INNOVATIVE TECHNOLOGY
Summary Report

DOE/EM-0540

Paint Scaler

Deactivation and Decommissioning
Focus Area

Prepared for
U.S. Department of Energy
Office of Environmental Management
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INNOVATIVE TECHNOLOGY
Summary Report

Paint Scaler

OST/TMS ID 2952

Deactivation and Decommissioning
Focus Area

Demonstrated at
Idaho National Engineering and Environmental Laboratory
Idaho Falls, Idaho

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Summary Report

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine whether a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://ost.em.doe.gov under "Publications."

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SECTION 1
SUMMARY

Introduction

The United States Department of Energy (DOE) continually seeks safer and more cost-effective technologies for decontamination and decommissioning (D&D) of nuclear facilities. To this end, the Deactivation and Decommissioning Focus Area (DDFA) of the DOE's Office of Science and Technology sponsors large-scale demonstration and deployment projects (LSDDPs). At these LSDDPs, developers and vendors of improved or innovative technologies showcase products that are potentially beneficial to the DOE's projects and to others in the D&D community. Benefits sought include decreased health and safety risks to personnel and the environment, increased productivity, and decreased cost of operation.

The Idaho National Engineering and Environmental Laboratory (INEEL) LSDDP generated a list of need statements defining specific needs or problems where improved technologies could be incorporated into ongoing D&D tasks. Although not addressed explicitly, the use of a paint scaler is needed to quickly and efficiently collect samples of paint and other coatings for laboratory analysis during the characterization process for contaminants such as lead, polychlorinated biphenyls (PCB), asbestos, and radioactive isotopes. Currently samples are collected using handheld tools such as paint scrapers, putty knives, chisels, and hammers.

This demonstration investigated the feasibility of using the Bosch Rotary Hammer Drill (innovative technology) to collect samples where handheld tools (baseline) are currently being used on D&D activities. Benefits expected from using the innovative technology include:

- Decreased exposure to radiation, chemical, and/or physical hazards during sample collection
- Easier use
- Shorten D&D schedule
- Reduced cost of operation.

This report compares the cost and performance of using handheld tools to the cost and performance of the Bosch Rotary Hammer Drill.

Technology Summary

Baseline Technology

D&D and maintenance operations need to quickly and efficiently collect samples of paint and other coatings for lab analysis during the characterization process for contaminants such as lead, PCBs, asbestos, and radioactive isotopes. Presently, samples are collected using handheld tools such as paint scrapers, putty knives, chisels and hammers. This can be a time-consuming and physically demanding task for the sample collectors.

Samples are collected from a variety of surfaces such as metal and concrete. Figure 1 shows a sample operator collecting a paint sample from a metal tank support.

Figure 1: Baseline Sample Collection

Innovative Technology

The Bosch 11225VSRH is a 24-Volt, battery-operated, ¾-in. rotary hammer drill (See Figure 2). When used with an optional chipping adapter, the Bosch rotary hammer drill can be used to perform chipping and chiseling tasks such as paint removal from either concrete or metal surfaces. It is ultra-compact, lightweight (9 lb.), and has an ergonomically balanced grip. The unit is small and light enough that it can easily be operated at waist level and below or at chest/shoulder height. Since it is battery operated, it gives the operator more flexibility during sampling activities than an electric or air powered paint scaler would allow.

A variety of bits can be used with this unit. The bits shown in Figure 3 were purchased for this demonstration. From left to right, the bits are:

- Wide Chisel 1½ x 10-in.
- Chisel ¾ x 10-in
- Point Chisel
- Wood Chisels: ¼-in., ½-in., ¾-in. and 1-in (shown).

Figure 2: Bosch 11225VSRH Rotary Hammer Drill

Figure 3: Optional Chisel Bits

The unit has a battery gauge that displays five stages of charge levels. It illuminates with the tool on or off. The advanced charger provides full charge and extends battery life. It comes with a 3 amp-hour, interchangeable battery and can be recharged in approximately 26 minutes. The vendor states that approximately 155 holes (¼-in dia. X 1½-in deep) can be drilled into average strength concrete. Extra battery packs can be purchased to minimize down time.

Demonstration Summary

The Bosch 11225VSRH rotary hammer drill was demonstrated in September 1999 at the Idaho National Engineering and Environmental Laboratory (INEEL). The demonstration took place at the Test Reactor Area (TRA) in the Engineering Test Reactor (ETR) Delay Tanks and the General Electric Experimental Loop (GEEL) Filter Pit Tunnels. This device was used to collect several different types of samples from lead bricks, concrete and metal surfaces. The types of samples included lead brick shavings, paint, and a tar-type sealant. Figure 4 shows the rotary hammer drill removing shavings from a lead brick.

Figure 4: Lead Brick Shavings

Key Results

The key results of the demonstration are summarized below. Section 3 describes these results in detail.

- The innovative technology was 2 to 5 times faster than the baseline technologies in removing material for sampling.
- The innovative technology is versatile; it can be used on both metal and concrete surfaces.
- Worker fatigue was greatly reduced when using the innovative technology.
- The innovative technology can remove hard, thick coatings much easier than the baseline technology.
- The innovative technology minimizes the time required to collect samples, thus reducing worker exposure in radiological environments.
- The innovative technology reduces the amount of substrate that is inadvertently collected with the coating sample.
- The innovative technology reduces the possibility of personal injury associated with the use of hand tools.
- Cost reductions and accelerated schedules are possible because more samples can be taken in a shorter period of time.

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Web Site

The INEEL LSDDP Internet web site address is http://id.inel.gov/lsddp

Licensing

No licensing activities were required to support this demonstration.

Permitting

No permiting activities were required to support this demonstration.

Other

All published Innovative Technology Summary Reports are available on the OST Web site at http://ost.em.doe.gov under “Publications”. The Technology Management System, also available through the OST Web site, provides information about OST programs, technologies, and problems. The OST reference number for the Paint Scaler is 2952.

SECTION 2
TECHNOLOGY DESCRIPTION

Overall Process Definition

Demonstration Goals and Objectives

The purpose of this demonstration was to assess the benefits of using the innovative paint scaler over using the baseline handheld tools. The demonstration collected valid operational data so that a legitimate comparison could be made between the innovative technology and the baseline technology in the following areas:

- Safety
- Productivity rates
- Ease of use
- Limitations and benefits
- Cost.

Description of the Technology

The Bosch rotary hammer, model 11225VSRH, is a commercially available, 24-volt battery-operated unit. The Bosch rotary hammer was selected for this demonstration because it is battery operated. This eliminates the need for extension cords or pneumatic hoses to drive the unit that could become contaminated. This is especially important when sampling is done in remote locations where power is not available or convenient. This makes this unit more versatile than other cord-powered units. It is powered by a 3.0 amp-hour, 24-volt battery that has a 26-minute recharge time. The battery has a gauge that displays five stages of charge levels. It illuminates with the tool on or off.

The standard Bosch rotary hammer has two modes of operation: drill and hammer-drill. However, when used with an optional chipping adapter, the 11225VSRH can operate in a hammer-only mode. This is used to perform light chiseling or chipping tasks. This unit also has a variable speed trigger, which is helpful in collecting delicate or thin-coated samples. A variety of SDS bits and chisels can be used with the 11225VSRH. During this demonstration, the following chisels were used (See Figure 3 for a photo of the chisel bits):

- Point Chisel (10-in. long)
- Chisel (¾-in. wide x 10-in. long)
- Wide Chisel (1-½-in. wide x 10-in. long)
- Wood Chisels (¼-in., ½-in., ¾-in. and 1-in. wide)

Specific features of the 11225VSRH Bosch rotary hammer include the following:

- Battery operated – no cords or hose required for operation. Eliminates potential contamination of cords.
- 3 amp-hour battery provides a long running time between recharges.
- Battery gauge displays charge level.
- Easy to use and set up.
- Variable speed trigger allows sampling of thin or delicate material.
- ALARA dose reduction resulting from quick sample collection.
- Reduces worker fatigue during sampling activities.
- Works with a variety of bits or chisels.

- Can collect thick or hard-to-remove samples easier.

System Operation

Table 1 summarizes the operational parameters and conditions of the Paint Scaler demonstration.

Table 1. Operational parameters and conditions of the Paint Scaler demonstration

Working Conditions	
Work area location	ETR Delay Tanks and GEEL Filter Pit Tunnels at TRA
Work area access	Access controlled by D&D project through use of fencing and posting
Work area description	Work area posted as asbestos-controlled area and D&D/construction hazard area, requiring training, hard hat, safety glasses, and safety shoes for entry. Under certain conditions, respirators and anti-C clothing were required.
Work area hazards	Asbestos contamination Radiological contamination Tripping hazards Temperature extremes Confined Spaces
Equipment configuration	Paint Scaler was configured at the job site as needed.
Labor, Support Personnel, Special Skills, Training	
Work crew	Minimum work crew: • 1 Sampler • 1 Data Collector • 1 Radiological Control Technician (RCT) – when applicable.
Additional support personnel	• 1 Data Collector • 1 Health And Safety Observer (periodic) • 1 Test Engineer
Special skills/training	Reading the owners manual to become familiar with the features and operation of the equipment.
Waste Management	
Primary waste generated	No primary wastes were generated
Secondary waste generated	Disposable personal protective equipment
Waste containment and disposal	All secondary wastes were collected and packaged for disposal with the D&D project waste.
Equipment Specifications and Operational Parameters	
Technology design purpose	Equipment is designed to drill holes in concrete. It is also designed for light chipping and chiseling activities when used with the optional chipping adapter.
Portability	Equipment can be packaged and transported in its case.
Materials Used	
Work area preparation	No preparation was necessary for the demonstration. The D&D project already had necessary controls and preparations in place.
Personal protective equipment	Cotton scrubs Cotton glove liners (When applicable) Tyvek coveralls (When applicable) Respirators (When applicable) Pair of rubber gloves (When applicable) Shoe covers (When applicable) Steel toe shoes Safety glasses
Utilities/Energy Requirements	
Power, fuel, etc.	110V AC required to charge the battery - 26 min charge time. 155 holes (¼-in dia. X 1½-in deep) can be drilled into average strength concrete

SECTION 3
PERFORMANCE

Demonstration Plan

Problem Addressed

D&D and maintenance operations need to quickly and efficiently collect paint samples for laboratory analysis during the characterization process for contaminants such as lead, PCBs, asbestos, and radioactive isotopes. This can be a time-consuming and physically demanding task for the sample collectors.

The purpose of this demonstration is to compare the performance of the innovative technology to the baseline technology, which is handheld tools such as putty knives, hammers, chisels, etc.

Demonstration site description

The INEEL site occupies 569,135 acres (889 square miles) in southeast Idaho. The site consists of several primary facility areas situated on an expanse of otherwise undeveloped, high-desert terrain. Buildings and structures at the INEEL are clustered within these primary facility areas, which are typically less than a few square miles in size and separated from each other by miles of primarily undeveloped land.

The test areas for this demonstration were the ETR Delay Tanks and the GEEL Filter Pit Tunnels at the Test Reactor Area. These areas were selected based on the scheduled sampling activities during the demonstration period. A tar type sealant on concrete was sampled at ETR Delay Tanks. Lead brick shavings and paint on a concrete surface were sampled at the GEEL Filter Pit Tunnels.

Major objectives of the demonstration

The major objectives were to evaluate the Bosch rotary hammer drill against the baseline handheld tools in the following areas:

- Cost effectiveness (based on time required to collect sample)
- Reducing worker exposures in radiation areas
- Ease of use
- Productivity
- Limitations.

Major elements of the demonstration

Both the baseline technology and the innovative technologies were used to collect coating samples for laboratory analysis. The intent of the demonstration was to gather information helpful in deciding which technology to use in the future. This demonstration included a wide variety of applications. The following samples were collected:

- Lead brick shavings
- Paint from concrete and metal surfaces
- Tar type sealant from a concrete surface.

Results

Both technologies were evaluated under similar physical conditions. Every attempt was made to allow work to proceed under normal conditions with no bias. All parties involved in the demonstration were requested to perform the work normally with no special emphasis on speed or efficiency. Both technologies were used during each demonstration.

During the demonstration, the same person operated both the baseline and the innovative technologies. Table 2 shows the performance comparison of the baseline and innovative technology in collecting various types of sample for laboratory analysis.

Table 2. Performance comparison innovative vs. baseline technology sample collection.

Performance Factor	Baseline Technology Handheld tools	Innovative Technology Bosch Rotary Hammer
Personnel/equipment/ time required to collect lead brick shavings	Personnel: • 1 Sampler Collector • 1 Laborer • 1 RCT Equipment: • Handheld hammer and chisel Removal Rate: • 9.4 grams/min (See Page B-3 for Sample Information) PPE: • Respirator • Tyvek • Rubber Gloves • Rubber Boots • Steel Toe Shoes	Personnel: • 1 Sample Collector • 1 Laborer • 1 RCT Equipment: • Bosch Rotary Hammer with optional chipping adapter and 1-in. wood chisel Removal Rate: • 53.3 grams/min (See Page B-3 for Sample Information) PPE: • Respirator • Tyvek • Rubber Gloves • Rubber Boots • Steel Toe Shoes
Personnel/equipment/ time required to collect tar type sealant from concrete	Personnel: • 1 Sampler Collector • 1 RCT Equipment: • Handheld Scraper Removal Rate: • 16.67 ml/min (See Page B-3 for Sample Information) PPE: • Leather Gloves • Coveralls • Safety Glasses • Steel Toe Boots • Falls Protection	Personnel: • 1 Sampler Collector • 1 RCT Equipment: • Bosch Rotary Hammer with optional chipping adapter and 1-in. wood chisel Removal Rate: • 33.3 ml/min (See Page B-3 for Sample Information) PPE: • Leather Gloves • Coveralls • Safety Glasses • Steel Toe Boots • Falls Protection

Performance Factor	Baseline Technology Handheld tools	Innovative Technology Bosch Rotary Hammer
Personnel/equipment/ time required to collect thick coating paint from concrete	Personnel: • 1 Sampler Collector • 1 Industrial Safety Equipment: • Handheld Scraper Removal Rate: • 0.05 ft^2/min (See Page B-3 for Sample Information) PPE: • Coveralls • Leather Gloves • Safety Glasses • Steel Toe Boots	Personnel: • 1 Sampler Collector • 1 Industrial Safety Equipment: • Bosch Rotary Hammer with optional chipping adapter and 1-in. wood chisel Removal Rate: • 0.167 ft^2/min (See Page B-3 for Sample Information) PPE: • Coveralls • Leather Gloves • Safety Glasses • Steel Toe Boots
Superior capability	• Samples were taken of a thin paint coating on a metal surface. Baseline technology remove the thin paint as fast as the innovative technology. • If a limited number of samples are required then the baseline technology may be cheaper.	• Easier to use. • Collect samples faster than the baseline technology. • Reduced worker fatigue during sampling activities. • A more representative sample can be collected. • Versatile – can be used to remove a variety of materials from different substrates. • Can be used in remote locations without the need for an external power source.

During the demonstration, testers noted that the wood chisel performed the best for sample collection. The wood chisel has a sharper edge, which allows the chisel to get under the coating. They also noted that the wood chisel performed better when the taper on the chisel was allowed to ride on the surface of the substrate (taper side down). In typical applications using a wood chisel, the taper is facing away from the substrate (taper side up). When the wood chisel was used with the taper facing away from the substrate, it was too aggressive (see figures 5 & 6); it wanted to dig deep into the underlying surface (e.g., concrete, lead, metal). The objective during sample collection is to remove only the coating and minimize the amount of substrate material in the sample. Therefore, during all the tests performed during this demonstration, a wood chisel was used, with the taper side down. Base on our observations during this demonstration, only the coating was removed using the innovative technology. Very little, if any, substrate material was removed with the coating. When the baseline technology was used, some substrate material was removed with the coating when collecting samples from concrete surfaces.

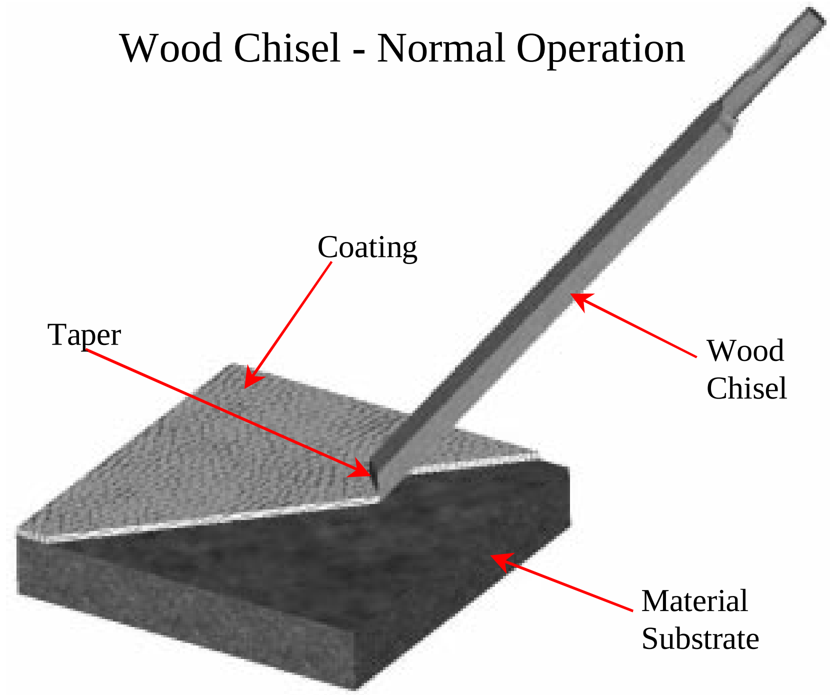

Figure 5: Wood Chisel Taper Side Up.

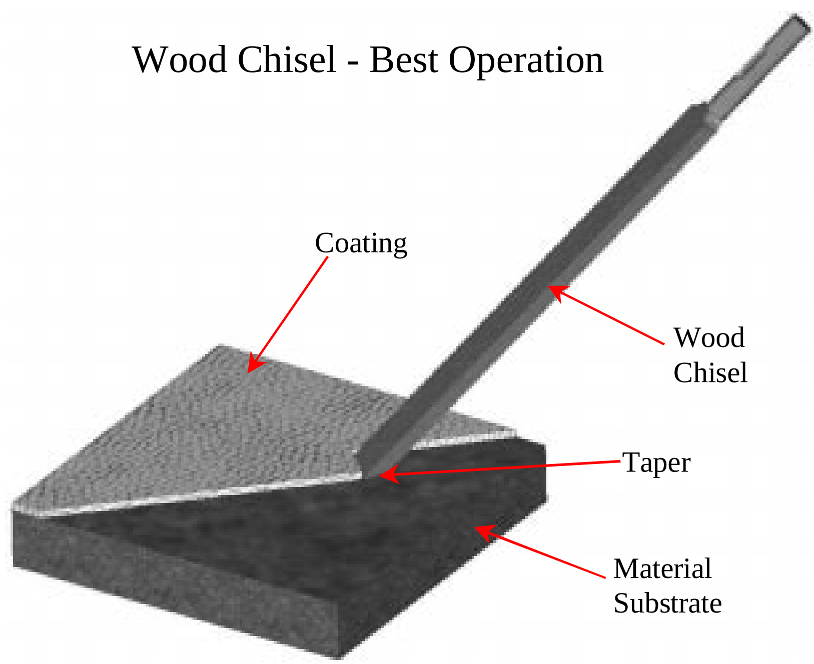

Figure 6: Wood Chisel Taper Side Down.

Another advantage of the innovative technology is its ability to collect samples from hard-to-remove material. The testers noted than when collecting samples using the baseline technology, it takes considerable effort to remove paint that is tightly adhered to the surface. When the paint from these areas cannot be removed, areas are selected that have started to rust or flake off (See Figure 7). This makes sampling easier, but may not be representative of the paint sample required. For example, rust could add elements to the sample that are not present in the actual paint. It was shown during this demonstration that the innovative technology can remove tightly adhered material much easier than the baseline technology. Worker fatigue associated with this typing of sample activity was greatly reduced.

Figure 7: Baseline Sample Collection – Putty Knife

Figure 8: Material Placed Into Sample Bottle

SECTION 4
TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

Baseline technology

The baseline technology for this demonstration is handheld tools such as putty knives, hammers, chisels, and scrapers. There are many manufacturers that produce variations of these tools.

Other competing technologies

A broad range of rotary hammers are commercially available from other vendors. However, Bosch was the only vendor we were able to find that offered a unit that was battery operated. During the procurement of this unit, the vendor recommended that we purchase a unit that was cord operated. The vendor stated that the cord power models were more powerful and could be used for larger task than the battery-operated model. However, for this application, the added power provided by the cord-operated unit is not required. The ability to operate at remote locations without the need for an external power source was the key driver in purchasing the battery-operated Bosch rotary hammer.

Technology Applicability

The innovative technology is fully developed and commercially available. Its superior performance over the baseline in most areas makes it a prime candidate for deployment throughout the DOE complex. It has potential to reduce costs for many D&D projects. The INEEL has deployed the Bosch rotary hammer on other D&D projects where sampling activities are required.

Patents/Commercialization/Sponsor

The Bosch 24-Volt, ¾-in. Rotary Hammer model 11225VSRH and accessories are commercially available and can be obtained through an authorized Bosch dealer. To find a Bosch dealer in your area, visit the Bosch Tools Web Site at http://www.boschtools.com/.

SECTION 5
COST

Introduction

This section compares the cost of sample collection for the innovative and the baseline methods. This cost analysis is based on observing the sampling of three types of media with the intention of collecting sufficient samples to characterize any contamination present in the media.

Methodology

This analysis is based on Government ownership of the equipment and use of on-site labor to perform the work. The costs for the innovative and baseline technologies are derived from observed duration of the work activities that are recorded as the demonstration proceeds using costs derived from similar work, and extrapolation of the observations to "real work" conditions. The quantity of sample material collected during the demonstration varied for each media sampled and for the method of sampling. Approximately 667 grams of paint sample, 500 grams of tar sample, and 800 grams of lead brick sample were collected using the innovative technology. Approximately 333 grams of paint sample, 500 grams of tar sample, and 47 grams of lead sample were collected using the baseline technology. This cost analysis uses the production rates observed during the demonstration. But, the cost comparison is based on different quantities than those observed in the demonstration. The cost analysis uses quantities that the test engineer judged to represent "real work" conditions and is based on the following:

- Paint Samples - 1,000 grams (2 samples for TCLP, 2 samples for Rad, 2 samples for PCBs, 2 samples VOCs, with each sample being 100 grams, except for the PCB which is 200 grams for a total of 1,000 grams)
- Tar Samples - 1,000 grams (2 samples for TCLP, 2 samples for Rad, 2 samples for PCBs, 2 samples VOCs, with each sample being 100 grams, except for the PCB which is 200 grams for a total of 1,000 grams)
- Lead Brick Samples - 400 grams (2 samples Rad, 2 samples total metals, with each sample being 100 grams for a total of 400 grams)

The preparation for work, storage of equipment, and sample record journal preparation were not directly observed and those costs are estimated based on experience with similar work. The number of persons involved in the demonstration work varied. In one case, the test engineer performed the sample collection; in other cases technicians that routinely collect samples were used. This cost analysis uses a team of two sample collectors and one industrial hygienist as the basis of the costs. The labor rates for the crew are based on standard rates for the INEEL site. The equipment rates are based on the amortized purchase price. This cost analysis omits some non-productive costs. For example, the work for the paint sample collection was on standby for more than two hours until an industrial hygienist was available for the job. The cost associated with this standby time, and similar delays to the work were omitted. Additional details of the basis of the cost analysis are described in Appendix B.

Cost Analysis

Costs to Purchase, Rent, or Procure Vendor Provided Services

The innovative technology is available from the vendor with optional components. The purchase prices of the basic equipment and optional features used in the demonstration are shown in Table 3.

Table 3. Improved technology acquisition costs

Acquisition Option	Item Description	Cost ($)
Equipment Purchase	Bosch 24 volt, ¾-in. rotary hammer	626.41
	SDS chipping adapter	48.65
	Point chisel	16.05
	¾-in x 10-in. chisel	16.05
	1½-in. x 10-in. wide chisel	26.73
	Set of 4 wood chisels (¼-in., ½-in., ¾-in. and 1-in.)	71.65

The amortized cost of owning the equipment (amortization of the purchase price) on a per hour basis is summarized in Table 4.

Table 4. Ownership costs

Equipment	Amortized Purchase
Innovative Equipment	
Bosch rotary hammer	$0.49/hr
Chisels and adapter	$0.33/hr
Baseline Equipment	
Hammer/Chisel/Scraper	$0.60/hr

Fixed and Unit Costs

Table 5 shows the fixed and unit costs for the innovative and baseline technologies. The costs are based on the costs summarized in Appendix B, Table B-1 and B-2.

Table 5. Summary of Fixed and Unit Costs and Production Rates

COST ELEMENT	BASELINE COST	PRODUCTION RATE	INNOVATIVE COST	PRODUCTION RATE
Mobilization	$1,181 ea mob.	N/A	$1,184 ea mob.	N/A
Characterization				
Paint Samples	$0.056/g	2001 g/hr	$0.017/g	6,670 g/hr
Tar Samples	$0.112/g	1000 g/hr	$0.056/g	2,000 g/hr
Lead Samples	$0.199/g	564 g/hr	$0.035/g	3,200 g/hr
Don & Doff PPE	$53.21/person/day	N/A	$53.24/person/day	N/A
Sample Transport	$19/day	N/A	$19/day	N/A
Sample Journals	$19/day	N/A	$19/day	N/A
Demobilization	$19 ea demob.	N/A	$19 ea demob.	N/A
Disposal	$150/cf	N/A	$150/cf	N/A

The labor, equipment and material costs that form the basis of the unit costs shown in Table 5 are shown in Appendix B, Table B-2 and B-3.

Payback Period

For this demonstration, the innovative technology saves approximately $158 per job over the baseline for a job size of 2,400 grams of sample collection. At this rate of savings, the difference in purchase price between the innovative and baseline of $774 ($805 - $31 = $774) would be recovered by using the innovative technology to collect approximately 14,000 grams of sample material or approximately 5 jobs similar in size to this demonstration as shown in Figure 9. This computation assumes a series of jobs that are similar to the demonstration in size and scope.

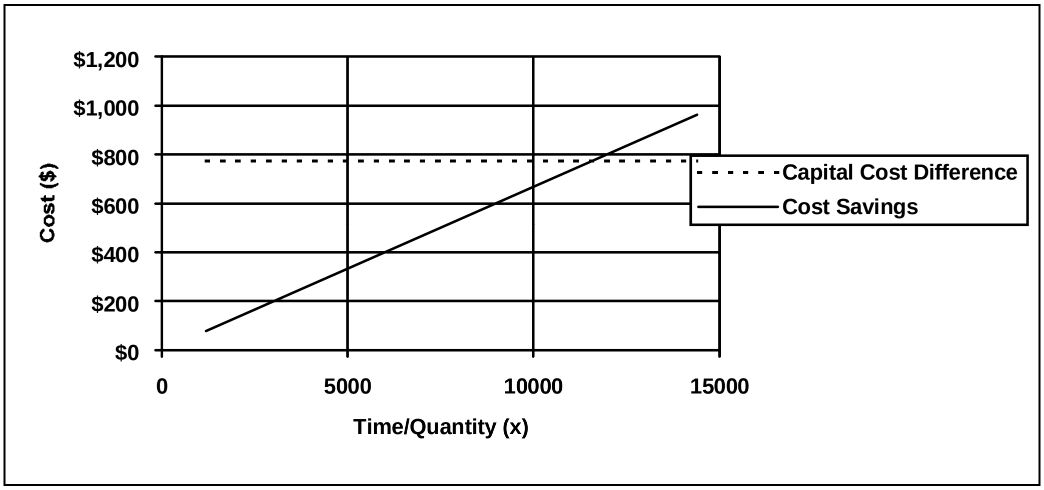

Figure 9. Payback Period for Difference in Capital Cost.

Observed Costs for Demonstration

Figure 10 summarizes the costs observed for the innovative and baseline technology for surveying 20 locations. The details of these costs are shown in Appendix B and include Tables B-2 and B-3, which can be used to compute site-specific costs by adjusting for different labor rates, crew makeup, etc.

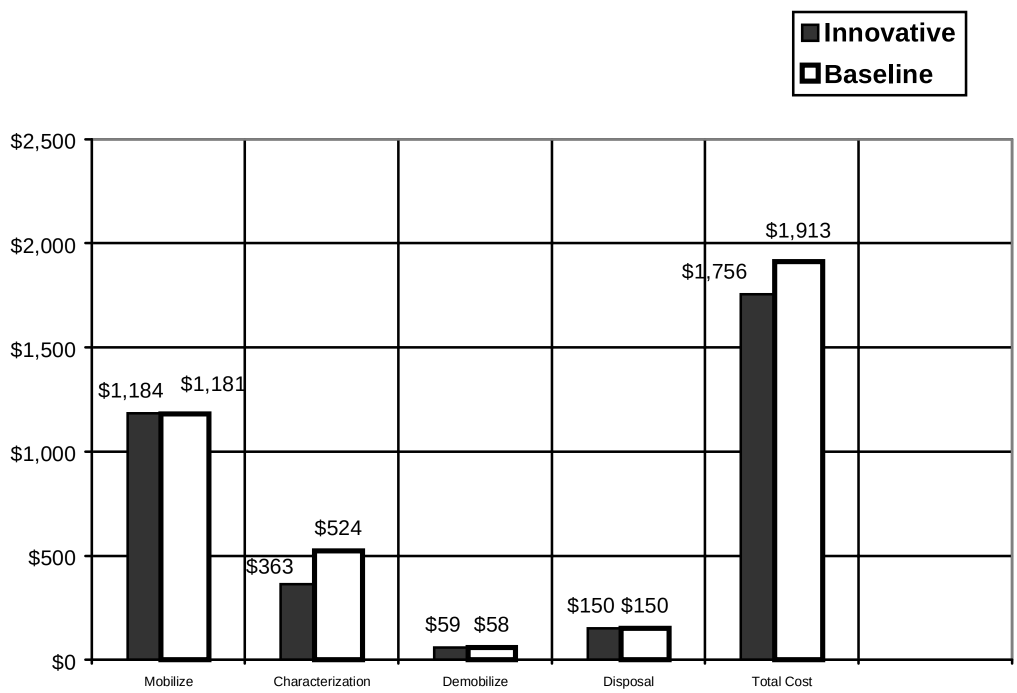

Figure 10. Summary of technology costs.

Cost Conclusions

The mobilization and demobilization costs for the innovative and baseline technologies are driven by the specific requirements of the individual job. The travel to the work area is an example of a cost that varies for each job location. Another example is the preparation effort for sample collection. The preparation procedures will vary from site to site and with the type of sampling being performed. The mobilization and demobilization costs will vary for each situation. But, it is anticipated that the variation will not change the overall cost comparison.

The innovative technology savings result from higher production rates for the sample collection. On average, the innovative technology took samples more than twice as fast as the baseline technology and provided samples with fewer impurities than the baseline. The production rates for the innovative and the baseline technologies are summarized below:

Table 6. Summary of sampling production rates

Type of Sample Collection	Production Rate		
	Innovative Technology	Baseline Technology	% Increase In Production Rate
Paint Samples	6,670 grams/hour	2,001 grams/hour	333.33%
Tar Samples	2,000 grams/hour	1,000 grams/hour	200.00%
Lead Brick Samples	3,200 grams/hour	564 grams/hour	567.38%

The production rates will vary depending on the number of sampling locations, sample sizes, sample preparation requirements, etc. But, the variation in production rate is anticipated to affect a relatively small portion of the overall job, and any variation for site-specific work requirements should have little impact on the overall cost.

SECTION 6
REGULATORY AND POLICY ISSUES

Regulatory Considerations

There were no regulatory issues with the innovative technology during this demonstration.

Safety, Risks, Benefits, and Community Reaction

Because the Bosch rotary hammer can collect samples faster than the baseline, there is a reduction in exposure to workers involved in sampling activities. The exposure may be to radiation, chemicals, or asbestos, as was the case in this demonstration. The worker may also be exposed to physical hazards such as extreme temperatures (heat or cold). The Bosch rotary hammer is compact, lightweight and has an ergonomically balanced grip. This further reduces worker fatigue during sampling activities, thus increasing the safety of the workers.

SECTION 7
LESSONS LEARNED

Implementation Considerations

The innovative technology is a mature technology that performed very well during the INEEL demonstration.

The workers found the innovative technology to be much easier to use than the baseline hand tools. There are several items that should be considered during the use of the Bosch rotary hammer. These recommendations are listed below, along with items that have already been addressed by the manufacturer.

- Check the battery gauge to ensure there is adequate charge in the battery for the sampling activity.
- Having an extra battery will reduce down time associated with charging the battery.
- Keep in stock a variety of chisel bits for various types of sampling activities.
- Become familiar with which bit and configuration works best for the particular sample activity to be performed.
- Check each chiseling bit that will be used prior to operation to ensure they are in good condition.

Technology Limitations and Needs for Future Development

The Bosch rotary hammer performed well during this demonstration. There were no significant technology limitations. Bosch makes other accessories to use with the rotary hammer; one in particular is an “Air Sweep Dust Extraction Fixture”. Using a vacuum system attached to this fixture it may be possible to use this device for collecting the sample as it is being removed from the surface.

Technology Selection Considerations

Based on the INEEL demonstration, the innovative technology is better suited than the baseline technology for sampling activities. The innovative technology is easier to use and more cost effective in the long run. There are instances where the baseline technology would be preferable:

- If the material is a thin paint coating on a metal surface, the baseline technology is just as fast as the innovative technology.

APPENDIX A

REFERENCES

None

APPENDIX B
COST COMPARISON DETAILS

Basis of Estimated Cost

The activity costs used in this analysis to estimate the cost of the technologies are based on the observed work activities performed for the demonstration and on experience with similar types of work at INEEL. In the estimate, the activities are grouped under higher-level work titles per the work breakdown structure shown in the ***Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary*** (HTRW RA WBS) (USACE 1996). The HTRW RA WBS, developed by an interagency group, is used in this analysis to provide consistency with the established national standards.

The costs shown in this analysis are computed from observed duration and hourly rates for the crew and equipment. The following assumptions were used in computing the hourly rates:

- The innovative and the baseline equipment are assumed to be owned by the Government.
- The equipment rates for Government ownership are computed by amortizing the purchase price of the equipment, plus a procurement cost of 5.2% of the purchase price.
- The equipment hourly rates assume a service life of 5 years for the hammer used in the baseline technology cost estimate and 3 years for the Bosch rotary hammer. The chisels and scrapers are assumed to have a one-year life. A relatively short service life is assumed for the chisels and scrapers because it is easier to discard them rather than try to decontaminate them when they become badly contaminated. An annual usage of 500 hours per year is assumed for both the innovative and baseline equipment.
- The equipment hourly rates for the Government's ownership are based on general guidance contained in Office of Management and Budget (OMB) Circular No. A-94, ***Cost Effectiveness Analysis***.
- The crew used in this cost analysis is based on similar work at INEEL.
- The standard labor rates established by the INEEL are used in this estimate and include salary, fringe, departmental overhead, material handling markups, and facility service center markups.
- The equipment rates and the labor rates do not include the INEEL M&O contractor general and administrative (G&A) markups. The G&A are omitted from this analysis to facilitate understanding and comparison with costs for the individual site. The G&A rates for each DOE site varies in magnitude and in the way they are applied. Decision makers seeking site-specific costs can apply their site's rates to this analysis without having to first back-out the rates used at the INEEL.

The analysis does not include costs for oversight engineering, quality assurance, administrative costs for the demonstration, or work plan preparation costs. It omits some non-productive costs. For example, the sampling work for the paint sample collection was on standby for more than two hours until an industrial hygienist was available for the job. The cost associated with this standby time, and similar delays to the work were omitted.

Activity Descriptions

The scope, computation of production rates, and assumptions (if any) for each work activity is described in this section.

Mobilization (WBS 331.01)

Preparation for Work: This is based on previous work at INEEL for the Niton Lead Paint Analyzer and was not directly observed for this demonstration. The activity accounts for performing the "Sampling Checklist" at the supply shop prior to traveling to the job site. It includes chain of custody requirements, paper work, label preparation, tool organization, etc. This cost analysis assumes that the collection of the paint, tar, and lead samples occur on separate days (were separate events for the demonstration) and that this preparation is required for each event.

Pre-Job Safety Meeting: The duration for the pre-job safety meeting is based upon the observed time for the demonstration. The labor costs for this activity are based upon an assumed crew (rather than the actual demonstration participants, and all subsequent activities are based on the assumed crews). This cost analysis assumes that the collection of the paint, tar, and lead samples occur on separate days (were separate events for the demonstration) and that this safety meeting is required for each event.

Characterization (WBS 331.17)

Don Personal Protective Equipment (PPE): This activity includes the labor and material cost for donning the articles of clothing listed in Table B-1. The duration of the donning and the number of donning events are based on observations of the demonstration. The material costs for PPE for each day of use is summarized in Table B-1. Only the sampling of the lead brick occurred in a radiation area. This cost analysis assumes that there is only one sampling event that requires donning and doffing PPE.

Table B-1. Cost for PPE (per man/day)

Equipment	**Cost Each**	**Number of Times Used Before Discarded**	**Cost Each Time Used ($)**	**No. Used Per Day**	**Cost Per Day ($)**
Rubber overboots (pvc yellow 1/16 in thick)	$12.15	30	$0.41	1	$0.41
Glove liners pr. (cotton	$0.40	1	$0.40	2	$0.80
inner)	$1.20	1	$1.20	2	$2.40
Rubber gloves pr. (outer)	$3.30	1	$3.30	1	$3.30
Coveralls (white Tyvek)	$193.20	50	$3.86	1	$3.86
Respirator	$8.75	1	$8.75	2	$17.50
HEPA cartridges					
TOTAL COST/DAY/PERSON					**$28.27**

Collect Paint Samples: The cost for this activity is based on observed production rates where sample material was collected from a 1.5 ft^2 area and divided into 8 samples (6,670 grams/hour for the innovative and 2,001 grams/hour for the baseline methods). The quantity of samples collected is assumed to be 1,000 grams, based on the following requirements:

2 TCLP samples, 100 grams each
2 Rad samples, 100 grams each
2 PCB samples, 200 grams each
2 VOC samples, 100 grams each.

Collect Tar Samples: The cost for this activity is based on observed production rates for collecting 1,000 grams of sample from two locations and divided into 8 samples (2,000 grams/hour for the innovative and 1,000 grams/hour for the baseline methods). The quantity of sample collected is assumed to be 1000 grams based on the following requirements:

2 TCLP samples, 100 grams each
2 Rad samples, 100 grams each
2 PCB samples, 200 grams each
2 VOC samples, 100 grams each.

Collect Lead Samples: The cost for this activity is based on observed production rates for collecting sample material from one lead brick and dividing that sample into four samples (3,200 grams/hour for the innovative and 564 grams/hour for the baseline methods). The quantity of sample collected is assumed to be 400 grams based on the quantity of sample needed for the following samples:

2 total metals samples, 100 grams each
2 Rad samples, 100 grams each

Doff PPE and Exit Zone: This activity accounts for the labor costs for doffing PPE and exiting the rad area is based on the duration observed in the demonstration.

Transport Samples: This activity is based on the duration observed in the demonstration and is assumed to occur on three occasions (once for the paint sample collection, once for the tar sample collection, and once for the lead sample collection).

Sample Journal: This activity accounts for the labor costs for completing the sampler's log book and includes documenting the start/stop time, number of samples collected, amount of sample collected, PPE required, sample locations, environmental conditions, general notes about the activity, and problems that may have occurred.

Demobilization (WBS 331.21)

Return to Storage: This activity includes breaking down the equipment and stowing it in the equipment cases. The duration is based on similar work at INEEL (i.e., demonstration for the Niton Paint Analyzer).

Disposal (WBS 331.18)

Used PPE Disposal: This activity includes the disposal fee for disposal of low-level radioactive solid waste at the cost of \$150/ft^3. The quantity is estimated based on the description of the PPE and observations of the test engineer.

Cost Estimate Details

The cost analysis details are summarized in Tables B-2 and B-3. The tables breaks out each member of the crew, each labor rate, each piece of equipment used, each equipment rate, each activity duration, and all production rates so that site specific differences in these items can be identified and a site-specific cost estimate may be developed.

Table B-2. Innovative Technology Cost Summary

Work Breakdown Structure	Unit	Unit Cost $/unit	Quan-tity	Total Cost	Computation of Unit Cost: Pro-duction Rate	Duration (hr)	Labor Item	$/hr	Equipment Items	$/hr	Other $	Comments
Facility Deactivation, Decommissioning, & Dismantlement								**TOTAL COST FOR DEMONSTRATION =**			**$**	**1,755.53**
Mobilization (WBS 331.01)										Subtotal =	$	1,183.94
Preparation for Work	ea	312.64	3	$ 937.92		4	2FT	77.34	IN on standby	0.82		4 hr prep, ea dif. job
Pre-Job Safety Meeting	ea	82.01	3	$ 246.02		0.50	2FT + 1JS + IH	163.19	IN on standby	0.82		3 different days of work
Characterization (WBS 331.17)										Subtotal =	$	362.97
Don PPE & Enter Zone	ea	122.30	1	$ 122.30		0.33	2FT + IH	111.66	IN on standby	0.82	84.81	1 day in rad zone & $28 ea P
Collect Paint Samples	g	0.02	1,000	$ 16.86	6670		2FT + IH	111.66	IN	0.82		6670 g/hr production rate
Collect Tar Samples	g	0.06	1,000	$ 56.24	2000		2FT + IH	111.66	IN	0.82		2000 g/hr production rate
Collect Lead Samples	g	0.04	400	$ 14.06	3200		2FT + IH	111.66	IN	0.82		3200 g/hr production rate
Doff PPE & Exit Zone	ea	37.49	1	$ 37.49		0.33	2FT + IH	111.66	IN	0.82		1 day in rad zone
Transport Samples	ea	19.34	3	$ 58.01		0.25	2FT	77.34				3 different days
Sample Journal	ea day	19.34	3	$ 58.01		0.50	FT	38.67				3 different days
Demobilization (WBS 331.21)										Subtotal =	$	58.62
Return to Storage	ea	19.54	3	$ 58.62		0.250	2FT	77.34	IN on standby	0.82		3 different jobs
Disposal (WBS 331.18)										Subtotal =	$	150.00
Used PPE Disposal	ft^3	150.00	1.00	$ 150.00								disposal cost $150/$ft^3$

Labor and Equipment Rates used to Compute Unit Cost

Crew Item	Rate $/hr	Abbrev-eation	Crew Item	Rate $/hr	Abbreveation	Equipment Item	Rate $/hr	Abbrev-eation	Equipment Item	Rate $/hr	Abbrev-eation
Job Supervisor	51.53	JS				Bosch Rotary Hammer	0.82	IN			
Engineering Technician	38.67	FT									
Industrial Hygienist	34.32	IH									

Notes:

1. Unit cost = (labor + equipment rate) X duration + other costs, or = (labor + equipment rate)/production rate + other costs
2. Abbreviations for units: ls = lump sum; ea = each; and, loc = location; ft^3 = cubic feet.
3. Other abbreviations: PPE = personal protective equipment.

Table B-3. Baseline Technology Cost Summary

Work Breakdown Structure	Unit	Unit Cost $/unit	Quan-tity	Total Cost	Computation of Unit Cost							Comments
					Pro-duction Rate	Duration (hr)	Labor Item	$/hr	Equipment Items	$/hr	Other $	
Facility Deactivation, Decommissioning, & Dismantlement									**TOTAL COST FOR DEMONSTRATION =**			**$ 1,913.06**
Mobilization (WBS 331.01)										Subtotal =		$ 1,180.97
Preparation for Work	ea	311.76	3	$ 935.28		4	2ET	77.34	BL on standby	0.60		4 hr prep. ea dif. job
Pre-Job Safety Meeting	ea	81.90	3	$ 245.69		0.50	2ET + 1JS + IH	163.19	BL on standby	0.60		3 different days of work
Characterization (WBS 331.17)										Subtotal =		$ 523.64
Don PPE & Enter Zone	ea	122.23	1	$ 122.23		0.33	2ET + IH	111.66	BL on standby	0.60	84.81	1 day in rad zone & $28 ea PP
Collect Paint Samples	g	0.06	1,000	$ 56.10	2001		2ET + IH	111.66	BL	0.60		2001g/hr production rate
Collect Tar Samples	g	0.11	1,000	$ 112.26	1000		2ET + IH	111.66	BL	0.60		1000 g/hr production rate
Collect Lead Samples	g	0.20	400	$ 79.62	564		2ET + IH	111.66	BL	0.60		564 g/hr production rate
Doff PPE & Exit Zone	ea	37.42	1	$ 37.42		0.33	2ET + IH	111.66	BL	0.60		1 day in rad zone
Transport Samples	ea	19.34	3	$ 58.01		0.25	2ET	77.34				3 different days
Sample Journal	ea day	19.34	3	$ 58.01		0.50	ET	38.67				3 different days
Demobilization (WBS 331.21)										Subtotal =		$ 58.46
Return to Storage	ea	19.49	3	$ 58.46		0.250	2ET	77.34	BL on standby	0.60		3 different jobs
Disposal (WBS 331.18)										Subtotal =		$ 150.00
Used PPE Disposal	ft^3	150.00	1.00	$ 150.00								

Labor and Equipment Rates used to Compute Unit Cost

Crew Item	Rate $/hr	Abbrev-eation	Crew Item	Rate $/hr	Abbreveation	Equipment Item	Rate $/hr	Abbrev-eation	Equipment Item	Rate $/hr	Abbrev-eation
Job Supervisor	51.53	JS				Chisel & Scraper	0.60	BL			
Engineering Technician	38.67	ET									
Industrial Hygienist	34.32	IH									

Notes:

1. Unit cost = (labor + equipment rate) X duration + other costs, or = (labor + equipment rate)/production rate + other costs
2. Abbreviations for units: ls = lump sum; ea = each; and, loc = location; ft^3 = cubic feet.
3. Other abbreviations: PPE = personal protective equipment.

APPENDIX C

ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
CF	Central Facility
D&D	decontamination and decommissioning
DDFA	Deactivation and Decommissioning Focus Area
DOE	United States Department of Energy
ETR	Engineer Test Reactor
G&A	General and Administrative
GEEL	General Electric Experimental Loop
INEEL	Idaho National Engineering and Environmental Laboratory
LLW	low-level waste
LSDDP	Large Scale Demonstration and Deployment Project
NETL	National Energy Technology Laboratory
OMB	Office of Management and Budget
OST	Office of Science and Technology
PCB	polychlorinated biphenyls
PPE	Personal Protective Equipment
RCT	Radiation Control Technician
TCLP	Toxicity Characteristic Leaching Procedure
TRA	Test Reactor Area
WBS	Work Breakdown Structure