INNOVATIVE TECHNOLOGY
Summary Report

Concrete Shaver

OST Reference #1950

Deactivation and Decommissioning
Focus Area

Demonstrated at
Hanford Site
Richland, Washington

DISCLAIMER

INNOVATIVE TECHNOLOGY
Summary Report

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine if 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.

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SECTION 1

SUMMARY

The Marcrist Industries Limited concrete shaver is an electrically driven, self-propelled concrete and coating removal system. This technology consists of a 25-cm (10-in.)-wide diamond impregnated shaving drum powered by an electric motor and contains a vacuum port for dust extraction. The concrete shaver is ideal for use on open, flat, floor areas. The shaver may also be used on slightly curved surfaces. This shaver is self-propelled and produces a smooth, even surface with little vibration. The concrete shaver is an attractive alternative to traditional pneumatic scabbling tools, which were considered the baseline in this demonstration. The use of this tool reduces worker fatigue (compared to the baseline) due to lower vibration. The shaver is more than five times faster than the five-piston pneumatic scabbler at removing contamination from concrete. Because of this increased productivity, the shaver is 50% less costly to operate than baseline technologies. The U.S. Department of Energy has successfully demonstrated the concrete shaver for decontaminating floors for free-release surveys prior to demolition work.

■ Technology Summary

This section summarizes the demonstration of a concrete and coating removal tool developed by Marcrist Industries Limited (Doncaster, England). This improved technology was demonstrated for the U.S. Department of Energy's (DOE's) C Reactor Interim Safe Storage (ISS) Large-Scale Demonstration and Deployment Project (LSDDP) for the Hanford Site in Richland, Washington. DOE's Office of Science & Technology/ Deactivation and Decommissioning Focus Area, in collaboration with the Environmental Restoration Program, is undertaking a major effort of demonstrating improved technologies at its sites nationwide. If successfully demonstrated at the Hanford Site, these improved technologies could be implemented at other DOE sites and similar government or commercial facilities.

The Marcrist Industries Limited concrete shaver provides an attractive alternative to traditional methods of decontaminating floors, which is typically accomplished using pneumatic scabbling tools. The concrete shaver (model DTF25) is a self-propelled, electric-powered, concrete diamond-shaving machine that can remove concrete surfaces with extremely accurate tolerances. This unit has a 25-cm (10-in.)-wide shaving drum that is suitable for flat or slightly curved floors and a vacuum port for dust extraction. For decontamination and decommissioning (D&D) projects, the shaver can be used for decontamination of large areas or hot spots on floors. This demonstration was performed in an area formerly used as a sample room, with the goal of decontaminating the floors to free-release levels in preparation for demolition. This technology is suitable for DOE nuclear facility D&D sites or similar public or commercial sites that must be decontaminated.

Problem Addressed

The DOE is in the process of D&D for many of its nuclear facilities throughout the United States. These facilities must be dismantled and the demolition waste sized into manageable pieces for handling and disposal. The facilities undergoing D&D are typically chemically and/or radiologically contaminated. To facilitate this work, DOE requires a tool capable of removing the surface of radiologically contaminated concrete floors. Operating requirements for the tool include simple and economical operation, the capability of operating in ambient temperatures from 3°C to 40°C (37°F to 104°F), and the ability to be easily decontaminated. The tool also must be safe for workers.

Features and Configuration

- Weight: 150 kg (330 lbs)
- Shaving drum width is 25 cm (10 in.)
- Requires 380- to 480-volt, 3-phase power; minimum 16 amps
- Self-propelled, variable speed (1 to 8 m/min) with forward and reverse
- Cutting depth can vary from 0 to 1.3 cm (0.5 in.)
- Can shave within 7.5 cm (3 in.) from a wall/floor interface or other obstruction

- Contains an extraction port that can be used in conjunction with a vacuum extraction system for dust-free operation
- The design for mounting the blades on the drum results in low vibration levels.

Potential Markets/Applicability

The concrete shaver is useful at DOE, U.S. Environmental Protection Agency (EPA), or U.S. Nuclear Regulatory Commission (NRC) sites where contaminated concrete surfaces must be removed as part of the decontamination process. The technology could be used at other public or commercial facilities where a concrete or coating removal system is required. This technology can be used to decontaminate concrete floors and slabs that are generally planar. It can be used both on interior and exterior surfaces. The self-propelled, electric-powered concrete shaver is particularly useful on large, flat, open areas.

Advantages of the Improved Technology

Table 1 summarizes the advantages of the improved technology against the baseline tool, a hand-pushed pneumatic multi-piston concrete scabbler on wheels, in key areas.

Table 1. Summary of advantages of concrete shaver

Category	Comments
Cost	The operating costs for the concrete shaver technology are $14.21/m^2 ($1.32/ft^2) versus $43.60/m^2 ($4.05/ft^2) for the baseline scabbler.
Performance	The concrete shaver removes concrete surfaces much faster than the baseline technology (by a factor of almost five) (11.9 m^2/hr [128 ft^2/hr] vs. 2.5 m^2/hr [27 ft^2/hr] at 3 mm [1/8 in.] depth). The concrete shaver leaves a smoother surface than the baseline tool, so final release surveying is more reliable.
Implementation	The concrete shaver weighs approximately 150 kg (330 lb) and is easy to operate. It requires no specialized training to use. No special site services are required to implement the concrete shaver.
Secondary Waste Generation	The concrete shaver generates dust that is collected with a high-efficiency particulate air (HEPA) filtration system, as with the baseline tool. The volume of dust generated by the improved technology is slightly less than the baseline.
ALARA/Safety	Use of concrete shaver is consistent with as low as reasonably achievable (ALARA) exposure. Decontamination can be accomplished more rapidly then baseline, thereby reducing exposure time in a contaminated area. The concrete shaver operator experiences reduced levels of vibration compared to the baseline.

Upon completing the demonstration using the concrete shaver on a rental basis, the unit was purchased for further use at C Reactor and upcoming D&D at the Hanford Site F and DR Reactors.

Shortfalls/Operator Concerns

The large amount of concrete dust generated by the improved technology (as well as by the baseline tools) requires the use of a vacuum filtration unit. Workers must be vigilant to ensure that the vacuum hose stays connected properly and that a suitable vacuum level is maintained.

Skills/Training

Training of field technicians is minimal, provided that the trainees have a basic understanding of similar equipment.

Demonstration Summary

This report covers the period of November 1997, during which the Marcrist Industries Limited concrete shaver was demonstrated by the Hanford Site C Reactor Technology Demonstration Group.

Demonstration Site Description

This concrete shaver technology was demonstrated for the first time at the DOE's Hanford Site. Decontamination of a sample room floor was performed at the C Reactor to radiologically release the room from contamination prior to demolition. The demonstration was conducted by onsite D&D workers who were instructed by the vendor prior to and during the demonstration.

Regulatory Issues

There are no special regulatory or permit requirements associated with implementation of this technology. Normal worker safety practices should be applied when using this tool in accordance with applicable regulations, particularly 10 *Code of Federal Regulation* (CFR), Parts 20, 835, and proposed Part 834, for protection of workers and the environment from radiological contaminants; and 29 CFR Occupational Safety and Health Administration (OSHA) worker requirements.

Technology Availability

The concrete shaver demonstrated at the Hanford C Reactor is available through Marcrist Industries Limited, located in Doncaster, England.

Technology Limitations/Needs for Future Development

Due to the physical size and geometry of the concrete shaver, it is not appropriate for use on very small concrete floors and slabs or those with a significant number of obstructions. This tool is well-suited for large, wide-open concrete floors and slabs where push-type and wheel-powered diamond grinders and shavers can be used. The demonstration at the C Reactor ISS Project did not reveal any need to modify the tool.

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Others
All published Innovative Technology Summary Reports are available at http://em-50.em.doe.gov. The Technology Management System, also available through the EM50 Web site, provides information about OST programs, technologies, and problems. The OST Reference Number for Concrete Shaver is 1950.

SECTION 2

TECHNOLOGY DESCRIPTION

■ Overall Technology/Process Definition

The DOE nuclear facility D&D program requires decontamination techniques suitable for flat or slightly curved surfaces as a part of D&D projects. The improved tool demonstrated can be used for radiological decontamination of large areas or hot spots on floors. The manufacturer produces similar models that can be track mounted for removing concrete surfaces from walls as well as floors.

The model DTF25 concrete shaver is a self-propelled, walk-behind electric-powered shaving machine that uses diamonds impregnated on drum-mounted blades to shave concrete surfaces with extremely accurate tolerances. The shaver is suitable for flat (or slightly curved) walls and floors. The machine is fitted with a 25-cm (10-in.) wide by 12.7-cm (5-in.) diameter shaving drum, onto which are fitted numerous Marcrist-patented diamond-impregnated blades. The number of blades chosen is dependent upon the surface finish required. The design for mounting the blades on the drum results in low vibration levels. Infinitely variable shaving depths from 0.01 cm (0.004 in) to 1.3 cm (0.5 in) can be achieved. The system is designed to be used with a vacuum extraction unit for dust-free operations. The travel rate is infinitely variable, giving a high production rate. The unit weighs 150 kg (330 lb) and consumes 16 amps of 380-volt to 480-volt, 3-phase power, and has forward and reverse action. The depth of shaving is set by the use of a manual rotary wheel that is linked to a digital display. One set of shaver blades is rated for 156 hours of operation.

The concrete shaver used for this demonstration is shown in Figure 1. Figure 2 shows the concrete shaver in use during the technology demonstration at the Hanford Site C Reactor building in Sample Room X.

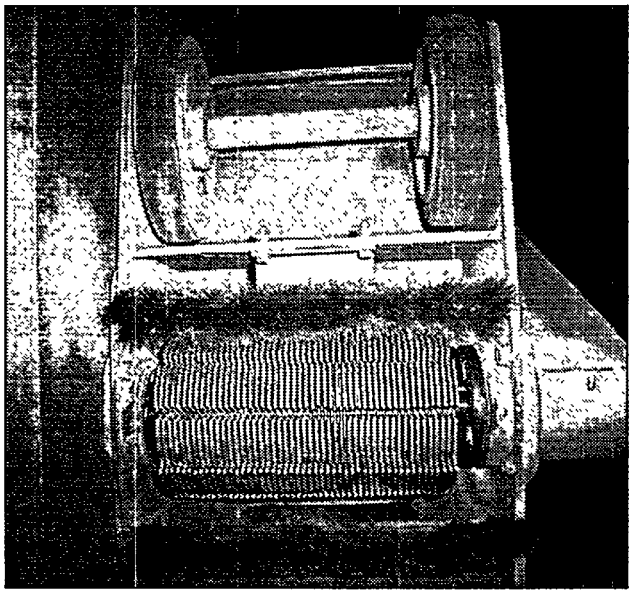

Figure 1. Shaver and the shaving drum.

Figure 2. Decontamination in Sample Room X.

Overview

- The concrete shaver (model DTF25) is a self-propelled, electric-powered tool that weighs 150 kg (330 lbs) and contains a vacuum port for containment of dust. This tool is suitable for flat (or slightly curved) floors.
- The unit can shave concrete as close to corners as 7.5 cm (3 in.) with the standard configuration, and this can be reduced to 1.5 cm (5/8 in.) with an optional side unit.
- Variable shaving depths from 0 to 1.3 cm (0.5 in.) can be achieved; depth is set by the use of a manual rotary wheel linked to a digital display.

- The horizontal traveling speed is variable (1 to 8 m/min) and can provide high production rates.
- The shaving drum can be fitted with a variety of diamond-impregnated blades, depending on the surface finish required.
- The design for mounting the blades on the drum results in low vibration levels.

Components

The concrete shaver consists of the following components:

- A 25-cm (10-in.) wide by 12.7-cm (5-in.)-diameter shaving drum, onto which numerous Marcrist-patented diamond-impregnated blades are fitted. The number of blades chosen is dependent upon the surface finish required.
- An extraction port for use with a vacuum extraction unit for dust-free operations.
- Manual rotary wheel depth control with electronic readout.

System Operation

Setup Procedure

Approximately 10 minutes is required to set up the system under normal operation conditions. The setup involves the following steps:

- Free wheel check of the shaver drum
- Check power cable for cuts or external wear
- Check vacuum port and exhaust system and connect all hoses
- Connect the power cords to 480-volt source
- Perform a system check to verify that all of the components are operating.

Operation

The Hanford Site C Reactor concrete shaving decontamination was performed by four persons. One person operated the improved concrete shaver; and three other persons provided support services.

- Attach vacuum hose
- Adjust depth of concrete surface removal desired
- Connect electric power
- Check vacuum filtration operation and depth of shaving; re-adjust as necessary
- Proceed with shaving operation.

SECTION 3

PERFORMANCE

■ Demonstration Plan

Site Description

This demonstration was conducted at the DOE's Hanford Site by Bechtel Hanford, Inc. (BHI), the DOE's Environmental Restoration Contractor responsible for the D&D program at the Hanford Site. The purpose of the LSDDP is to demonstrate at full-scale (measuring performance and costs) innovative/improved technologies, and to deploy superior ones. A part of the LSDDP is integrated with a D&D project with a goal to place the Hanford Site's C Reactor into an interim storage mode for up to 75 years, or until the final disposal of the reactor's core is completed. The C Reactor ISS objectives include placing the reactor in a condition that will not increase future decommissioning costs, minimizing the potential for releases to the environment, and reducing the frequency of inspections, thereby reducing potential risk to workers.

The DOE is in the process of decontaminating and decommissioning many of its nuclear facilities throughout the United States. Facilities must be dismantled and demolition waste must be sized into manageable pieces for handling and disposal. The facilities undergoing D&D are typically chemically and/or radiologically contaminated. To support this D&D work, DOE requires a tool capable of removing the surface of radiologically contaminated concrete floors. The tool must to be easy and economical to operate, capable of operating in ambient temperatures from 3°C to 40°C (37°F to 104°F), and easy to decontaminate using conventional equipment. The tool also must be safe for workers to use. The Marcrist Industries Limited concrete shaver satisfies these needs and is an attractive alternative to traditional technologies used for similar operations (e.g., concrete multi-piston scabblers).

The demonstrations of the concrete shaver were conducted during November 1997 at Sample Rooms X and Y at the Hanford Site's C Reactor building. The baseline technology was conducted during October and November 1997 at Sample Rooms A and B at the C Reactor building. Approximately 76 m^2 (816 ft^2) of floors were decontaminated to free-release levels using the shaver, removing 3-mm (1/8- in.) depth from the concrete surfaces.

Performance Objectives

Objectives of the demonstration included the following desired capabilities and design features for the equipment:

- Capable of removing concrete preferably using diamond grinding technology.
- Compatible with a dust collection shroud that may be attached to an existing onsite high-efficiency particulate air (HEPA) filtration system.
- Fitted with a power cord and energized with commonly available electric power.
- Able to remove 3 mm (1/8-in.) depth of potentially contaminated concrete. Multiple passes may be used to achieve this depth.
- Able to handle steel-reinforcing bar and piping that may be imbedded in the concrete being decontaminated.
- Able to operate in an ambient temperature environment from 3°C to 40°C (37°F to 104°F).

The sample rooms required 1.5 to 3 mm (1/16 in. to 1/8 in.) of concrete removal from floors (small areas to 6 mm [1/4 in.]). The sample rooms had lead-based paint on the floor.

Baseline Technology

The baseline technology was an air-powered scabbler, which is a walk-behind push-type device with five piston heads. The scabbler is designed to remove concrete surfaces between 0.3 cm^2 (1/8 in.) and 0.6 cm (1/4 in.) from large areas. A single pass with this tool on an area of 3.0 cm^2 (11.5 in.) delivers 1,200 piston strikes per minute to the concrete surface. A moisture separator and pressure regulator are mounted directly on unit frame, and the unit also contains an automatic in-line oiler for low piston maintenance. The entire unit is mounted on a sturdy wheeled hand-cart assembly for ease of movement. Figure 3 shows the baseline unit as it was used. Three types of scabbler bits are available to meet the desired surface preparation, with each scabbler bit designed for 50 hours of operation. Figure 4 shows one of the 5 piston heads used in the baseline demonstration, with the type of bits employed.

Figure 3. Baseline 5-piston scabbler.

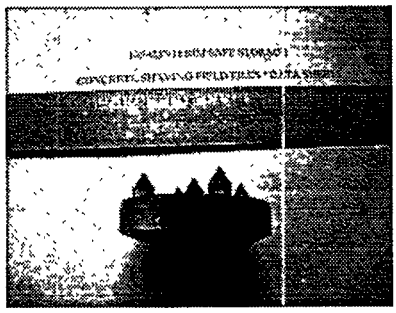

Figure 4. Piston head with bits for scabbler.

■ Technology Demonstration Results

Key Demonstration Results

Successes

- The demonstration decontaminated to free-release levels floors in Sample Rooms X and Y at the Hanford Site C Reactor building southeast work area.
- The concrete shaver leaves a smoother surface than the baseline tool, so final release surveying is more reliable.
- The concrete shaver removes concrete surfaces approximately five times faster than the baseline.
- The concrete shaver vibrates less than baseline tool.
- The concrete shaver abrades embedded steel in addition to concrete.
- There was no visible wear after removing 0.3 cm (1/8 in.) depth of concrete from the two sample rooms. Blade life is estimated by the manufacturer to be good for removing 0.3 cm (1/8 in.) depth from 1,800 m^2 (20,000 ft^2) of concrete surface area. This would be equivalent to over three times the hours of usage between blade changes versus bit changes for the baseline scabbler.

Upon completing the demonstration using the concrete shaver on a rental basis, the unit was purchased for further use at C Reactor and upcoming D&D at the Hanford Site F and DR Reactors.

Shortfalls

No shortfalls were noted.

Meeting Performance Objectives

All objectives listed in the Demonstration Plan section were met, except that the last item (operate in the 3°C to 40°C range) was not attempted during the demonstration. The manufacturer's specifications indicate that the technology can meet this objective.

■ Comparison of Improved Technology to Baseline

The major difference in productivity between the improved and baseline technologies is related to the removal methodology that each technology employs. With the floor shaver, the diamond-bit drum enables single-pass cutting depth precision while minimizing and containing the waste generated. The scabbler is neither as precise nor as fast as the floor shaver as it essentially works on a carbide-tipped bit, hammer-blow principle. After making a pass with the scabbler, the resulting floor surface is left rough and irregular and not always cut to the proper depth. This forces the operator to decrease the speed of the device and rework areas to achieve the proper depth. The reworking required to achieve the correct depth also means more concrete waste is generated, thus increasing disposal costs.

Table 2 summarizes performance and operation of the improved technology compared to the baseline technology.

Table 2. Comparison of improved and baseline technologies

Activity or Feature	Improved Technology Shaver	Baseline Technology Scabbler
Setup[a], minutes	2	42
Flexibility	Same	Same
Safety	Better[b]	Good
Durability	Good	Good
Ease of operation	Easy, weighs less and less vibration than baseline	Easy
Waste generation	Slightly less dust generation than baseline	Slightly more dust/particulate generation than improved tool[c]
Utility requirements	480v / 3-phase /50 to 60 Hz	4570 liters/min @ 1230 bars (160 cfm air @ 85 psig)
Training	Same	Same
Area Removed	76 m² (816 ft²)	64 m² (686 ft²)
Total Duration (hours)	5.6	21.7
Performance (production rate)	11.9 m²/hr (128 ft²/hr)	2.6 m²/hr (27 ft²/hr)
Comments	The shaver blades exhibited no noticeable wear after shaving two sample rooms. The unit can shave material within 7.5 cm (3 in.) of a wall.	The scabbler performs well in large open areas to remove gross volumes of concrete. The unit can scabble material to within 10 cm (4 in.) of a wall.

Notes: a. Average times connected to electric outlet or air supply unit and tested before use. Both improved and baseline tools used a HEPA system, which required much more time to set up (approximately one day).
b. Worker fatigue and potential harm to hands is reduced because of the shaver's lower operating vibration.
c. A precise depth cannot be achieved with the scabbler. Therefore, multiple passes are often needed and the resulting surface is irregular, with some areas having a larger amount of material removed than the minimum required.

With the improved technology the depth of shaving is controlled. With the baseline scabbler at least 3-mm (1/8-in.) depth is removed; the total depth is difficult to control and the volume of waste generated is higher than with the shaver. This increased waste volume can significantly increase costs at sites with high waste disposal unit costs. Because of the variety of functions and facilities, the DOE complex presents a wide range of D&D working conditions. The working conditions for an individual job directly affect the manner in which D&D work is performed. The improved and baseline technologies presented in this report are based upon a specific set of conditions and/or work practices found at the Hanford Site, which are summarized in Table 3. Table 3 is intended to help the technology user identify work item differences between baseline and improved technologies.

Table 3. Summary of variable conditions

Variable	Improved Technology	Baseline Technology
Scope of Work		
Quantity and type of material decontaminated in test areas	76 m^2 (816 ft^2) of concrete floor surfaces	64 m^2 (686 ft^2) of concrete floor surfaces
Location of test area	Reactor Building, Sample Rooms X and Y	Reactor Building, Sample Rooms A and B
Nature of work	Remove 0.3 cm (0.13 in.) of concrete with lead-based paint	Remove 0.3 cm (0.13 in.) of concrete with lead-based paint
Work Environment		
Fixed or removable contamination in the test areas	Contamination that might be present is fixed	Contamination that might be present is fixed
Condition of floor in test areas	Unobstructed	Unobstructed
Work Performance		
Technology acquisition means	For this demonstration only, the shaver was rented on a daily basis, with option to purchase	Purchased tool
Compliance requirements	Must meet 10 CFR 835, Appendix D (see BHI-SH-04 in Appendix A)	Must meet 10 CFR 835, Appendix D (see BHI-SH-04 in Appendix A)
Work Process Steps		
Operation	Attach vacuum hose to filtration unit and plug in cord to electrical power supply. Inspect shaving drum occasionally during use, and change the blades every 156 hours usage time.	Attach vacuum hose to filtration unit and pneumatic hose to air compressor. Inspect scabbler head occasionally during use, and change every 45 hours usage time.

Skills/Training

Training of field technicians is minimal, provided that the trainees are proficient in operating similar equipment.

Operational Concerns

Both the baseline and the improved technologies should be used with a vacuum filtration unit. The operator must be vigilant to ensure that the vacuum hose remains properly connected and that the manufacturer-recommended level of vacuum suction is maintained.

SECTION 4

TECHNOLOGY APPLICABILITY AND ALTERNATIVE TECHNOLOGIES

■ Technology Applicability

- The concrete shaver technology can be used to decontaminate floors, walls, and other concrete surfaces.
- The system may be used both on interior and exterior surfaces.
- The concrete shaver is applicable to radiologically contaminated sites with surface contamination or suspect surface contamination slated for D&D activities and subsequent release (DOE, EPA, or NRC sites).
- The concrete shaver can also be used for any concrete resurfacing or deep-cleaning operations, particularly where a smooth finish is desired.

■ Competing Technologies

- In addition to the baseline multi-piston scabbler demonstrated, there are also other types of large scabblers that are suitable for large, open surfaces:

  - Push type
  - Wheel powered
  - Track mounted.

- Other methods of concrete surface decontamination technologies (e.g., laser ablation, media blasting, cryogenic nitrogen blasting, and carbon dioxide pellet blasting) take longer to set up and demobilize, cost more, and may not have as high a production rate.
- A diamond-wheel concrete grinder can also be used for such surface decontamination. A smaller, hand-held unit that was demonstrated at the Hanford Site's C Reactor has a competitive production rate but is not suitable for use in decontaminating large areas.

■ Patents/Commercialization/Sponsors

- The concrete shaver demonstrated at the Hanford C Reactor is available through Marcrist Industries Limited (Doncaster, England). (No U.S. distributors currently).

SECTION 5

COST

■ Introduction/Methodology

The purpose of this section is to summarize cost elements for the improved technology and analyze the potential for savings relative to equivalent cost elements for the baseline technology. The objective is to assist a decision maker who is debating whether further investigation of the improved technology is warranted. For this demonstration, the improved technology saved approximately 50% over the baseline. Details of the cost comparison are covered in Appendix C of this report and summarized in Figure 3.

This cost analysis compares the Marcrist concrete shaving improved technology for removing concrete floor surfaces to precise depths to a baseline technology consisting of a concrete floor scabbler with a five-piston head. Costs for the improved technology are based on two decontamination technicians using the floor shaver for concrete removal work inside a contamination zone, assisted by one decontamination technician outside the contamination zone. Also included in costs for the improved technology is monitoring for radiological contamination conducted by a radiological control technician (RCT) and air sampling for lead conducted by an industrial hygienist. (Floors in the demonstration area have a lead-based paint coating).

Costs for the baseline technology are based upon the same number of D&D workers conducting the same removal activities but using the five-piston scabbler. Monitoring for radiological contamination and airborne lead contamination are also included in calculation of the baseline costs.

Activities included for cost comparison are as follows:

Improved Technology	Baseline Technology
• Setting up the vacuum HEPA filtration unit and air compressor in the work area and wrapping powered air purifying respirators (PAPRs)	• Setting up the vacuum HEPA filtration unit and air compressor in the work area & wrapping PAPRs
• Setting up the Marcrist floor shaver (installing blades and testing operability)	• Setting up the floor scabbler
• Donning personal protective equipment (PPE)	• Donning PPE
• Removing 0.3 cm (1/8 in.) of concrete floor with the Marcrist floor shaver	• Removing 0.3 cm (1/8 in.) of concrete floor with the floor scabbler
• Monitoring workers and waste stream for radiological contamination	• Monitoring workers and waste stream for radiological contamination
• Disassembling equipment and air hoses, and doffing PPE.	• Disassembling equipment/air hoses, and doffing PPE.
• Disposing of removed concrete, PPE, and plastic sheeting and sleeving.	• Disposing of removed concrete, PPE, and plastic sheeting and sleeving.

■ Cost Analysis

Table 4 presents acquisition costs for both the baseline and the improved technologies.

Table 4. - Technology Acquisition Costs

TECHNOLOGY	ITEM	COST
Diamond Shaver[a,b]	• Marcrist DTF Diamond Floor Shaver (complete with drum & one set of diamond blades)	$10,700.00
	• Replacement Diamond Blades[c,d] Normal Concrete Abrasive Concrete	 $7,161.00/set (100 blades) $7,715.00/set (70 blades)
Scabbler	• 5-Piston Floor Scabbler	Approximately $7,000.00
	• Replacement Carbide-Tipped Scabbling Bits	$480.00 (full set of 5 bits)

Notes:
a. Costs were supplied by Marcrist Industries Ltd., 1997. This cost estimate was for a used machine. A new machine including drum without blades was quoted at $12,375, May, 1998.
b. Marcrist Industries Ltd. does not offer an equipment rental option or decontamination services.
c. The manufacturer is currently offering a 40% discount on the price of replacement blades for customers who make minimum purchases of $20,000 per year.
d. Blade life is estimated at 1860 m^2 (20,000 ft^2) for removing 0.3 cm (1/8 in.) depth of concrete or 156 hours of use.

Observed unit costs and production rates for principal components of the demonstrations for both the improved and baseline technologies are presented in Table 5.

Table 5. Summary of production rates and unit costs

Improved Technology			Baseline Technology		
Cost Element	**Production Rate**	**Unit Cost**	**Cost Element**	**Production Rate**	**Unit Cost**
Removing 0.3 cm (1/8 in.) of concrete floor with the Marcrist floor shaver	11.9 m^2/hr (128 ft^2/hr)	$14.21/$m^2$ ($1.32/$ft^2$)*	Removing 0.3 cm (1/8 in.) of concrete floor with the concrete floor scabbler	2.5 m^2/hr (27 ft^2/hr)	$43.60/$m^2$ ($4.05 ft^2)*
Replacement blades for the Marcrist concrete floor shaver	1 set/1,860 m^2 (20,000 ft^2) of concrete shaved **or** 1 set/156 hrs use (based on the above listed productivity)	$7,172.00/set (for normal concrete)	Replacement bits for the concrete floor scabbler	1 set/113 m^2 (1,215 ft^2) of concrete scabbled **or** 1 set/45 hrs use (based on the above listed productivity)	$480.00/set (for normal concrete)

*Unit cost for improved technology includes blade wear.

The unit costs and production rates shown do not include mobilization, other losses associated with non-productive portions of the work (e.g., suit-up, breaks, etc.), or waste disposal. The intention of Table 5 is to show unit costs at their elemental level which are free of site specific factors (such as work culture or work environment influences on productivity loss factors). Consequently, the unit cost for removing concrete floor surfaces is the unit cost shown for the "Remove Concrete Floor Surface" line item of Table B-2 and Table B-3 of Appendix B. These tables can be used to compute site-specific costs by inserting quantities and adjusting the units for conditions of a

individual D&D job. The unit costs for blade and bit replacement are based on quoted rates and the experience of the vendor.

Figure 5 is a chart displaying a comparison of costs between the improved and baseline technologies for removal of 0.3 cm (1/8 in.) of concrete floor surface. The comparison is based on costs experienced during demonstrations of both technologies at the Hanford Site C Reactor. The concrete shaver was demonstrated on 816 ft^2 of floor in Sample Rooms X and Y. The concrete scabbling baseline technology was demonstrated on 686 square feet of floor in Sample Rooms A and B located in the northeast reactor area.

To create an equitable comparison between the improved and baseline technologies, the floor area demonstrated for the baseline technology has been extrapolated to match the actual floor area demonstrated for the improved technology. The concrete removal by scabbling productivity measured on a square foot basis is multiplied by 816 ft^2 (76 m^2) to calculate the increase in hours for the extrapolation. All other baseline technology costs, (e.g., setting up equipment, donning/doffing PPE, disassembling equipment, and disposing of waste) are based on hours actually experienced during the demonstration.

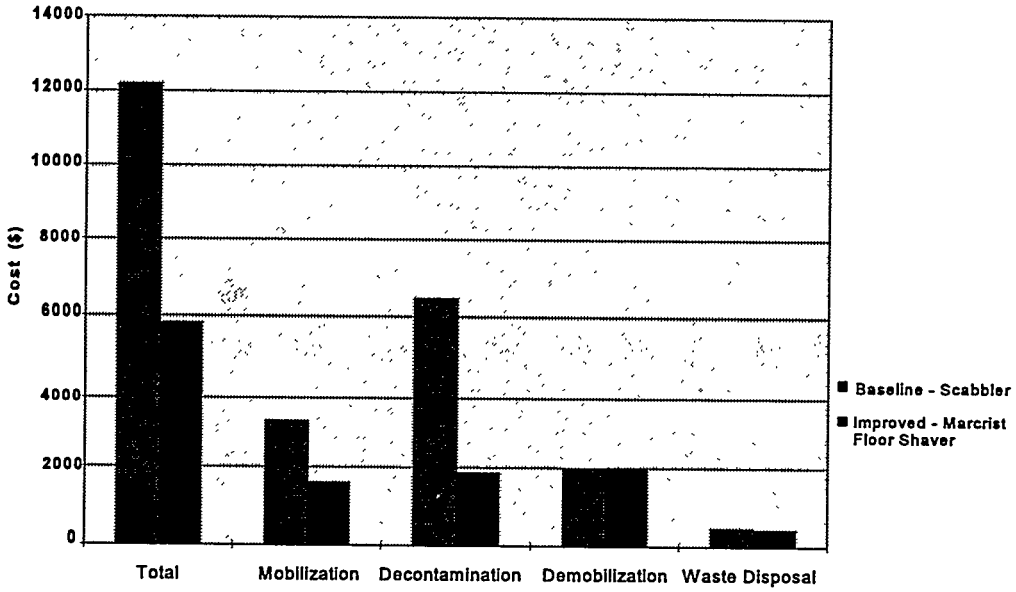

Figure 5. Cost comparison between the improved and baseline technologies.

■ Cost Conclusions

Under the conditions of this technology demonstration, the improved concrete shaver saved approximately 50% in cost over the baseline scabbling technology. Most of this difference is attributable to the increased productivity realized with the floor shaver (see Table 2) and the effect this increase has on the number of days worked. The slower removal rate experienced with the baseline technology resulting in more days worked in the contamination area, thus, more time required for donning/doffing PPE and more time required for RCT and industrial hygienist support.

The improved technology provides another cost advantage related to routine replacement parts. As seen in Table 5, a set of replacement blades for the floor shaver (100 blades per drum are required) costs $7,172, versus $480 for a set of five replacement scabbling bits. According to the manufacturer, one set of floor shaver blades can remove up to 1860 m^2 (20,000 ft^2) of normal concrete, while the scabbling bits are projected to remove 113 m^2 (1,215 ft^2). Given these estimates for longevity, one set of shaver blades will cost approximately $730 less than scabbling bits for an area of 1860 m^2 (20,000 ft^2).

The major difference in productivity between the improved and baseline technologies is related to the removal methodology each employ. With the floor shaver, the diamond-bit drum enables single-pass cutting depth precision while minimizing and containing the waste generated. The scabbler is neither as precise nor as fast as the floor shaver since it essentially works on a carbide-tipped bit hammer-blow principle. After making a pass with the scabbler, the resulting floor surface is left rough and irregular and not always cut to the proper depth. This forces the operator to decrease the speed of the device and rework areas to achieve the proper depth. The reworking required to achieve the correct depth also means more concrete waste is generated, thus, increasing disposal costs.

The potential savings realized by using the improved technology increases at sites with high disposal costs. The disposal quantity for scabbling is approximately twice the amount observed for the improved technology (due to the scabbler's tendency to remove more than 0.3-cm (1/8-in.) depth of material). The costs for disposal at the Hanford Site are minimal, consequently the difference in disposal volume does not translate into significant cost savings. At other sites, the ability to finely control the amount removed and reduced volume of waste may result in significant savings.

SECTION 6

REGULATORY/POLICY ISSUES

■ Regulatory Considerations

- The concrete shaver is a concrete decontamination tool used for cleaning contaminated concrete surfaces; therefore, there are no special regulatory permits required for its operation and use.
- The system can be used in daily operation under the requirements of 10 CFR Parts 20 and 835, and proposed Part 834 for protection of workers and environment from radiological contaminants; and 29 CFR, OSHA worker requirements.
- Although the demonstration took place at a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) site, no CERCLA requirements apply to the technology demonstrated.

■ Safety, Risk, Benefits, and Community Reaction

Worker Safety

- Normal radiation protection and worker safety procedures used at the facility would apply. Unless field tests show that the vacuum system is collecting airborne particulates effectively, respiratory protection should be used.
- To avoid spreading contamination, the operator must be vigilant to ensure that the vacuum hose connections remain secured, that adequate vacuum is maintained, and that the filters are operating normally.
- All procedures and equipment must meet the National Electrical Code, especially regarding grounding.

Community Safety

Implementation of the improved diamond-grinding technology would not present any adverse impacts to community safety if vacuum filtration is properly used.

■ Environmental Impact

Implementation of the improved diamond-grinding technology would not present any adverse impacts to the environment if vacuum filtration is properly used.

■ Socioeconomic Impacts, and Community Perception

No socioeconomic impacts are expected with the use of this technology.

SECTION 7

LESSONS LEARNED

Implementation

- No special implementation concerns apply to concrete shaver technology. Industrial electrical power supply voltage (480 VAC) and circuitry are required. A HEPA vacuum filtration unit is required.

Technology Limitations/Needs for Future Development

- The concrete shaver is not appropriate for small, congested concrete floors and slabs where smaller hand-held tools (e.g., diamond-wheel grinders) can be used. This technology is well-suited for large open areas, say over 10 m^2 (100 ft^2), with few obstructions.
- Currently, there is no need to modify the tool demonstrated at the Hanford Site C Reactor.
- The model DTF 25 shaver demonstrated is designed for use on floors or slabs (not walls). Other models are available that can be track-mounted for use on walls.

Technology Selection Considerations

- The technology is suitable for DOE nuclear facility D&D sites or similar sites where concrete structures must be decontaminated to facilitate property transfer or release.
- The concrete shaver tool demonstrated should be considered for decontamination of open unobstructed floors where a smooth finish is desired.
- The concrete shaver abrades embedded steel in addition to concrete. The baseline scabbler is not designed to process steel.

APPENDIX A

REFERENCES

10 CFR Part 834, "Environmental Radiation Protection," *Code of Federal Regulations,* as proposed.

10 CFR Part 835, "Occupational Radiation Protection," *Code of Federal Regulations,* as amended.

10 CFR Part 20, "Occupational Radiation Protection," *Code of Federal Regulations,* as amended.

29 CFR Part 1910, "General Industry Occupational Safety and Health Standards," *Code of Federal Regulations,* as amended.

29 CFR Part 1926, "Construction Occupational Safety and Health Standards," *Code of Federal Regulations,* as amended.

BHI-SH-04, *Radiological Control Work Instructions,* Procedure 3.8, "Material Release Surveys and Practice," Bechtel Hanford, Inc., Richland, WA, 1998

Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary, U.S. Army Corps of Engineers, Washington, D.C., 1996.

Means, 1997, *Means Construction Equipment Cost Estimates,* R.S. Means Co., Kingston, Massachusetts.

Office of Management and Budget Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*

APPENDIX B

COST COMPARISON

This cost analysis compared the Marcrist Industries Limited concrete shaving improved technology for removing concrete floor surfaces to precise depths to a baseline technology consisting of a concrete floor scabbler with a five-piston head. Costs for the improved technology are based on two decontamination technicians using the floor shaver for concrete removal work inside a contamination zone assisted by one decontamination technician from outside the contamination zone. Costs for the baseline technology are based upon the same number of D&D workers conducting the same removal activities but using the five-piston scabbler. Monitoring for radiological contamination and airborne lead contamination are also included in the cost comparison. Tabulated costs for the improved technology and the baseline are in Tables B-2 and B-3, respectively.

To provide consistency with established national standards, the activities analyzed in this cost comparison follow those used in the *Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary* (USACE 1996).

Some costs are omitted from this analysis so it is easier to understand and to facilitate comparison with costs for the individual site. The overhead and general and administrative (G&A) markup costs for the site contractor managing the demonstration are omitted from this analysis. Overhead and G&A rates for each DOE site vary in magnitude and the way in which 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 Hanford Site.

The following assumptions were used as the basis of the improved cost analysis:

- Oversight engineering, quality assurance, and administrative costs for the demonstration are not included. These are normally covered by another cost element, generally as an undistributed cost.
- The procurement cost of 7.5% was applied to all equipment costs to account for costs of administering the purchase (this cost is included in the hourly rate).
- The equipment hourly rates for the shaver and for the scabbler represents the Government's ownership, and are based on general guidance contained in Office of Management and Budget (OMB) circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.*
- The standard labor rates established by the Hanford Site for estimating D&D work are used in this analysis for the portions of the work performed by local crafts personnel.
- The analysis uses an eight-hour work day.
- An anticipated life of five years and an average usage of 500 hrs/year are used in the calculation for the floor shaver and the vacuum HEPA filtration unit.

Improved Technology - Marcrist Diamond Floor Shaver

MOBILIZATION (WBS 331.01)

Set Up Floor Shaver: This includes time for loading equipment from storage boxes into a truck bed and moving the equipment to the work area. It also includes setting up the compressor and air lines.

Install Blades: This activity involves installing the 100 diamond blades in the drum (would not be repeated for every job).

Set Up Vacuum: This activity involves setting up the vacuum HEPA filtration unit and its hoses.

Sleeve Vacuum Hoses: This activity involves using duct tape to attach plastic tubing to the vacuum hoses to prevent surface contamination of the hoses in the radiation zone.

Wrap PAPR's in Rooms X and Y: On a daily basis, three to five PAPR units are required to be wrapped with a plastic cover along with the hose that delivers air to the mask. This measure is taken to prevent contaminating the units which, if it occurred, would mean discarding them. The activity is measured as one each and is the time it takes to wrap all PAPR used in the demonstration.

DECONTAMINATION (WBS 331.17)

Pre-Work Briefing and Safety Meeting: This activity involves everyone who will work in or around the contamination area. A pre-work briefing and safety meeting are requirements to be conducted every day of demolition work and, thus, is measured as a daily activity.

Don and Doff PPE: This cost item includes time for each worker to fully suit-up in PPE as well as material costs for the PPE, and includes removal of the PPE. The time spent donning and doffing each day is based on observed times for previous deployments (long-term and large-scale jobs). Material costs for daily PPE for one D&D worker at the Hanford Site are shown in the table below:

Table B-1. Daily PPE costs

Equipment	Cost Each Time Used ($)	No. Used Per Day	Cost Per Day ($)
Air purifying respirator (PAPR)	71.06	1 ea	71.06
Face shield	1.28	1 ea	1.28
Booties	0.62	2 pr	1.24
Coverall	5.00	2 ea	10.00
Double coverall (5% of the time)			0.56
Hood	2.00	2 ea	4.00
Gloves (inner)	0.14	2 pr	.28
Gloves (outer)	1.30	2 pr	2.60
Gloves (liner)	0.29	2 pr	.58
Rubber overshoe	1.38	2 pr	2.76
Total			**94.36**

Notes: Based on a PAPR price of $603/each, assuming 50 uses; four cartridges required per day at a cost of $14/each; and maintenance and inspection costs of $150 over the life of the PAPR (50 uses). One worker is assumed to remain outside the contaminated area and is not suited up. Based on a face shield price of $64/each and assuming 50 uses.

Remove Concrete Floor Down 0.3 cm (1/8 in. With the Scabbler (Rooms A and B): Concrete removal was conducted with a crew consisting of 3 D&D Workers. Two of the workers were fully suited in PPE (equipped with respirators) and worked inside the contamination area. The other workers acted to support the workers inside the contamination area by providing them with needed supplies and ensuring that the air and vacuum lines remained operational. Removal work took place in two different rooms at the C Reactor (referenced as Sample Rooms X and Y) on various floor areas where spot contamination was present. Based on the type of contamination, it was only necessary to remove the concrete to 0.3 cm (1/8 in.) deep. Removal time includes the time it took to move the floor shaver from spot to spot within Rooms X and Y. Costs for the removal work are calculated on a per square foot basis to establish a per square foot unit cost.

Move the Floor Shaver from Room X to Room Y: This activity is accounted for separately because of some restaging of vacuum hoses that was required when the floor shaver was moved from one room to the other. The activity is measured as one each.

Monitor Workers & Waste Stream for Contamination: This activity involved one fully suited RCT accompanying the D&D worker into the contamination area to monitor for changes in levels of contamination and worker exposure. This is a required activity under the standard operating procedures at the Hanford Site.

The RCT also monitored demolished material exiting the contamination area. All monitoring was done with conventional handheld instrumentation (e.g., Eberline E-600 equipped with various probes). The RCT was retained for the full duration of the removal work to eliminate waiting for his services. The cost element is measured as one each and matches the total time for the demolition work.

Monitor for Airborne Lead Contamination: Since the floors in demonstration Rooms X and Y were coated with lead-based paint, it was necessary to retain an industrial hygienist to take air samples during and after the removal work. Sampling time for the industrial hygienist is measured as number of hours worked per day of removal work.

Worker Breaks: Time taken on breaks was not recorded during the demonstration but is included in the cost comparison since normal work breaks occur in typical work situations and are generally considered necessary to minimize worker fatigue. Work breaks total 30 minutes per day of removal work for the full-time demolition crew of three D&D workers and one RCT.

DEMOBILIZATION (WBS 331.21)

Disassemble Equipment and Air Hoses and Decontaminate Equipment: This activity includes unwrapping disassembling, and decontaminating the vacuum HEPA filtration unit hoses, as well as decontaminating the floor-shaving device. The activity involved four D&D workers and two RCTs and is measured as one each.

WASTE DISPOSAL (WBS 331.18)

Disposal of Waste Material: This includes disposal of PPE, plastic wrapping and sleeving for the vacuum HEPA filtration unit hoses, plastic sheeting around openings into the contamination area, and the waste concrete generated by the floor shaver. Disposal fees are those charged for final disposal at the Environmental Restoration Disposal Facility (landfill), which are $60/ton. However, since a ton of waste material was not generated during the demonstration, a minimum waste disposal fee of $60 was used. Also, PPE and miscellaneous plastic sheeting and sleeving material were disposed of separately from the waste concrete, leading to two minimum disposal fees.

Table B-2. Improved technology cost summary - Marcrist Diamond Floor Shaver

Work Breakdown Structure (WBS)	Unit Cost (UC)						Total Quantity (TQ)	Unit of Measure	Total Cost (TC)	Crew	Comments
	Labor		Equipment		Other	Total UC					
	HRS	Rate	HRS	Rate							
Mobilization (WBS 331.01)								**Subtotal**	**$1,577**		
Move Equipment to Work Area	4	$63.94	4	23.17		$348.44	1	each	348	2 D&D workers	
Install Drum	0.25	$127.88	0.25	$23.17		$37.76	1	each	$38	4 D&D workers	
Set Up Vacuum	2	$159.85	2	$23.17		$366.04	1	each	$366	5 D&D workers	
Sleeve Vacuum Hoses	4.4	$63.94	4.4	$23.17		$383.28	1	each	$383	2 D&D workers	
Wrap PAPRs	8	$31.97	8	$23.17		$441.12	1	each	$441	1 D&D worker	
DECONTAMINATION (WBS 331.17)								**Subtotal**	**$1,842**		
Pre-Work Briefing and Safety Meeting	0.25	$200.00	0.25	$23.17		$55.83	1	day	$56	3 D&D workers, 1 RCT, 1industrial hygienist	
Don/Doff Personal Protective Equipment (PPE)	0.34	$168.16	0.34	$69.14	$88	$153.05	1	day	$153	2 D&D workers, 1 RCT, 1 industrial hygienist	Other rate incudes 4 sets of PPE $22 ea
Remove Concrete Floor Surface	0.008	$95.91	0.008	$69.14		$1.32	816	square feet	$1,077	3 D&D workers	0.3 cm (1/8 in.) removed in Rooms X and Y
Move Floor Shaver	0.25	$95.91	0.25	$23.17		$29.77	1	each	$30	3 D&D workers	From room X to Y
Monitor Workers & Waste Stream for Radioactive	6.528	$49.45	6.53	$1.38		$331.82	1	each	$332	1 RCT	
Monitor for Air-Borne Lead	2	$54.77				$109.54	1	day	$110	1 industrial hygienist	
Worker Breaks	0.5	$145.36	0.5	$23.17		$84.27	1	day	$84	3 D&D workers, 1 RCT	
DEMOBILIZATION (WBS 331.21)								**Subtotal**	**$2,000**		
Disassemble Equipment and Air Hoses and Decontaminate	8	$226.78	8	$23.17		$1,999.60	1	each	$2,000	4 D&D workers, 2 RCT	
WASTE DISPOSAL (WBS 331.18)								**Subtotal**	**$403**		
Disposal of PPE, Plastic Sheeting, and Sleeving	0.5	$113.39			$60	$116.70	1	each	$117	2 D&D workers, 1 RCT	Minimum waste disposal fee
Disposal of Concrete	2	$113.39			$60	$286.78	1	each	287	2 D&D workers, 1 RCT	One-half of a drum (55 gal)
								TOTAL:	**$5,821**		

NOTES

a TC=UC x TQ (where TC=total cost; UC=unit cost, and TQ=total quantity)

b Labor rates are $31.97/hr for a D&D worker, $49.45/hr for an RCT, and $54.77/hr for an industrial hygienist. Labor rates include base wages, fringes, and area overhead, but exclude Bechtel Hanford, Inc. G&A and overhead.

c Equipment rates are: $53.43/hr for the Marcrist diamond floor shaver when it operates (includes blade wear) and $7.46 when it is on standby, $15.71/hr for the vacuum HEPA filtration unit, and $1.38/hr for the RCT detector instruments. Since both the floor shaver and the vacuum are mobilized and/or set up in the work area for the duration of the removal work, their combined hourly cost is carried on all activities associated with completing the job. In other words, even though a particular work activity may not actually involve using either piece of equipment, their combined hourly cost is applied to the activity since the equipment is on standby.

d Two D&D workers are required to operate the floor shaver within the contamination area. The third D&D worker acts as support for the other two workers from outside the contamination area. The third D&D worker is not required to be suited up in PPE.

e Although a total of four D&D workers were trained on the use of the floor shaver, only two D&D workers actually used it during the demonstration. Therefore, to keep the cost comparison useable for other facilities, it was decided to keep training costs applicable only to those individuals actually using the floor shaver.

Baseline Technology - 5-Piston Scabbler

MOBILIZATION (WBS 331.01)

Move Scabbling Tools from Storage and Set Up in the Work Area: This includes time for leading equipment, airlines, etc., from storage boxes into a truck bed and moving the equipment to the work area. It also includes setting up the compressor and air lines.

Install Bits: This includes the time required to install new bits into the scabbler. The duration used is based on observed time requirements from the demonstration.

Set Up Vacuum: This activity involves setting up the vacuum HEPA filtration unit.

Sleeve Vacuum and Air Hoses: This activity involves using duct tape to attach plastic tubing to the vacuum and air hoses to prevent surface contamination of the hoses in the Rad Zone.

Wrap PAPRs in Rooms A and B: On a daily basis, three to five PAPR units are required to be wrapped with a plastic cover along with the hose that delivers air to the mask. This measure is taken to prevent contaminating the units, which could mean disposing of them as waste.

DECONTAMINATION (WBS 331.17)

Pre-Job Briefing and Safety Meeting: This activity involves everyone who will work in or around the contamination area. The pre-work briefing and safety meeting are requirements to be conducted every day of demolition work and, thus, is measured as a daily activity.

Don and Doff PPE: Same as for improved technology.

Remove Concrete Floor Down 0.3 cm (1/8 in.) With the Scabbler (Rooms A and B): Concrete removal was conducted with a crew consisting of three D&D workers. Two of the workers were fully suited in PPE (equipped with respirators) and worked inside the contamination area. The other worker acted as support for the workers inside the contamination area by providing them with needed supplies and ensuring the air and vacuum lines remained operational. Removal work took place in two different rooms at the C Reactor (Sample Rooms A and B) on various floor areas where spot contamination was present. Based on the type of contamination, it was only necessary to remove the concrete to 0.3 cm (1/8 in.) deep. Removal time includes the time it took to move the scabbler from spot to spot within Rooms A and B. Costs for the removal work are calculated on a per unit area basis to establish a unit cost.

Move the Scabbler from Room A to Room B: This activity is accounted for separately because of some restaging of compressor air hoses that was required when the scabbler was moved from one room to the other. The activity is measured as one each.

Monitor Workers & Waste Stream for Contamination: This activity involved one fully suited RCT accompanying the D&D workers into the contamination area to monitor for changes in levels of contamination and worker exposure. It is a required activity under the standard operating procedures at Hanford. The RCT also monitored demolished material exiting the contamination area. All monitoring was done with conventional hand held instrumentation (e.g., Eberline E-600 equipped with various probes). The RCT was retained for the full duration of the removal work to eliminate waiting for his/her services. The cost element is measured as one each and matches the total time for the demolition work.

Monitor for Airborne Lead Contamination: Since the floors in demonstration Rooms A and B were coated with lead-based paint, it was necessary to retain an industrial hygienist to take air samples during and after the removal work. Sampling time for the industrial hygienist is measured as number of hours worked per day of removal work.

Worker Breaks: Time taken on breaks was not recorded during the demonstration, but is included in the cost comparison since normal work breaks occur in typical work situations and are generally considered necessary to minimize worker fatigue. Work breaks total 30 minutes per day of removal work for the full-time demolition crew of three D&D workers and one RCT.

DEMOBILIZATION (WBS 331.21)

Disassemble Equipment and Air Hoses and Decontaminate Equipment: This activity includes unwrapping, disassembling, and decontaminating air and the vacuum HEPA filtration unit hoses, as well as decontaminating the scabbling device. The activity involved four D&D workers and two RCT and is measured as one each.

WASTE DISPOSAL (WBS 331.18)

Disposal of Waste Material: This includes disposal of PPE, plastic wrapping and sleeving for air and the vacuum HEPA filtration unit hoses, plastic sheeting around openings into the contamination area, and the waste concrete generated by the scabbler. Disposal fees are those charged for final disposal at the Environmental Restoration Disposal Facility (landfill), which are $60/ton. However, since a ton of waste material was not generated during the demonstration, a minimum waste disposal fee of $60 was used. Also, PPE and miscellaneous plastic sheeting and sleeving material were disposed of separately from the waste concrete, leading to two minimum disposal fees.

Table B-3 Baseline technology cost summary - 5-Piston Scabbler

Work Breakdown Structure (WBS)	Unit Cost (UC)						Total Quantity (TQ)	Unit of Measure	Total Cost (TC)	Crew	Comments
	Labor		Equipment		Other	Total UC					
	Hrs	Rate	Hrs	Rate							
MOBILIZATION (WBS 331.01)								**Subtotal**	**$3,315**		
Move Equipment to Work Area	4	$63.94	4	$20.06		$336.00	1	each	$336	2 D&D Workers	Includes loading, transport, and preparation
Install Bits	2	$63.94	2	$20.06		$168.00	1	each	$168	2 D&D Workers	
Set Up Vacuum	2	$159.85	2	$20.06		$359.82	1	each	$360	5 D&D Workers	
Sleeve Vacuum and Air Hoses	4.4	$63.94	4.4	$20.06		$369.60	1	each	$370	2 D&D Workers	
Wrap PAPRs	40	$31.97	40	$20.06		$2,081.20	1	each	$2,081	1 D&D Workers	Rooms A and B
DECONTAMINATION (WBS 331.17)								**Subtotal**	**$6,431**		
Pre-Job Briefing and Safety Meeting	0.25	$200.13	0.25	$20.06		$55.05	4	day	$220	3 D&D Workers, 1 RCT, 1 Industrial Hygienist	
Don/Doff Personal Protective Equipment (PPE)	0.34	$168.16	0.34	$20.06	$88	$151.99	4	day	$608	2 D&D Workers, 1 RCT, 1 Industrial Hygienist	Other cost includes four sets of PPE at $22/each
Remove Concrete Floor Surface	0.032	$95.91	0.032	$30.72		$4.05	816	square feet	$3,307	3 D&D Workers (see note 4)	0.3 cm (1/8 in.) over 686 ft^2 actual; estimate uses 816 ft^2 to match improved technology
Move Floor Scabbler	0.5	$127.88	0.5	$20.06		$73.97	1	each	$74	4 D&D Workers	From Room A to Room B
Remove Concrete Debris	0.20	$63.94	0.20	$20.06		$16.80	7.4	cubic feet	$124	2 D&D Workers	Vacuum scabbled surface
Monitor Workers and Waste	26.11	$49.45	26.11	$1.38		$1,327.27	1	each	$1,327	1 RCT	
Monitor Airborne Lead	2	$54.77				$109.54	4	day	$438	1 Industrial Hygienist	
Worker Breaks	0.5	$145.36	0.5	$20.06		$82.71	4	day	$331	3 D&D Workers, 1 RCT	
DEMOBILIZATION (WBS 331.21)								**Subtotal**	**$1,975**		
Disassemble Equipment and Hoses and Decontaminate	8	$226.78	8	$20.06		$1,974.72	1	each	$1,975	4 D&D Workers, 2 RCT	
WASTE DISPOSAL (WBS 331.18)								**Subtotal**	**$460**		
Disposal of PPE, Plastic Sheeting, and Sleeving	1	$168.16			$60	$173.39	1	each	$173	2 D&D Workers, 1 RCT	
Disposal of Concrete Debris	2	$113.39			$60	$286.78	1	each	$287	2 D&D Workers, 1 RCT	One drum (55 gal) of debris that was disposed as waste
								TOTAL:	**$12,180**		

NOTES

a TC=UC x TQ (whereTC=total cost; UC=unit cost & TQ=total quantity)

b Labor rates are $31.97/hr for a decon tech, $49.45/hr for an RCT, and $54.77/hr for an industrial hygienist. Labor rates include base wages, fringes, and area overhead, but exclude BHI G&A and overhead.

c Equipment rates are: $15.01/hr for the scabbler during operation (includes bit wear) and $4.35 on standby, $15.71/hr for the vacuum HEPA filtration unit, and $1.38/hr for the RCT detector instruments. Since both the scabbler and the vacuum HEPA filtration unit are mobilized and/or set up in the work area for the duration of the removal work, their combined hourly cost is carried on all activities associated with completing the job. In other words, even though a particular work activity may not actually involve using either piece of equipment, their combined hourly cost is applied to the activity since the equipment is on standby.

d Two D&D workers are required to operate the floor shaver within the contamination area. The third D&D worker acts as a 'runner' supporting the other two workers from outside the contamination area. The third D&D worker is not required to be suited up in PPE.

APPENDIX C

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Description
ALARA	as low as reasonably achievable
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
EPA	U.S. Environmental Protection Agency
FETC	Federal Energy Technology Center
G&A	general and administrative (costs)
HEPA	high-efficiency particulate air (filtration)
ISS	interim safe storage
LSDDP	Large-Scale Demonstration and Deployment Project
OSHA	Occupational Safety and Health Administration
NRC	U.S. Nuclear Regulatory Commission
PAPR	powered air purifying respirators
PPE	personal protective equipment
RCT	radiological control technician
USACE	U.S. Army Corps of Engineers
VAC	volts, alternating current
WBS	work breakdown structure