a cost savings of over 80% compared to the baseline technology. These cost figures are based on local municipal water rates and wastewater treatment costs at the Hanford Site Effluent Treatment Facility at $0.25/gallon (gal.), sampling and analysis costs at $0.41/gal., and tanker-truck transport costs at $0.02/gal.

VecLoader HEPA Vacuum Insulation Removal (1, 11, 12)

Vector Technologies markets a VecLoader high-efficiency particulate air (HEPA) vacuum (VAC) system to remove, vacuum, transport, and bag asbestos and other types of loose insulation. The VecLoader HEPA-VAC system is a trailer-mounted system that includes a 102 horsepower diesel engine-powered vacuum, wet cyclone separator, HEPA filter, and five-inch diameter vacuum hose. The five-inch diameter vacuum hose can transport insulation at distances up to 500 feet to the wet cyclone separator for wetting and bagging. The powerful vacuum has a suction of 1,700 cubic feet of air per minute at a vacuum of 15 inches of mercury.

In the Fernald Plant 1 LSDDP, the VecLoader was demonstrated to remove mineral wool sandwiched between transite panels of the building. The baseline approach used to remove loose insulation at Fernald is to wet the insulation and place workers on man lifts or scaffolds to manually remove the insulation and stuff it into bags. The demonstration showed that the VecLoader HEPA-VAC System could remove 716 square feet per day (sq. ft./day) of four-inch thick mineral wool insulation compared to only 197 sq. ft./day for manual removal of insulation with a three-person crew. Another advantage of the VecLoader HEPA-VAC System is that it compacts the insulation nearly 60 percent compared to only 7 percent compaction achieved by manual removal and bagging. The additional compaction achieved by the VecLoader HEPA-VAC System results in fewer bags and a smaller volume of asbestos and other insulation for disposal.

The unit cost to remove insulation using the VecLoader HEPA-VAC System was $1.32 per square foot (sq. ft.) of four-inch thick insulation, which is 34% less than the unit cost for manual removal of the insulation at $2.01 per sq. ft. The mobilization costs to move the VecLoader HEPA-VAC System to the Fernald site plus the demobilization costs to decontaminate and remove the VecLoader from the Fernald site can be recovered after removing 8,800 sq. ft. of four-inch thick insulation. The purchase price of the VecLoader HEPA-VAC System of about $89,000 plus mobilization and demobilization costs can be recovered after processing about 120,000 sq. ft. of four-inch thick insulation. Thus, the decision on whether to purchase or rent a VecLoader HEPA-VAC System will depend on the quantity of insulation available for processing.

In-Situ Object Counting System (9, 16)

The In-Situ Object Counting System (ISOCS) from Canberra consists of a germanium detector with portable cryostat; a cart for transporting the detector, lead shielding and collimators; a portable spectroscopy analyzer; a portable computer; and calibration software. The steel-jacketed lead surrounds the germanium detector to shield the detector from background radiation and to adjust the field of view between 30, 90, and 180°. The detector rotates on the cart to align with the area to be characterized by the ISOCS. The response of the germanium detector to a series of point sources surrounding it has been characterized using Monte Carlo code. ISOCS determines the radioactive sources associated with spectroscopy peaks and the software automatically ascertains the relationships between the geometry of the radioactive source, the measured count rate, and the quantity of radioactive material. ISOCS has nine standard geometry templates to correlate the count rate to the strength of the radiation source for a variety of geometries.

During its demonstration at the Chicago Pile 5 (CP-5) Research Reactor LSDDP, ISOCS was used to characterize concrete floors, casks containing 55 gallon drums, 5 gallon containers with radioactive material, walls of a drained reactor fuel pool, an instrument panel, a water filter, concrete corings, and a hot spot on a wall. Data collection time depends on the strength of the radiation source, but was typically 15 to

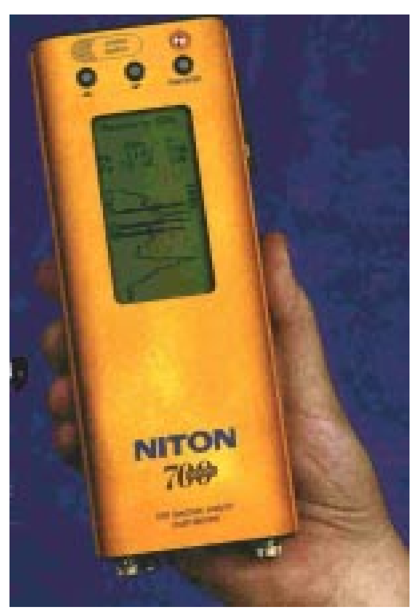
25 minutes. Based on characterization of concrete surfaces in the CP-5 Research Reactor LSDDP, the unit cost of using ISOCS was about $56 per location, compared to $140 per location using the baseline approach of collecting core samples and off-site laboratory analysis. The capital cost of ISOCS is about $75,000 and equipment lease options are available. This represents a cost savings of about 30%. Another advantage of ISOCS is the cost savings associated with schedule acceleration since ISOCS provides results for decision making in near-real time, while the offsite laboratory analyses may take weeks or months to obtain results.

Following its demonstration in the CP-5 LSDDP, ISOCS has been deployed at Oak Ridge, the 301 Hot Cell Facility at Argonne National Laboratory, Idaho National Engineering and Environmental Laboratory, the Brookhaven Graphite Research Reactor (BGRR), and other DOE and commercial sites. In September 1999, the Canberra's ISOCS was deployed in the BGRR Decommissioning Project to survey surface soils, ductwork, manways, sludge, dust, and a waste container. ISOCS was deployed in conjunction with a characterization plan developed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Deployment of ISOCS and MARSSIM at the BGRR is projected to save almost $1.1 million compared to the estimated cost for characterization using the baseline approach of collecting and analyzing a large number of physical samples (e.g., concrete boring, paint chips, swipe samples). The estimated cost of the BGRR survey using the baseline approach is $4.8 million. Following deployment at the BGRR, the techniques and equipment will be deployed by Bechtel Hanford to characterize nuclear facilities at Hanford.

Lead Paint Analyzer (15)

Most DOE D&D projects need to analyze paint and other coatings for lead content to determine the appropriate strategy to remediate an area. At most DOE sites, the baseline approach to analyze coatings for lead content is to collect field samples of the coating and send the samples to a laboratory for analysis. Sample collection can take hours and analytical results from the laboratory may not be available for months.

In the Idaho National Engineering and Environmental Laboratory (INEEL) LSDDP, a Niton 700 Series multi-element spectrum analyzer was demonstrated for real-time analysis of lead in the field. The 8-inch by 3-inch by 2-inch Niton 700 series analyzer is a hand-held, battery-operated unit which uses x-ray fluorescence spectroscopy to analyze 25 elements including the presence of lead in paint. The analyzer uses two radioactive sources, Americium-241 and Cadmium-109, to cause fluorescence of up to 25 heavy-metal contaminants for detection by the spectrograph. The battery has a life of eight hours and can be charged in two hours. Up to 3,000 data points and sample locations can be stored by the Niton 700 series analyzer and the data can be easily downloaded to a personal computer.



Data from the demonstration indicated that the Niton 700 series analyzer provides data equal to or better than laboratory data. Based on results of the demonstration, the Niton 700 series analyzer reduced surveys costs by 96% compared to the baseline approach. Using the Niton 700 series analyzer, the cost to analyze a survey area consisting of 14 sampling locations in the demonstration was about $800, compared to almost $20,000 for the baseline approach of collecting and sending paint samples to a laboratory for analysis. The capital cost of the Niton 700 series analyzer of about $25,000 can be recovered through cost savings attained after measurement of only 20 sampling locations.

The main value of the Niton 700 series analyzer is that it provides a result in about 20 seconds. These results can be used by the decommissioning project manager in making immediate decisions on the appropriate approach to remediate an area of a facility, instead of waiting weeks or months for laboratory results.

Remote Underwater Characterization System (RUCS) (17)

Visual inspection and radiological characterization of water-cooled and moderated research reactors and fuel storage pools requires equipment capable of operating underwater at depths often exceeding 20 feet. A commercial, remotely-operated, underwater vehicle called Scallop was purchased from Inuktun and DOE's Robotics Technology Development Program improved Scallop by adding a directional compass; an auto-depth feature to hold vertical position underwater; and a GM tube radiation sensor. The modified Scallop was named RUCS. It measures 12 inches by 9 inches by 6 inches and is rated to 100 feet of depth. Left and right variable speed thrusters turn and drive the RUCS forward and backward. A variable speed vertical thruster is used to drive the RUCS to a desired depth. RUCS has a forward-looking color camera with tilt capability and a backward-looking black-and-white camera.

In the INEEL LSDDP, RUCS was demonstrated in the common 30,000-gallon water canal for two research reactors (i.e., the Advanced Reactor Material Facility and the Coupled Fast Reactivity Measurement Facility). The competing baseline technology is manual deployment of an underwater zoom camera, underwater lights, and radiation sensor on extendable poles. Demonstration results indicated that the RUCS reduced survey costs by about 40% compared to the baseline technology due to reduced labor and a slight increase in survey speed. RUCS improved worker safety and reduced radiation dose by needing only one worker near the water canal to manage the tether, while two or three people are near the water canal when using the baseline approach. Payback time to recover the purchase price of about $22,000 is nearly 800 sampling points. The RUCS was also able to characterize portions of the canal that could not be characterized by the baseline technology.

Automatic Locking Scaffold (13)

Overhead D&D work is often performed by workers using tools while standing on scaffolds, ladders, manlifts, and other elevated platforms. Most overhead D&D projects at INEEL use scaffolds in situations where ladders do not provide enough mobility or mechanical platforms are not practical. The baseline scaffold used at INEEL and many DOE sites is the tube-and-clamp scaffold which uses nuts and bolts for assembly. In the INEEL LSDDP, an Excel Automatic Locking Scaffold was demonstrated to evaluate its performance compared to the baseline scaffold. The Automatic Locking Scaffold uses a patented positive-locking trigger mechanism to secure the horizontal bars and other attachments to the vertical legs. The

Automatic Locking Scaffold uses nearly 50 percent fewer pieces and tools than the tube-and-clamp scaffold since it eliminates nuts and bolts in its construction.

In the INEEL LSDDP, the Automatic Locking Scaffold was shown to reduce costs by about 49% compared to conventional tube-and-clamp scaffolds during two weeks of removing overhead asbestos from a 5-foot- by 7-foot- by 12-foot-high scaffold tower. Although the cost of the Excel Automatic Locking Scaffold at about $3,800 is about $1,900 more than the convention scaffold, this cost would be recovered through cost savings achieved in about 19 D&D jobs. Cost savings is achieved by faster erection and disassembly time for the Excel Automatic Locking Scaffold. The total time to erect and disassemble the demonstration tower was 75 minutes for the Automatic Locking Scaffold and 180 minutes for the tube-and-clamp scaffold. The Excel Automatic Locking Scaffold is more cost-effective than the conventional scaffold when it is moved more frequently than once every 11 weeks and D&D jobs typically require moving scaffolds at least every few weeks. Based on results of the demonstration, D&D workers at INEEL have purchased several units of Excel's Automatic Locking Scaffold and are deploying it on their D&D projects.

Conclusion

Through its LSDDPs, the DOE's DDFA has been successful in identifying many improved/innovative D&D technologies that have significant cost advantages compared to the competing baseline technologies. The cost savings of the improved/innovative D&D technologies has been validated through demonstration in LSDDPs and documented in ITSRs. As a result, many of these cost-effective improved/innovative D&D technologies have become the new baseline technologies at multiple DOE sites.

One of the DDFA's major goals is to reduce the cost to deactivate and decomission surplus DOE facilities by 25% for facilities to undergo D&D through Fiscal Year 2006. The DDFA also has a stretch goal to reduce the cost to deactivate and decomission DOE facilities by 50% for facilities to undergo decommissioning after Fiscal Year 2006. The current estimated cost to deactivate and decommission DOE's surplus facilities using existing technologies is in excess of $32 billion. The average cost reduction for the 26 improved/innovative technologies shown on Table 2 is approximately 60%. Implementation of these technologies and others to follow through the LSDDPs will assist the DDFA in achieving these goals.

References

(1) Innovative Technology Summary Report, VecLoader HEPA Vacuum Insulation Removal System, September 1999, DOE/EM-0469.

(2) Innovative Technology Summary Report, Oxy-Gasoline Torch, December 1998, DOE/EM-0401.

(3) Innovative Technology Summary Report, Portable X-Ray Fluorescence Spectrometer, December 1998, DOE/EM-0402.

(4) Innovative Technology Summary Report, Remote Control Concrete Demolition System, December 1998, DOE/EM-0410.

(5) Innovative Technology Summary Report, Concrete Shaver, December 1998, DOE/EM-0397.

(6) Innovative Technology Summary Report, Surface Contamination Monitor and Survey Information Management System, February 1998, DOE/EM-0347.

(7) Innovative Technology Summary Report, Personal Ice Cooling System (PICS), November 1998, DOE/EM-0393.

(8) Bossart, Steven J., Shoemaker, Harold D., and Kasper, Kenneth M., Improved Technologies to Alleviate Worker Heat Stress, Spectrum 98 – International Conference on Decommissioning and Decontamination and on Nuclear and Hazardous Waste Management, American Nuclear Society, Denver, Colorado, September 13-18, 1998.

(9) Bossart, Steven J., and Kasper, Kenneth M., Cutting Edge Characterization Technologies for D&D, Radwaste Magazine, January/February, 1999, Volume 6, Number 1, p. 23-30.

(10) Bossart, Steven J., and Shah, Sanjiv J., New Technologies for Dismantlement of DOE's Surplus Facilities, Waste Management 1998 Conference, Tucson, Arizona, March 5-8, 1998.

(11) Bossart, Steven J., Duda, John R., and Lupichuk, William, Life After Large-Scale Technology Demonstration, Waste Management 1999, Tucson, Arizona, February 28 – March 4, 1999.

(12) Bossart, Steven J., Duda, John R., Waste Minimization Technologies for D&D of Radioactively-Contaminated Facilities, 1999 U.S. Department of Energy Pollution Prevention Conference, Albuquerque, New Mexico, November 15-19, 1999.

(13) DOE Office of Science and Technology, "*Draft Innovative Technology Summary Report*" The Automatic Locking Scaffold System, Idaho Large Scale Demonstration and Deployment Project.

(14) Bossart, S. J. And R. Vagnetti, The U.S. Department of Energy's Market for Deactivation and Decommissioning Services, American Nuclear Society Second Topical Meeting and Exhibition on Decomissioning, Decontamination, and Reutilization, Knoxville, Tennessee, September 12-16, 1999.

(15) Innovative Technology Summary Report, Lead Paint Analyzer, September 1999, DOE/EM-0481.

(16) Innovative Technology Summary Report, In-Situ Object Counting System, September 1999, DOE/EM-0477.

(17) Innovative Technology Summary Report, Remote Underwater Characterization System (RUCS), September 1999, DOE/EM-0457.