DE-FG21-95EW55094--37

Decision Analysis Science Modeling for Application and Fielding Selection Applied to Equipment Dismantlement Technologies

Final Report
January 1998

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Work Performed Under Contract No.: DE-FG21-95EW55094

For
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ABSTRACT

Concrete surfaces contaminated with radionuclides present a significant challenge during the decontamination and decommissioning (D&D) process. As structures undergo D&D, coating layers and/or surface layers of the concrete containing the contaminants must be removed for disposal in such a way as to present little to no risk to human health or the environment. The selection of a concrete decontamination technology that is safe, efficient, and cost-effective is critical to the successful D&D of contaminated sites. To support U.S. Department of Energy (DOE) Environmental Management objectives and to assist DOE site managers in the selection of the best-suited concrete floor decontamination technology(s) for a given site, two innovative and three baseline technologies have been assessed under standard, non-nuclear conditions at the Hemispheric Center for Environmental Technology (HCET) at Florida International University (FIU). The innovative technologies assessed include the Pegasus Coating Removal System and Textron's Electro-Hydraulic Scabbling System. The three baseline technologies assessed include: the Wheelabrator Blastrac model 1-15D, the NELCO Porta Shot Blast™ model GPx-10-18 HO Rider, and the NELCO Porta Shot Blast™ model EC-7-2. These decontamination technology assessments provide directly comparable performance data that have previously been available for only a limited number of technologies under restrictive site-specific constraints. Some of the performance data collected during these technology assessments include: removal capability, production rate, removal gap, primary and secondary waste volumes, and operation and maintenance requirements. The performance data generated by this project is intended to assist DOE site managers in the selection of the safest, most efficient, and cost-effective decontamination technologies to accomplish their remediation objectives.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1 BACKGROUND

Structural surfaces contaminated with radionuclides such as uranium, thorium, and technetium-99 present a significant challenge during the decontamination and decommissioning (D&D) process. The two primary objectives for decontamination are: 1) reducing surface levels of contamination so that the potential for personnel and environmental exposure is minimized; and 2) reducing surface contamination levels to meet DOE Order 5400.5 for unrestricted use. As structures undergo D&D, coating layers and/or surface layers of contaminated concrete floors must be removed for disposal in such a way as to present little to no risk to human health or the environment. Selecting a decontamination technology that is safe, efficient, and cost-effective is critical to the successful D&D of contaminated sites.

1.2 PURPOSE OF THIS INVESTIGATION

The purpose of this investigation was to test and evaluate innovative and commercially available technologies for the surface decontamination of concrete floors. These data will be made readily accessible to DOE restoration site decision makers and will assist them in selecting the safest, most cost-effective technologies to develop and use during D&D operations.

1.3 METHODOLOGY

This project was performed at the Hemispheric Center for Environmental Technology (HCET) at Florida International University (FIU), where two innovative and three baseline technologies were evaluated under standard, non-nuclear testing conditions. Vendors demonstrated their decontamination technologies while FIU-HCET evaluators collected performance data. Representatives from the International Union of Operating Engineers (IUOE) were present during technology demonstrations to assess health and safety factors. A separate report has been generated by the IUOE based on the results of their evaluations. As a result of these assessments, directly comparable performance data related to health and safety, operations and maintenance, and primary and secondary waste generation have been compiled. Technology assessment data is managed using a Microsoft Windows-based multimedia information system. A prototype interactive decision analysis computer software application has been developed that uses these assessment data to facilitate the decontamination technology selection process. These software applications have been described in a separate report.

2.0 KEY RESULTS

This study provides a source of comparable data for concrete floor nuclear surface removal using innovative as well as nuclear and non-nuclear technologies. A summary of the data related to the production rates achieved by the technologies tested for coating removal are shown in Figure 1 (see below). Figure 2 presents the production rate data for technologies that were tested for concrete surface removal. Table 1 presents the production rate and depth of removal for each technology tested. These production rates were obtained over a test area of approximately 400 ft^2. All of the surface removal technologies tested removed approximately ¼ in. of concrete surface with the exception of the Electro-Hydraulic Scabbling system, which removed approximately 1 in. of concrete surface. The information presented in these figures should be used in combination with the more detailed information provided in the remainder of this document, since the selection of the most appropriate technology for a particular project must be determined by the integration of many factors. with emphasis on those factors most important for a particular site, e.g., production rate, cost, health and safety, or secondary waste generation.

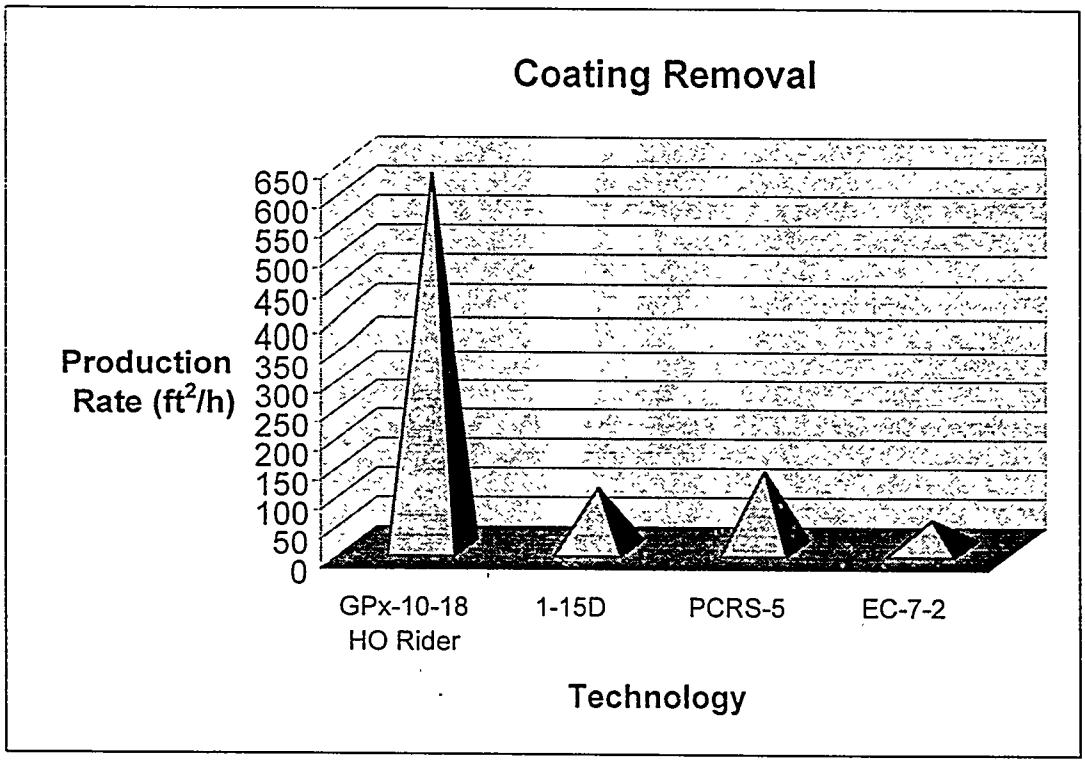

Figure 1. Coating removal production rates (ft^2/h) for the NELCO Porta Shot Blast™ GPx-10-18 HO Rider, the Blastrac 1-15D, the Pegasus PCRS-5, and the NELCO Porta Shot Blast™ EC-7-2.

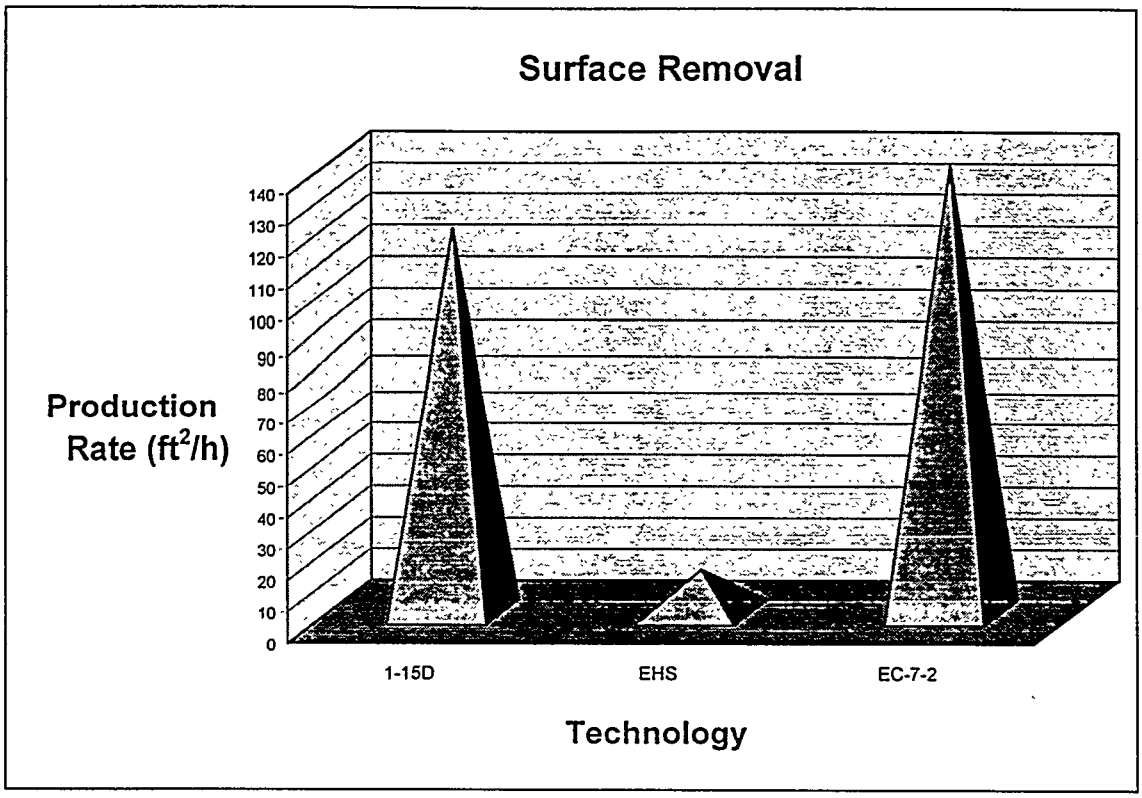

Figure 2. Surface removal production rates (ft^2/h) for the Blastrac 1-15D, the Textron EHS system, and the NELCO Porta Shot Blast™ EC-7-2.

Table 1.
Technology Name and Production Rate

	Technology Name	Depth of Removal	Production Rate (ft^2/h)
1	NELCO Porta Shot Blast™ (GPx-10-18 HO Rider)	< ¼ in.	625
2	Blastrac (1-15D)	< ¼ in.	119
3	PCRS-5*	Coating only	132
4	NELCO Porta Shot Blast™ (EC-7-2)	< ¼ in.	50
5	Electro-Hydraulic Scabbling System	1 in.	14

* Pegasus Coating Removal System

3.0 ENGINEERING STUDY APPROACH

3.1 STUDY OBJECTIVES

The objectives of this study were to perform comparative analyses of commercially available and innovative concrete surface removal technologies applicable to the D&D of DOE facilities. The basis for these analyses include the following:

- End point achieved
- Production rate
- Technology benefits and limitations.

3.2 EXPERIMENTAL DESIGN AND PROCEDURES

3.2.1 Selection of Technologies for This Study

Established sources and databases were used to categorize the technologies and perform the initial screening of technology types. These sources and databases included:

- DOE/EM-0142P *Decommissioning Handbook*
- ORNL/M-2751 *Oak Ridge National Laboratory Technology Logic Diagram*
- EGG-WTD-11104 *Idaho National Engineering Laboratory Decontamination and Decommissioning Technology Logic Diagram*
- DOE/ORO/2034 *Contaminated Concrete: Occurrence and Emerging Technologies for DOE Decontamination*
- Remedial Action Program Information Center (RAPIC) Database
- Hemispheric Center for Environmental Technology Multimedia Information System for Decontamination (MISD) Database.

The request for prospective bidders was advertised in the *Commerce Business Daily* in December 1996. Bidders were selected by considering their number of years of work experience in nuclear decontamination, and by references for previous work performed using the selected technology.

Considering the source and database review, and qualified bids received, the following innovative and commercially available technologies were tested:

- Pegasus Coating Removal System [innovative]
- Textron's Electro-Hydraulic Scabbling System [innovative]
- Wheelabrator's Blastrac model 1-15D [commercial]
- NELCO Porta Shot Blast™ model GPx-10-18 HO Rider [commercial]
- NELCO Porta Shot Blast™ model EC-7-2 [commercial].

3.2.2 FIU-HCET Technology Assessment Site

A schematic of the FIU-HCET technology assessment site is shown in Figures 3a and 3b. Each test bay consists of a concrete pad with 10-ft-high concrete or brick walls on three sides and, in some bays, a concrete ceiling covering half of the pad. All masonry walls, floors, and ceilings at the assessment site have a thickness of 8 in. Each floor test surface measures approximately 20-ft by 20-ft to yield an area of approximately 400 ft^2.

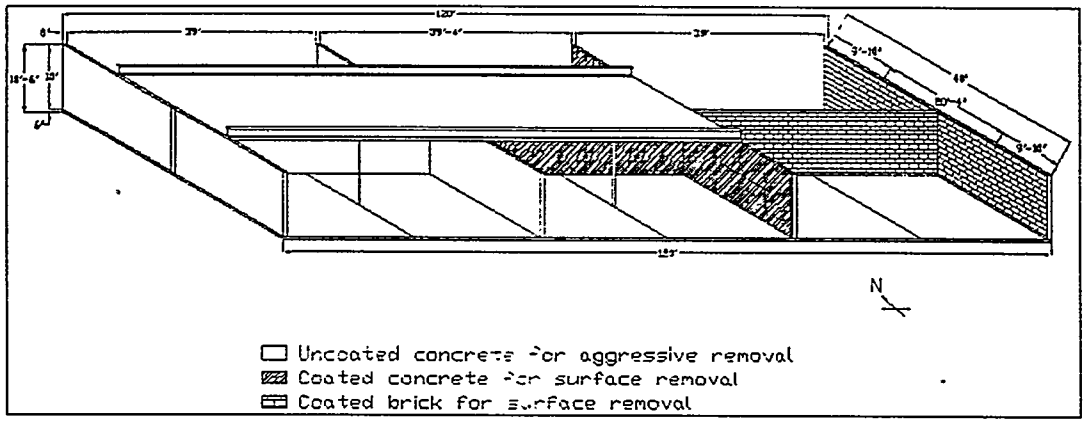

Figure 3a. FIU-HCET technology assessment site schematic.

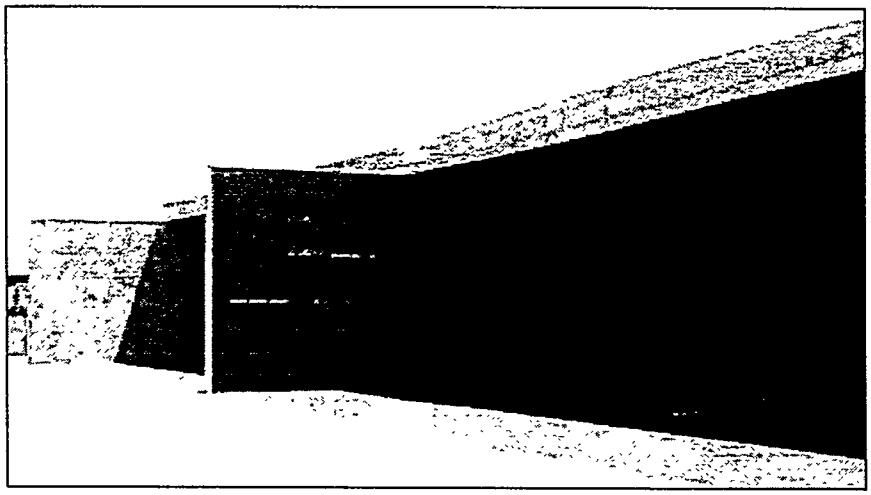

Figure 3b. FIU-HCET technology assessment site.

A preliminary review of the Fernald Environmental Management Project (FEMP) and other DOE sites indicated wide variability in the composition and types of the concrete used. This variability complicated the selection of the proper mix for the construction of the concrete test areas. A

4000-psi mix was specified. After the concrete was poured, for 3, 7, and 28 days, compression tests were performed, yielding, after the 28 days, a concrete compressive strength minimum of 4000 psi on all testing areas.

The FIU-HCET technology assessment site is surrounded by a 6-ft-high chain link fence to provide security and restrict access to the area. A trailer and an air conditioned metal shed, which serves as a field office, changing facility and cool-down area for the vendor, HCET, and IUOE representatives, are located adjacent to the assessment site test pads. During technology assessments, each test bay was covered by a tent with three side walls that served as a wind buffer and sun shield.

The selected coating was purchased from Michael A. Bruder & Son Architectural Industrial Coatings. The coating determination was made using FEMP's paint specification for acid resistant surfaces. The coating applied to the concrete floor consisted of one 8-mils-thick (wet) coat of Ply-Mastic epoxy polyamine coating primer, which dried to an approximate thickness of 7 mils. After 24 hours, a 3-mils-thick (wet) finish coat of Ply-Thane 890 HS was then applied, which dried to an approximate thickness of 1 ½ mils. The Material Safety Data Sheets (MSDSs) for both the Ply-Mastic and Ply-Thane coatings were provided to vendors for waste characterization.

3.2.3 Technology Assessment Methods

End point achieved

Technology vendors demonstrated their respective technology in the manner that they deemed most efficient. The goal for the coating removal systems was complete coating removal. The goal for surface removal technologies was removal of up to 1 in. of surface material. The depth of surface removal was estimated by each vendor using a tape measure or a surface profile gauge.

Production rates

Production rates were determined by measuring the total surface area removed by a given technology divided by the total number of hours of equipment operation required to complete the task.

Technology benefits and limitations

Benefits and limitations were obtained by conducting field demonstrations and performing a literature search of the individual technologies. If a conflict existed between published information and field demonstration, the data obtained in the field testing were used.

3.3 TECHNOLOGY ASSESSMENT DATA COLLECTED

Data were collected by direct measurement and observation, by querying vendors and technologists, and from literature supplied by the vendors. Table 2, presented below, details the data requirements and the collection method employed during the technology evaluation.

Table 2.
Description of Data Types for Decontamination Technology Demonstrations

Data Type	Definition	Collection Method[1]
Technology Description	General description of the technology, its operating principles, and unique qualifications.	1, 2
Basic Equipment Description	Technical description of the technology including only that equipment required by the original manufacturer.	1, 2
Support Equipment Description	Any required support equipment that may be procured from a variety of sources (e.g., a compressor).	1, 2
Basic Equipment Capital Cost	Current list price for basic system.	2
Support Equipment Cost	Current list price for support equipment.	2, 3
Benefits	Listing of technology-specific characteristics that may provide an advantage by using the given technology.	1, 2
Limitations	Listing of technology-specific characteristics that may provide a disadvantage by using the given technology.	1, 2
Applicable Surface Media	Possible substrate compositions to which the technology can be applied.	2
Applicable Geometries	Possible substrate geometries to which the technology can be applied.	2
Production Rate (ft^2/h)	The total area of surface media decontaminated divided by the total number of hours of equipment operation required to complete the task. Decontamination time includes only the time the equipment is in operation, and does not include time spent in site-specific activities or maintenance.	1
Removal Capabilities (inches)	The depth of surface media that may be removed by a given technology.	2
Utility Requirements	A listing of the types of utilities required to operate a technology.	2
Removal Media Type	Type of removal media used by a particular technology (e.g., sponge, steel shot, etc.).	1, 2
Removal Media Cost	Cost per unit of the removal media used by a particular technology.	2
Removal Media Usage Rate (units/hour)	A measure of the amount of removal media used by a particular technology with respect to time.	1
Maintenance Cost	Costs associated with regular maintenance of the technology.	2
Operation/Maintenance Requirements	Listing of the operation/maintenance requirements for a given technology.	2

[1] 1 = Direct Measurements/Observations; 2 = Vendor Query; 3 = Outside Reference Source

Table 2.
Description of Data Types for Decontamination Technology Demonstrations (Continued)

Data Type	Definition	Collection Method[2]
Primary/Secondary Waste Condition	Description of the observed physical condition of the primary/secondary waste generated by a given technology.	1
Primary/Secondary Waste Volume (ft^3/ft^2)	The volume of primary/secondary waste generated by a given technology with respect to the area of surface decontaminated.	1
Secondary Waste Characteristics	Description of the physical characteristics of the secondary waste generated by a given technology.	1
Environmental Conditions	Those physical environmental conditions generated by using a given technology.	1, 3
Equipment Portability	Brief description of the required personnel/equipment required to move the basic equipment for a given technology.	1
Equipment Availability	Average expected delay between order placement and vendor delivery.	2
Required Personnel	The minimum number of equipment operators and technicians required to operate a given technology	1
References	Includes any published works involving the operation of a given technology, as well as DOE site references.	2, 3

[2] 1 = Direct Measurements/Observations; 2 = Vendor Query; 3 = Outside Reference Source

4.0 TECHNOLOGY DESCRIPTIONS

4.1 PEGASUS COATING REMOVAL SYSTEM (PCRS-5)

PCRS-5 is a chemical coating removal method that has been developed by Pegasus International, Inc. for the removal of chemically resistant coatings (i.e. epoxies, urethanes, chlorinated, rubber, elastomeric. aluminum. vinyls, mastics, and most marine coatings). The PCRS-5 is an organic solvent mixture. clear in color, which carries a slightly sweet odor, and is supplied in 1-, 5-, or 55-gal plastic buckets. Depending on the substrate and operating conditions. PCRS-5 is applied by pouring directly from the bucket or from a smaller container, and long and/or short-handled spreaders or trowels are used to distribute it evenly across the surface. Removal of the PCRS-5 and primary waste are achieved by scraping the surface using trowels and/or large plastic shovels. This coating removal process using PCRS-5 is shown in Figure 3.

Figure 3. Concrete floor coating removal using PCRS-5.

4.2 TEXTRON'S ELECTRO-HYDRAULIC SCABBLING (EHS) SYSTEM

Textron's EHS system is categorized in the technology class of electrical scarification. The EHS system is capable of removing up to 1 in. of concrete through a series of electrical pulses

propagated under a layer of water between a pair of strip-shaped electrodes positioned with a minimum clearance over a concrete floor. The use of high current/short duration pulses create spark-like discharges in the water medium that produce shock waves and cavitating bubbles. The force of the direct and reflected shock waves impinging on the concrete surface results in the deformation, crushing, and cracking of the concrete surface layer.

The EHS system consists of an electric power supply, a scabbling chamber, a scabbling module mounted on a positioner, a vacuum system. and a water/rubble flow system. Most components are mounted on a conventional forklift. The 4-ft by 4-ft chamber isolates the 16-ft^2 floor area to be processed by sealing the bottom perimeter to the surface via a flexible gasket, thereby preventing the spread of water and contaminated waste over the surrounding surface. The scabbling module contains the electrode pair and is moved across the surface within the chamber by an X-Z positioner. The vacuum unit is used to improve the chamber isolation and to remove the rubble/sludge created by scabbling, and to deposit it into the collection drum. Flow system pumps are then used to circulate or discard the water after it is cleared by coarse and fine filters. The EHS system is shown in Figure 4.

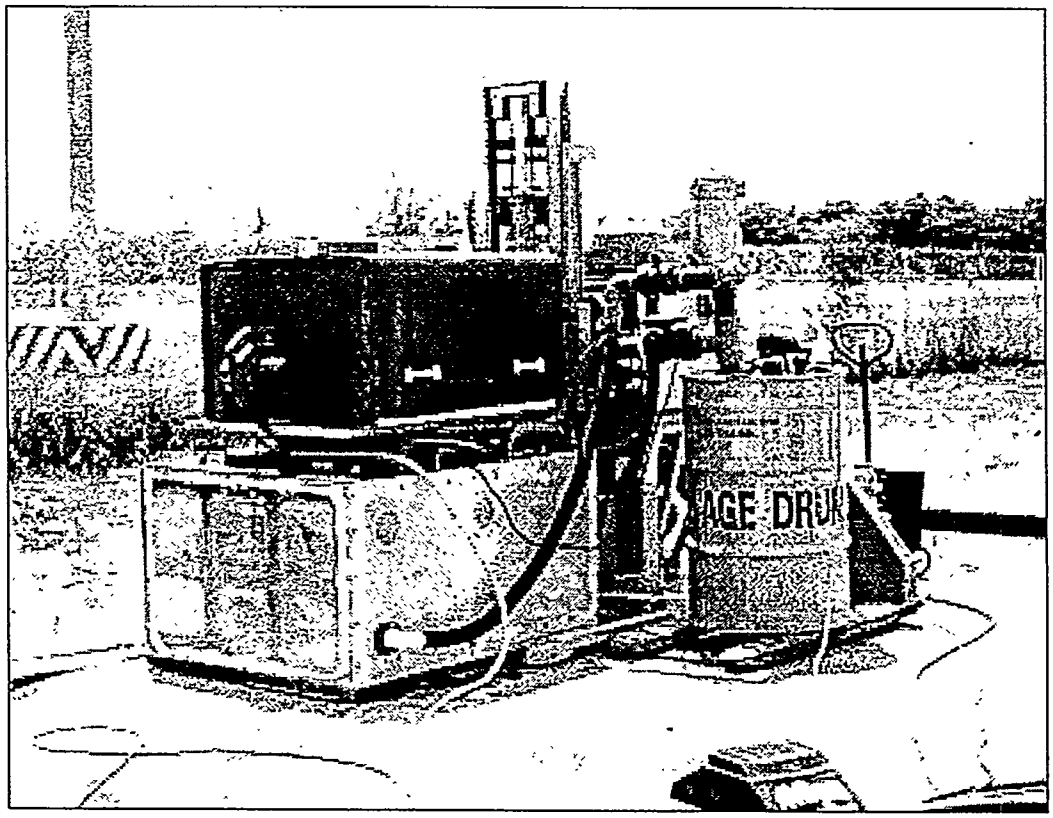

Figure 4. Textron's Electro-Hydraulic Scabbling System.

4.3 WHEELABRATOR'S BLASTRAC MODEL 1-15D

The Wheelabrator Blastrac Model 1-15D is categorized in the technology class of steel abrasive blasting. This portable shot blasting system uses a high-performance airless centrifugal wheel to propel blast media in a controlled pattern and direction. The abrasive metal scours the surface and rebounds into a recovery chamber where the pulverized dust and abrasive are collected. These byproducts are separated within the unit and the abrasive metal is reused to save material cost.

The Blastrac Model 1-15D is engineered for medium-to-large-sized flooring applications (2,000-75,000 ft^2) with a 15-in. cleaning path. The 1-15D is a self-propelled blast unit measuring 6 ft, 7 in. in length; 3 ft. 6 in. in height; and 1 ft. 11 in. in width. The material removal depth attained by the unit can be controlled by the speed of the wheel and the abrasive media used. The blast unit, shown in Figure 5, is connected to a 654-DC vacuum unit that collects the airborne dust and contaminants during operation and is able to reuse the blast media.

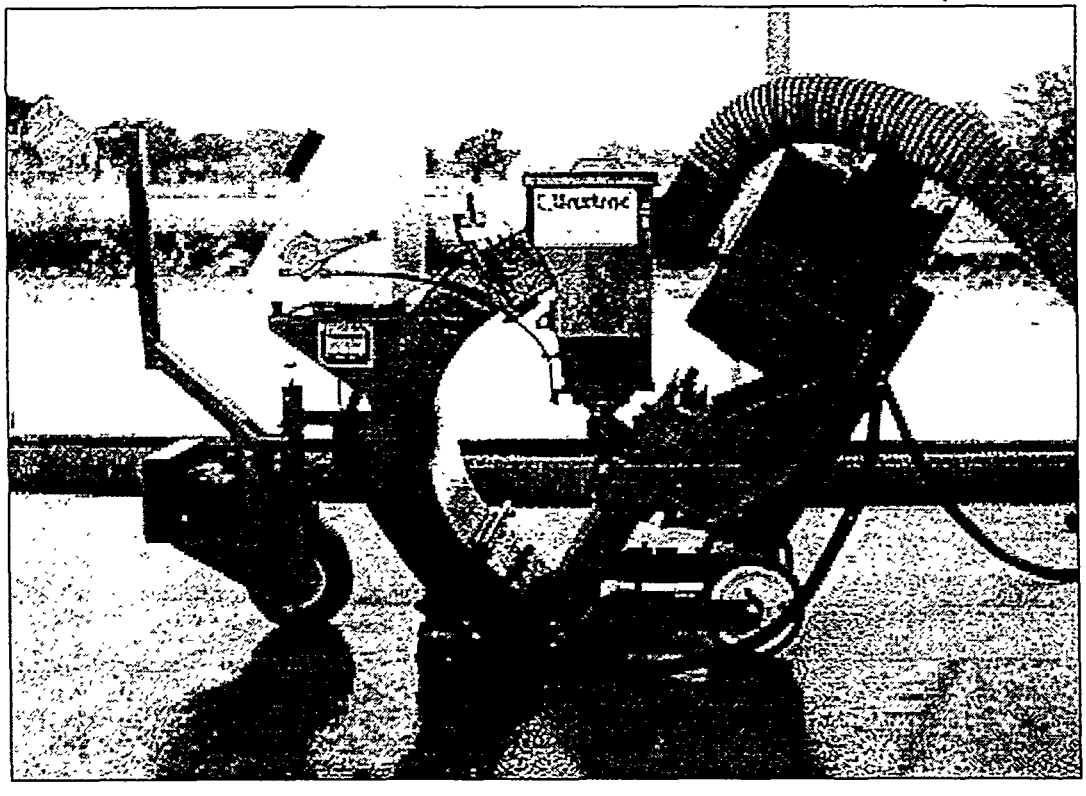

Figure 5. Wheelabrator's Blastrac model 1-15D.

4.4 NELCO PORTA SHOT BLAST™ MODEL GPX-10-18 HO RIDER

NELCO built the world's first portable shot blasting machine. NELCO manufactures 12 different Porta Shot Blast machines that are custom configured to meet users' specific requirements.

NELCO portable shot blasting machines are available in a wide range of sizes to suit most surface preparation requirements. NELCO's patented blast wheel design produces a uniform blast pattern, resulting in a smooth, uniform surface profile with no hot spots or grooves as are produced by blasters with centerfed wheel designs. Machines are available for indoor and outdoor use, for use on vertical or horizontal surfaces, and that are powered by propane, diesel, gasoline, electric, or pneumatic engines. NELCO will custom build shot blasters to suit specific customer requirements.

The NELCO Porta Shot Blast™, model GPx-10-18 HO Rider, shown in Figure 6, is engineered for medium to large size flooring applications with a 10-in. cleaning path. This self-propelled unit uses a centrifugal blast wheel to propel abrasives onto the surface for material removal. This model can adjust material removal depth by the different speeds of the blast wheel or the abrasive material used. A connecting vacuum collects all airborne contaminants to maintain a clean and dust free work environment.

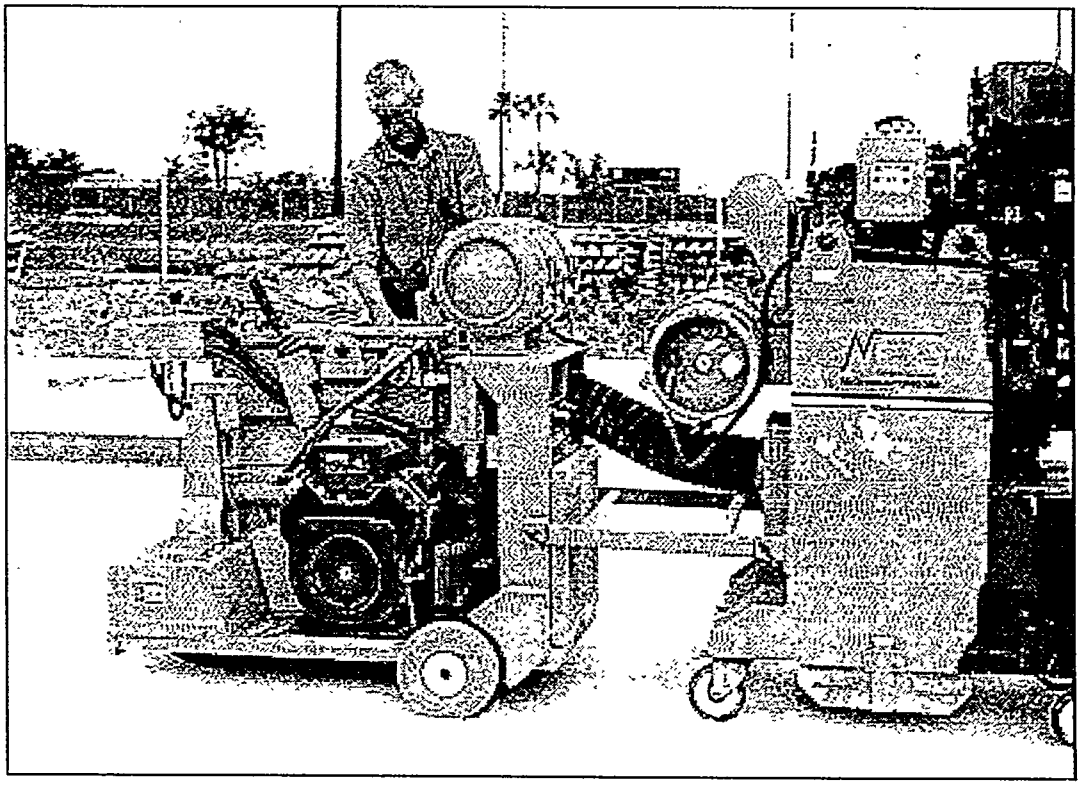

Figure 6. NELCO Porta Shot Blast™ model GPx-10-18 HO Rider.

4.5 NELCO PORTA SHOT BLAST™ MODEL EC-7-2

The NELCO EC-7-2 Porta Shot Blast™ machine is categorized in the technology class of steel abrasive blasting. This mechanical decontamination process removes surface layers as a result of

the mechanical impact imparted by the high speed propulsion of steel abrasive media. This unit, shown in Figure 7. has a 7-in.-wide blast pattern (cleaning path). Shot is introduced through a feed spout and propelled to the surface via a centrifugal blast wheel powered by a 2 horsepower (hp) electric motor. The shot and surface debris are vacuumed into an air wash system where the shot is separated for reuse. This unit continuously recycles shot while in operation, while the debris is collected into a sealed vacuum drum.

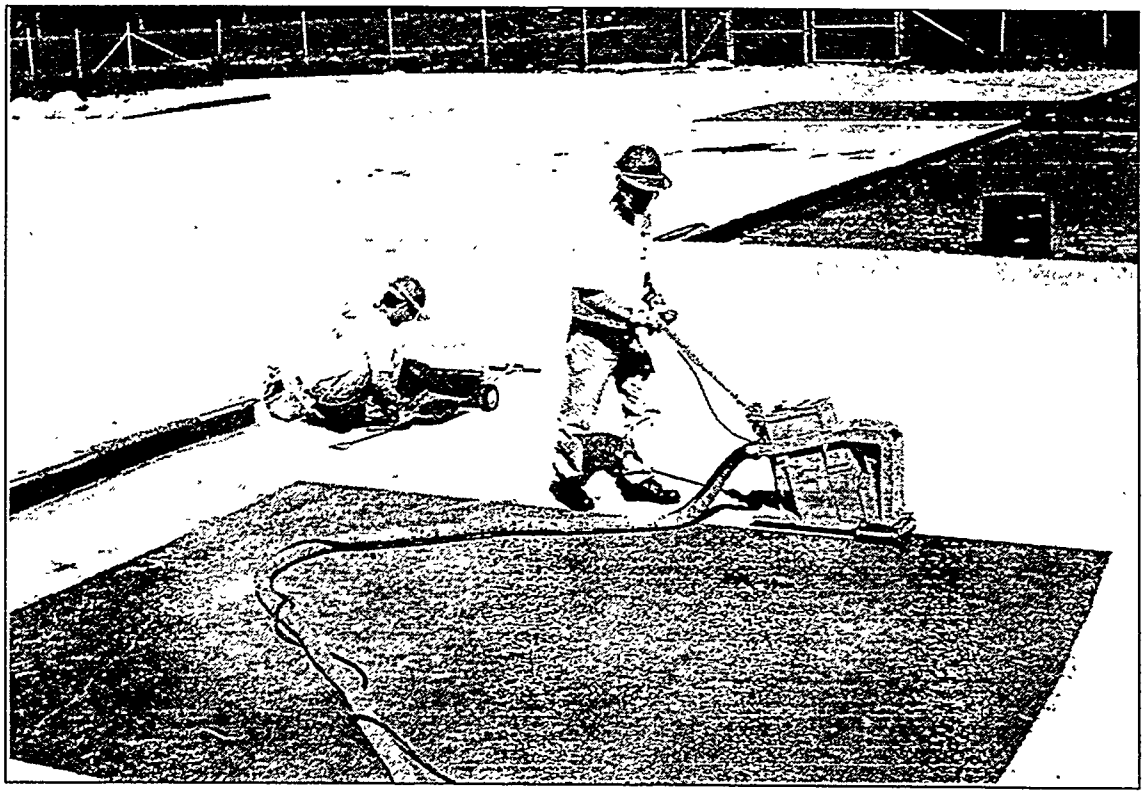

Figure 7. NELCO Porta Shot Blast™ model EC-7-2.

5.0 TECHNOLOGY RECOMMENDATIONS

The intent of this section is to review the operation of each of the technologies tested and to recommend ways to improve the technology based on the test results. It is important to note that some of the recommended changes may improve the system in one area of operation, but may adversely impact the technology's ability to excel in another area.

In the case of all of the technologies tested, no feedback was provided by the technology itself regarding the depth of removal achieved during operation. In most cases, a 2-in. by 4-in. piece of lumber was used following operation to estimate the depth of removal. This method of removal depth estimation is cumbersome and inaccurate. It would greatly facilitate the application of these technologies in future D&D operations if they were able to provide removal depth (or radiation level) measurements during operation.

5.1 PEGASUS COATING REMOVAL SYSTEM

The PCRS-5 was successful at removing the test coating from some areas of the test surface, but not from others. Even with repeated application, approximately 20% of the coating on the test surface could not be removed. It is possible that certain areas of the test surface bonded to the primer and/or finish coating layers in such a way as to prevent coating removal by this method. Further study would be required to determine the exact chemistry of the more strongly bonded surface coating areas impervious to PCRS-5 removal in order to reveal mixture changes that would improve the effectiveness of this agent on these coatings. Notwithstanding, PCRS-5 could function as an important tool for remediation efforts involving contaminated coating removal, since this chemical method is far less labor intensive than other conventional mechanical coating removal methods. It is recommended that, prior to large-scale use, patch tests on the target coating be conducted to determine the effectiveness of this agent in removing the coating and to see if there are any deleterious reactions between the PCRS-5 and the contaminated coating.

Some benefits of this system include the following:

- It can remove coatings from complex surface geometries that blasting equipment cannot reach;
- It requires no capital purchase;
- It can be used on both concrete and metal surfaces;
- No maintenance costs are incurred;
- No special service is required following successful coating removal. Additional coatings may be applied after a 24-hour drying period.

Some limitations of this system include the following:

- The surface must be clean and dry;
- The process is limited to applied coating characteristics. (i.e., it works well on some coatings but is ineffective on others.)

5.2 TEXTRON'S ELECTRO-HYDRAULIC SCABBLING SYSTEM

In order to use EHS in a radiological environment, this system must be completely redesigned to allow the waste water used during scabbling to be properly contained, separated from the solid waste material removed from the surface, and treated for later release or reuse. In addition, higher level personal protective equipment would have to be used by all equipment operators to protect them from being splashed by contaminated waste water. While the EHS system did effectively remove 1 in. of concrete surface from the test area and did yield a very even surface profile for this removal depth, the issues associated with the handling and treatment of secondary waste and the large size/low portability of the EHS equipment significantly reduce its potential for further development for use in site remediation.

Some benefits of this system include the following:

- No dust is produced by this decontamination system;
- The strong electric "explosions" allow for deep and wide one-pass concrete scabbling.

Some limitations of this system include the following:

- The concrete surface revealed by this process is highly irregular;
- The current system cannot operate closer than 1 ft away from walls, edges, or other obstructions;
- The presence of water-soluble media or contaminants severely reduces system efficiency.

5.3 WHEELABRATOR'S BLASTRAC MODEL 1-15D, THE NELCO PORTA SHOT BLAST™ MODEL GPX-10-18 HO RIDER, AND THE NELCO PORTA SHOT BLAST™ MODEL EC-7-2

These three steel abrasive blasting technologies were tested at FIU-HCET to determine, given identical site and operating conditions, whether there was a direct correlation between the width of the blasting path and the resulting production rate. One would expect that as the blasting path width increases, so does the production rate for surface removal. Interestingly, this was not the result obtained by this investigation. For the equipment manufactured by NELCO, the expected increase in production rate with increased blasting path width was observed: the GPX-10-18 HO Rider, with a blasting path width of 10 in., was found to have a production rate more than 10 times faster than the EC-7-2 model, with a blasting path width of 7 in. (refer back to Figure 1). Conversely, the equipment manufactured by Wheelabrator, the Blastrac model 1-15D with a blasting path width of 15 in., was only twice as fast at the NELCO EC-7-2, and only 1/6 as fast as the GPX-10-18 HO Rider. It should be evident from these results that blasting path width alone should not be used as the major decision criteria when selecting between steel abrasive blasting equipment for the most effective model for a given job, especially if those models are produced by different manufacturers.

Some benefits of Blastrac model 1-15D include the following:

- The large blast pattern increases the relative production rate;

- This process is not dependent on coating type;
- The blast media is inexpensive.

Some limitations of Blastrac model 1-15D include the following:

- The machine does not work on wet surfaces;
- It should not be used in the vicinity of flammable liquids;
- It cannot be operated in an elevated position;
- This machine is not effective for deep concrete removal.

Some benefits of the NELCO GPX-10-18 HO Rider include the following:

- The large blast pattern increases the relative production rate;
- The machine can be operated either forward or backward while blasting;
- It can be used on both concrete and metal surfaces;
- This process is not dependent on coating type;
- The blast media is inexpensive.

Some limitations of the NELCO GPX-10-18 HO Rider include the following:

- The machine does not work on wet surfaces;
- It should not be used in the vicinity of flammable liquids;
- It cannot be operated in an elevated position;
- This machine is not effective for deep concrete removal.

Some benefits of the NELCO EC-7-2 include the following:

- The machine can be operated either forward or backward while blasting;
- It can be used on both concrete and metal surfaces;
- This process is not dependent on coating type;
- The blast media is inexpensive.

Some limitations of the NELCO EC-7-2 include the following:

- The machine does not work on wet surfaces;
- It should not be used in the vicinity of flammable liquids;
- It cannot be operated in an elevated position;
- This machine is not effective for deep concrete removal.

6.0 REFERENCES

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APPENDIX

TECHNOLOGY ASSESSMENT DATA FORMS

Technology assessment data forms are completed following each FIU-HCET D&D technology evaluation. The Technology Description section describes generally the technology for which there are several models available. The Technology Demonstration section describes the model of the technology demonstrated at FIU-HCET in detail. There are several Performance Statistics sections for a given technology model tested, specifically one for each test surface. The Vendor Information and Manufacturer Information sections provide detailed information on technology providers including references for any D&D work previously done and various services provided.

WHEELABRATOR'S BLASTRAC MODEL 1-15D

Technology Description

Technology Name:	Blastrac
Technology Class:	Steel Abrasive Blasting
Vendor Name:	J&B Diversified Services
Manufacturer Name:	Wheelabrator Corporation
Description:	This portable shot blasting system uses a high performance airless centrifugal wheel to propel blast media in a controlled pattern and direction. The abrasive metal scours the surface and rebounds into a recovery chamber where the pulverized dust and abrasive are collected. These byproducts are separated within the unit and the abrasive metal is reused to save material cost.
Benefits:	• Cleans and profiles simultaneously leaving a chemically free and dry surface without airborne dust or contaminants. • Recycling of blast media reduces remediation costs.
Limitations:	
Secondary Waste Characteristics:	Contaminated Steel Abrasive
Applicable Surface Media:	Concrete - poured, Carbon steel
Applicable Geometries:	Floor
Removal Capabilities:	

Technology Demonstration

Technology Name:	Blastrac
Model #:	Blastrac 1-15D
Vendor Name:	J&B Diversified Services
Site:	FIU-HCET
Demonstration Date:	12/9/96-12/10/96
Principal Investigator:	Joe Boudreaux
Basic Equipment Description:	Blastrac Model 1-15D is engineered for medium to large-sized flooring applications (2,000-75,000 ft^2) with a 15-in. cleaning path. The 1-15D is a self-propelled blast unit measuring 6 ft. 7 in. in length, 3 ft, 6 in. in height, and 1 ft, 11 in. in width. The material removal depth attained by the unit can be controlled by the speed of the wheel and the abrasive media used. The blast unit is connected to a 654-DC vacuum unit that collects the airborne dust and contaminants during operation and is able to reuse the blast media.

Technology Demonstration (Continued)

Support Equipment Description:	Magnetic Broom
Basic System.Capital Cost:	Blastrac 1-15D and 654-DC Vacuum -Purchase price $ 33,500 (1996) -Rental price $1,900 weekly
Support Equipment Cost:	Magnetic broom -$12.50 weekly (1996)
Benefits:	• The large cleaning path reduces surface removal time.
Limitations:	• Cannot accommodate narrow passages.
Removal Media Type:	S-460 steel shot
Removal Media Cost ($/lb):	$ 0.41/lb
Operation/Maintenance Requirements:	
Maintenance Cost:	
Equipment Portability:	Blast unit - forklift Dust collector - mounted on wheel lift
Utility Requirements:	30 kW Generator
Equipment Availability:	In stock
Required Personnel:	1 equipment operator
Required/Recommended PPE:	Hearing protection Safety glasses with side shields
References:	

Performance Statistics

Technology Name:	Blastrac
Model #:	1-15D
Surface Media:	Concrete - poured
Surface Media Description:	Uncoated concrete
Geometry:	Floor
Vendor Name:	J&B Diversified Services
Production Rate (ft^2/h):	119.2
Area of Surface Removed (ft^2):	373.78
Removal Capability:	¼ in. estimated
Removal Gap (inches):	4 in.
Removal Media Usage Rate (lb/ft^2):	0.067
Primary/Secondary Waste Volume (ft^3/ft^2):	Not available
Primary/Secondary Waste Condition:	Not available

Performance Statistics

Technology Name:	Blastrac
Model #:	1-15D
Surface Media:	Concrete - poured
Surface Media Description:	Concrete with an epoxy urethane coating primer of 7 mils Ply-Mastic and 1.5 mils Ply-Thane 880.
Geometry:	Floor
Vendor Name:	J&B Diversified Services
Production Rate (ft^2/h):	103.3
Area of Surface Removed (ft^2):	373.78
Removal Capability:	3/16 in. estimated
Removal Gap (inches):	4 in.
Removal Media Usage Rate (lb/ft^2):	0.067
rimary/Secondary Waste Volume (ft^3/ft^2):	Not available
Primary/Secondary Waste Condition:	Not available

Vendor Information

Vendor Name:	J&B Diversified Services
Contact:	Jose & Bettie Ariza
Title:	Sales Manager
Vendor Address:	655 Wilma Street # 101 Longwood, Fl 32750
Vendor Web Site:	
Vendor Contact E-mail:	407-339-7877
Vendor Contact Phone:	407-339-1161
Vendor Fax:	
Vendor Services Available:	
DOE Site User References:	
Other Site References/Publications:	

Manufacturer Information

Manufacturer Name:	The Wheelabrator Corporation
Contact:	
Title:	
Manufacturer Address:	108 Pine Rd. Newnan, GA 30263
Manufacturer Web Site:	
Manufacturer Contact E-mail:	
Manufacturer Contact Phone:	770-251-6778 800-347-5764
Manufacturer Fax:	770-251-3573
Manufacturer Services Available:	
DOE Site User References:	
Other Site References/Publications:	

PEGASUS COATING REMOVAL SYSTEM PCRS-5

Technology Description

Technology Name:	Pegasus Chemical Coating Removal System
Technology Class:	Coating Remover
Vendor Name:	Pegasus International, Inc.
Manufacturer Name:	
Description:	PCRS is a chemical coating removal method that has been developed by Pegasus International, Inc. to remove chemically resistant coatings (i.e. epoxies, urethanes, chlorinated, rubber, elastomeric, aluminum, vinyls, mastics, and most marine coatings).
Benefits:	• Can remove coatings from complex surface geometries that blasting equipment cannot reach. • Requires no capitol purchase. • No maintenance costs are incurred. • No special service is required following successful coating removal. Additional coatings may be applied after a 24-h drying period.
Limitations:	• Surface must be clean and dry. • Dependent upon applied coating characteristics. Works well on some coatings, but is ineffective on others. • Cannot be used near any possible ignition source as PCRS vapors form an explosive mixture with air. • Decomposition products may be hazardous.
Secondary Waste Characteristics:	These organic solvent mixtures are currently not regulated by the Department of Transportation. Secondary waste characteristics vary depending on the model formula used.
Applicable Surface Media:	Aluminum, carbon steel, ceramic, composite, concrete – brick, concrete – block, concrete – poured, copper, glass, nickel, plastic, Plexiglas, stainless steel
Applicable Geometries:	Equipment, floor, glove box, obstructed, pier, pipe, plate, structural shape, tank, wire
Removal Capabilities:	Coating/Rust

Technology Demonstration

Technology Name:	Pegasus Chemical Coating Removal System
Model #:	PCRS-5
Vendor Name:	Pegasus International, Inc.
Site:	FIU-HCET
Demonstration Date:	3/17/97 to 3/22/97
Principal Investigator:	Joe Boudreaux
Basic Equipment Description:	PCRS-5 is a chemical coating removal method that has been developed by Pegasus International, Inc. for the removal of chemically resistant coatings (i.e. epoxies, urethanes, chlorinated, rubber, elastomeric, aluminum, vinyls, mastics, and most marine coatings). The PCRS-5 is an organic solvent mixture, clear in color, carries a slightly sweet odor, and is supplied in 1, 5, or 55-gallon plastic buckets. Depending on the substrate and operating conditions, PCRS-5 is applied by pouring directly from the bucket or from a smaller container, and long and/or short-handled spreaders or trowels are used to distribute it evenly across the surface. Removal of the PCRS-5 and primary waste are achieved by scraping the surface using trowels and/or large plastic shovels.
Support Equipment Description:	None
Basic System Capital Cost:	Service prices range from $48 to $100/gal (1997)
Support Equipment Cost:	• This low viscosity formula can be applied only to horizontal surface media.
Benefits:	• Can remove coatings from complex surface geometries that blasting equipment cannot reach. • Requires no capital purchase. • No maintenance costs are incurred. • No special service is required following successful coating removal. Additional coatings may be applied after a 24-h drying period.
Limitations:	• Surface must be clean and dry. • Limited to applied coating characteristics. Works well on some coatings, but is ineffective on others.
Operation/Maintenance Requirements:	None
Maintenance Cost:	None
Equipment Portability:	1 person
Utility Requirements:	None
Equipment Availability:	2-3 weeks
Required Personnel:	1 Equipment Operator

Technology Demonstration (Continued)

Required/Recommended PPE:	Face shield Butyl Rubber gloves Impervious apron Steel-toed boots NIOSH approved organic vapor respirator for enclosed areas
References:	Operating Procedure for Coating Removal on Concrete Flooring using PCRS-7/5, February 20, 1997, Pegasus International, Inc.

Performance Statistics

Technology Name:	Pegasus Chemical Coating Removal System
Model #:	PCRS-5
Surface Media:	Poured concrete
Surface Media Description:	Concrete floor (40 ft × 20 ft) with an epoxy urethane coating of 7 mils plymastic and 1.5 mils Plythane 880 with a 6-in.-high surrounding dike (3 sides).
Geometry:	Floor
Vendor Name:	Pegasus International Inc.
Absolute Production Rate (ft^2/h):	
Site-Specific Production Rate (ft^2/h):	132
Area of Surface Removed (ft^2):	728
Removal Capability:	Coating
Removal Gap (in.):	0
Primary/Secondary Waste Volume (ft^3/ft^2):	0.073
Primary/Secondary Waste Condition:	Waste consists of chunky blue and white flakes, resembling paint chips. Total waste volume includes all rags, disposable PPE. etc. used in this demonstration.

Vendor Information

Vendor Name:	Pegasus International, Inc.
Contact:	Paul Boudreaux
Title:	Project Engineer
Vendor Address:	106 Railroad Street, Schenley, PA 15682
Vendor Web Site:	
Vendor Contact E-mail:	
Vendor Contact Phone:	(412) 295-0066
Vendor Fax:	(412) 295-2340
Vendor Services Available:	○ Equipment Provider ○ Service Provider ⊙ Both
DOE Site User References:	
Other Site References/Publications:	Schenley Industrial Park Media and Process Technologies Schenley Bottling Company

NELCO PORTA SHOT BLASTTM MODEL EC-7-2

Technology Description

Technology Name:	Nelco Porta Shot Blast™
Technology Class:	Steel Abrasive Blasting
Decontamination Method:	Mechanical
Vendor Name:	Pegasus International. Inc.
Description:	Free-standing steel shot blaster. Blast pattern: 7-in. Shot is propelled to the surface via a centrifugal wheel powered by a 2-hp electric motor. The shot and debris are vacuumed into an air wash system where shot is separated for reuse. The debris is then collected in a vacuum drum.
Benefits:	• Machine can be operated either forward or backward while blasting. • Can be used on both concrete and metal surfaces. • Process is not dependent on coating type. • Blast media is inexpensive.
Limitations:	• Does not work on wet surfaces. • Should not be used in the vicinity of flammable liquids. • Cannot be operated in an elevated position. • Not effective for deep concrete removal.
Applicable Surface Media:	Aluminum, carbon steel, concrete – brick, concrete – block, concrete – poured, copper, nickel. stainless steel. wood
Applicable Geometries:	Floor, pier, plate
Removal Capabilities:	¼ in.
Secondary Waste Characteristics:	Contaminated steel shot

Technology Demonstration

Technology Name:	Nelco Porta Shot Blast™
Model #:	EC-7-2
Site:	Florida International University
Demonstration Date:	3/17/97 to 3/22/97
Principal Investigator:	Joe Boudreaux
Basic Equipment Description:	The EC-7-2 Porta Shot Blast machine has a 7-in. blast pattern. Shot is introduced through a feed spout and propelled to the surface via a centrifugal blast wheel powered by a 2-hp electric motor. The shot and surface debris are vacuumed into an air wash system where the shot is separated for reuse. This unit continuously recycles shot while in operation. The debris is then collected in a vacuum drum.
Support Equipment Description:	Vacuum unit Floor magnet
Basic System Capital Cost:	$8,000 (1997)
Support Equipment Cost:	Vacuum unit: $500 (1997) Floor magnet: $500 (1997)

Technology Demonstration (Continued)

Benefits:	▪ Surface preparation is easily and consistently accomplished. ▪ Shot is continuously recycled while the shot feed spout is open. ▪ Process is not labor intensive. ▪ Machine can be operated either forward or backward while blasting. ▪ Can be used on both concrete and metal surfaces. ▪ Process is not dependent on coating type. ▪ Blast media is inexpensive.
Limitations:	▪ Does not work on wet surfaces. ▪ Should not be used in the vicinity of flammable liquids. ▪ Cannot be operated in an elevated position. ▪ Not effective for deep concrete removal.
Utility Requirements:	110 V AC/30 A or 220V AC/20 A
Blast Media Type Used:	Steel shot #390 (can also use # 280)
Blast Media Cost ($/lb):	$0.40 (1997)
Operation/Maintenance Requirements:	Adjustment and cleaning of shrouds and blast shields. Changing of hoppers for different orientations. Changing wear plates. Lubricating bearings. Clean/replace vacuum filter as required. Inspection of belts.
Maintenance Cost:	
Equipment Portability:	2 people (blaster weighs approx. 185 pounds)
Equipment Availability:	2-3 weeks
Required Personnel:	1 equipment operator; 1 general laborer
Required/Recommended PPE:	Safety glasses with rigid side shields — Ear protection Face shield — Steel-toed shoes Work gloves — Durable pants Long sleeve shirt
References:	EC-7-2 Porta Shot-Blast Operator's Manual, Nelco Manufacturing Corporation. Operating Procedure for Coating Removal and Surface Preparation on Concrete Flooring Using 7-in. Shot Blaster, March 3, 1997, Pegasus International, Inc.

Performance Statistics

Technology Name:	Nelco Porta Shot Blast™
Model #:	EC-7-2
Surface Media:	Concrete floor (20 ft × 20 ft) with an epoxy urethane coating of 7 mils Plymastic and 1.50 mils Plythane 880 with a 6-in.-high surrounding dike (3 sides).
Removal Capability:	Coating
Production Rate (ft^2/h):	50
Area of Surface Removal (ft^2):	378
Removal Gap (inches):	2
Blast Media Usage Rate (lb/ft^2):	0.116
Primary/Secondary Waste Condition:	Waste resembles a very fine blue-gray powder.
Primary/Secondary Waste Volume (ft^3/ft^2):	1.89×10^{-4}

Performance Statistics

Technology Name:	Nelco Porta Shot Blast™
Model #:	EC-7-2
Surface Media:	Uncoated concrete floor (20 ft × 20 ft)
Removal Capability:	< ¼ in.
Production Rate (ft^2/h):	140
Area of Surface Removal (ft^2):	366
Removal Gap (inches):	2
Blast Media Usage Rate (lb/ft^2):	0.0479
Primary/Secondary Waste Condition:	Waste resembles a very fine gray powder.
Primary/Secondary Waste Volume (ft^3/ft^2):	1.14×10^{-4}

Vendor Information

Vendor Name:	Pegasus International, Inc.
Contact:	Paul Boudreaux
Title:	Project Engineer
Company Address:	106 Railroad Street, Schenley, PA 15682
Company Website Address:	
E-mail:	
Phone:	(412) 295-0066
Fax:	(412) 295-2340
Services Available:	○ Equipment Provider ○ Service Provider ⊙ Both
DOE Site User References:	
Other Site References/Publications:	Schenley Industrial Park Media and Process Technologies Schenley Bottling Company

Manufacturer Information

Manufacturer Name:	NELCO Manufacturing Corp.
Contact:	Travis McCutchen
Title:	Sales Coordinator
Manufacturer Address:	6215 Aluma Valley Drive, P.O. Box 36239, Oklahoma City, Oklahoma 73136-2239
Manufacturer Web Site:	
Manufacturer Contact E-mail:	
Manufacturer Contact Phone:	(800) 256-3440
Manufacturer Fax:	(405) 478-3440
Manufacturer Services Available:	Equipment provider
DOE Site User References:	
Other Site References/Publications:	

TEXTRON'S ELECTRO-HYDRAULIC SCABBLING SYSTEM

Technology Description

Technology Name:	Textron's Electro-Hydraulic Scabbling (EHS) System
Technology Class:	Scarification
Vendor Name:	Textron Inc./Textron Systems Corporation
Manufacturer Name:	(Same as Vendor)
Description:	The Electro-Hydraulic Scabbling (EHS) System is capable of removing up to 1 in. of concrete through a series of electrical pulses propagated under a layer of water between a pair of strip-shaped electrodes positioned with a minimum clearance over a concrete floor. The use of high current/short duration pulses create spark-like discharges in the water medium that produce shock waves and cavitating bubbles. The force of the direct and reflected shock waves impinging on the concrete surface results in the deformation, crushing, and cracking of the concrete surface layer.
Benefits:	• No dust is produced by this decontamination system. • Strong electric "explosions" allow for deep and wide one-pass concrete scabbling.
Limitations:	• Current system cannot operate closer than 1 ft away from walls, edges, or other obstructions. • The presence of water soluble media or contaminants severely reduces system efficiency.
Secondary Waste Characteristics:	Contaminated water
Applicable Surface Media:	Concrete block, concrete poured
Applicable Geometries:	Floor
Removal Capabilities:	1 in.

Technology Demonstration

Technology Name:	Textron's Electro-Hydraulic Scabbling (EHS) System
Model #:	*(Currently under development)*
Vendor Name:	Textron Inc./Textron Systems Corporation
Site:	HCET-FIU
Demonstration Date:	3/31/97 to 4/15/97
Principal Investigator:	Tanza Ross
Basic Equipment Description:	The EHS system consists of an electric power supply, a scabbling chamber, a scabbling module mounted on a positioner, a vacuum system and a water/rubble flow system. Most components are mounted on a conventional forklift. The 4-ft × 4-ft chamber isolates the 7-ft^2 floor area to be processed by sealing the bottom perimeter to the surface via a flexible gasket, thereby preventing the spread of water and contaminated waste over the surrounding surface. The scabbling module contains the electrode pair, and is moved across the surface within the chamber by an X-Z positioner. The vacuum unit is used to improve the chamber isolation and to remove the rubble/sludge created by scabbling, and to deposit it into the collection drum. Flow system pumps are used to circulate or discard the water after it is cleared by coarse and fine filters.
Support Equipment Description:	3-phase AC generator (30 kW) Compressor 25 hp
Basic System Capital Cost:	$100,000 (1997)
Support Equipment Cost:	$15,000 (1997)
Benefits:	
Limitations:	• The system produces sparks; therefore it cannot be used in environments containing flammable vapors.
Removal Media Type:	N/A
Removal Media Cost ($/lb):	N/A
Operation.Maintenance Requirements:	• Conventional for pumps, electric controls and vacuums. • Coating and changing of the electrodes. • Replacement of the foam gaskets and air and water filter elements.
Maintenance Cost:	
Equipment Portability:	Large truck and forklift required.
Utility Requirements:	AC power: 20-30 kW total Water: City line; 10 gpm Compressed air: 100 psi, 100 CFM
Equipment Availability:	To be determined.
Required Personnel:	2 equipment operators
Required.Recommended PPE:	Safety glasses with rigid side shields Hearing protection Steel-toed shoes
References:	FERMCO. January, 1996. Field assessment of and data package for the electro-hydraulic scabbling demonstration conducted at the FEMP, September 18-29, 1995. Goldfarb, V., and R. Gannon. 1995. Concrete decontamination by electro-hydraulic scabbling. Proceedings of the Environmental Technology Through Industry Partnership Conference. Vol. I, DOE/METC-96/1021. Goldfarb, V., and R. Gannon. 1995. Progress of electro-hydraulic scabbling technology for concrete decontamination. DOE/METC Contract No. DE-AC21-93 MC30164.

Performance Statistics

Technology Name:	Textron's Electro-Hydraulic Scabbling (EHS) System
Model #:	*(Currently under development)*
Surface Media:	Concrete – poured
Surface Media Description:	Concrete floor (20 ft × 40 ft) with an epoxy urethane coating of 7 mils Plymastic and 1.50 mils Plythane 880 with a 6-in.-high surrounding dike (3 sides)
Geometry:	Floor
Vendor Name:	Textron Inc. / Textron Systems Corporation
Absolute Production Rate (ft^2/h):	13.67
Area of Surface Removed (ft^2):	391.05
Removal Capability:	1 in.
Removal Gap (inches):	12
Removal Media Usage Rate (lb/ft^2):	N/A
Primary/Secondary Waste Volume (ft^3/ft^2):	11.05×10^{-3}
Primary/Secondary Waste Condition:	Waste resembles a very fine blue-gray powder.

Vendor Information

Vendor Name:	Textron Inc./Textron Systems Corporation
Contact:	Dr. Victor Goldfarb
Title:	
Vendor Address:	201 Lowell Street, Bldg. 9 Wilmington, MA 01887
Vendor Web Site:	
Vendor Contact E-mail:	
Vendor Contact Phone:	(508) 657-6743
Vendor Fax:	(508) 657-6770
Vendor Services Available:	Equipment Provider and Service Provider
DOE Site User References:	FERMCO. January, 1996. Field assessment of and data package for the electro-hydraulic scabbling demonstration conducted at the FEMP, September 18-29, 1995.
Other Site References/Publications:	Goldfarb, V., and R. Gannon. 1995. Concrete decontamination by electro-hydraulic scabbling. Proceedings of the Environmental Technology Through Industry Partnership Conference. Vol. I. DOE/METC-96/1021. Goldfarb, V., and R. Gannon. 1995. Progress of electro-hydraulic scabbling technology for concrete decontamination. DOE/METC Contract No. DE-AC21-93 MC30164.

NELCO PORTA SHOT BLASTTM MODEL GPX-10-18 HO RIDER

Technology Description

Technology Name:	NELCO Porta Shot-Blast™
Technology Class:	Steel Abrasive Blasting
Vendor Name:	Custom Coating
Manufacturer Name:	NELCO Manufacturing Corp.
Description:	NELCO built the world's first portable shot blasting machine. NELCO manufactures 12 different Porta Shot-Blast machines that are custom-configured to meet users specific requirements. NELCO portable shot blasting machines are available in a wide range of sizes to suit most surface preparation requirements. NELCO's patented blast wheel design produces a uniform blast pattern, resulting in a smooth, uniform surface profile with no hot spots or grooves as are produced by blasters with centerfed wheel designs. Machines are available for indoor and outdoor use, that can be used on vertical or horizontal surfaces, and that are powered by propane, diesel, gasoline, electric, or pneumatic engines. NELCO will custom-build shot blasters to suit specific customer requirements.
Benefits:	• The blast wheel produces a uniform surface profile. • NELCO machines require minimal setup time. • NELCO shot blast machines have simple, easy-to-reach controls. • Novice operators become productive quickly.
Limitations:	• Not effective for heavy coating removal. • Not recommended for large surface areas.
Secondary Waste Characteristics:	Contaminated Steel Abrasive
Applicable Surface Media:	Aluminum, carbon steel, ceramic, composite, concrete – brick, concrete – block, concrete – poured, copper, nickel, stainless steel, wood
Applicable Geometries:	Floor, obstructed, pier, pipe, plate, structural shape, tank, wall
Removal Capabilities:	¼ in.

Technology Demonstration

Technology Name:	NELCO Porta Shot-Blast™
Model #:	GPx-10-18 HO Rider
Vendor Name:	Custom Coating
Site:	FIU-HCET
Demonstration Date:	12/2/96
Principal Investigator:	Joe Boudreaux

Technology Demonstration (Continued)

Basic Equipment Description:	The NELCO Porta Shot-Blast™, model GPx-10-18 HO Rider is engineered for medium to large size flooring applications with a 10-in. cleaning path. This self-propelled unit utilizes a centrifugal blast wheel to propel abrasives onto the surface for material removal. This model can adjust material removal depth by the different speeds of the blast wheel or the abrasive material used. A connecting vacuum collects all airborne contaminants to maintain a clean and dust free work environment.
Support Equipment Description:	
Basic System Capital Cost:	$2,500 NELCO Porta Shot-Blast™ (1996) Dust Collector 1400 CFM
Support Equipment Cost:	
Benefits:	• Capable of reusing blast media. • Blast wheel creates a uniform surface removal. • Easy to operate controls. • Maintains a dust free work environment.
Limitations:	• Cannot operate on wet surfaces. • Forklift is needed to transport equipment.
Removal Media Type:	S-390 Steel Shot
Removal Media Cost ($/lb):	$ 0.40
Operation/Maintenance Requirements:	
Maintenance Cost:	
Equipment Portability:	Forklift to transport to site.
Utility Requirements:	
Equipment Availability:	2 weeks advance
Required Personnel:	1 equipment operator
Required/Recommended PPE:	Hearing protection Hard hat with face shield Steel-toed boots
References:	

Performance Statistics

Technology Name:	NELCO Porta Shot-Blast™
Model #:	GPx-10-18 HO Rider
Surface Media:	Concrete-poured
Surface Media Description:	Concrete with an epoxy urethane coating primer of 7 mils Ply-Mastic and 1.5 mils Ply-Thane 880.
Geometry:	Floor
Vendor Name:	Custom Coating
Production Rate (ft^2/h):	625.36
Area of Surface Removed (ft^2):	354.58
Removal Capability:	¼ in. estimated
Removal Gap (inches):	4.5
Removal Media Usage Rate (lb/ft^2):	
Primary/Secondary Waste Volume (ft^3/ft^2):	
Primary/Secondary Waste Condition:	Contaminated steel shot

Vendor Information

Vendor Name:	Custom Coating
Contact:	Charles Justice
Title:	President
Vendor Address:	108904 Hale Ave. Panama City Beach, Fl 32407
Vendor Web Site:	
Vendor Contact E-mail:	
Vendor Contact Phone:	904-234-9334
Vendor Fax:	904-234-9334
Vendor Services Available:	
DOE Site User References:	
Other Site References/Publications:	

Manufacturer Information

Manufacturer Name:	U.S. Filter Blastac
Contact:	
Title:	
Manufacturer Address:	6215 Aluma valley Drive Oklahoma City, OK 73121
Manufacturer Web Site:	www.blastrac.com
Manufacturer Contact E-mail:	
Manufacturer Contact Phone:	800-256-3440 405-478-3440
Manufacturer Fax:	405-478-5327
Manufacturer Services Available:	
DOE Site User References:	
Other Site References/Publications:	