

**THE ADVANCED RECYCLABLE MEDIA SYSTEM
DEMONSTRATIONS AT
ARGONNE NATIONAL LABORATORY, CP5
AND
FLORIDA INTERNATIONAL UNIVERSITY**

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ABSTRACT

Surface Technology Systems (STS) performed demonstration projects using its Advanced Recyclable Media System (ARMS) system on a variety of concrete and steel surfaces. One group of trials took place at Florida International University (FIU) and the other at Argonne National Laboratory (ANL). The materials cleaned (various steel and concrete surfaces) at FIU were the same for all technologies tested and the test at ANL was on a section of the CP-5 reactor concrete floor. An independent observer from FIU documented performance for each technology during each trial.

The ARMS technology had exceptional performance on painted and rusted steel surfaces with cleaning rates ranging from 2.82 to 7.61 m²/hr (30.4 to 81.9 ft²/hr). (1,2) These rates were 3.8 to 12.8 times faster than the second best technology. For concrete surfaces, the cleaning rates ranged from 3.9 to 11.8 m²/hr (41.9 to 127 ft²/hr) for CP-5 and FIU respectively. (3) Waste generation rates were in the 0.00014 to 0.00059 m³/m² (0.005 to 0.021 ft³/ft²) for concrete and steel surfaces. Surface finish for metal was near white metal (SPCC 8) which was the highest of all technologies evaluated.

From the observed performance measures and vendor supplied cost, an approximation for cleaning cost was calculated. This approximation is based on a standard labor rate and disposal cost. Consumables and capital cost were considered in the calculation. Generally, the technology that has the best combination of waste generation and cleaning rates is the most cost effective providing it is not too capital intensive. Cost need to be calculated for a specific situation to be most accurate. For 6mm (0.25") steel plates the ARMS cost is \$1.20/kg (\$0.50/pound). The cost for the I-beam cleaned was \$0.90/kg (\$0.40/pound). Certainly, the system is very effective for steel with thickness above 2.55mm (0.1 inch).

INTRODUCTION

Company History

STS a small business with offices located in North Canton, Ohio and Oak Ridge, TN decontaminates and decommissions equipment and facilities using various methods at sites throughout the United States. STS employs an experienced team of environmental technicians and talented project managers who have been fully trained in all aspects of remediation techniques and regulations. Other services include analysis, removal, transportation, and disposal of low level and mixed waste materials. STS holds a broad spectrum mobile radioactive materials license R-01085-I03 issued by the Tennessee Division of Radiological Health. This license allows the management of 1 curie of each isotope with atomic number between 1 and 103 and 1-curie total of special nuclear material. STS can clean and release material at the limits specified in Reg Guide 1.86 under this license.

STS utilizes the ARMS technology in support of ongoing decontamination and decommissioning projects. The ARMS technology is extremely effective in removing and segregating surface contaminants for responsible disposal. The system has been successful at removing grease, oil, paint, and radioisotopes from metal, wood, concrete and graphite surfaces. Various geometries such as angles, corners, floors, vertical surfaces, overhead surfaces and pipe can be cleaned effectively with the ARMS technology.

THE ARMS Technology

The ARMS technology is capable of removing soot from wallpaper and cleaning metal to a white metal finish, depending on media type and air pressure. The soft media is highly absorptive and can be used either dry or wetted with a variety of cleaning agents and surfactants to capture, absorb, and remove surface contaminants such as oils, greases, lead compounds and radionuclides. The aggressive grades of media are used to remove a variety of surface contaminants to include low-level radioactive materials, paints, protective coatings and rust. The media is also used to roughen concrete and metallic surfaces, if desired. Various geometries such angles, corners, floors, vertical surfaces, overhead surfaces and pipe with a 6 cm (2.5") ID can also be cleaned effectively and economically.

The ARMS treatment equipment consists of the following easily transportable modules.

Feed Unit 0.8 x 0.8 x 1.5 m, 204 kg (32" x 32" x 60", 450 lbs.)

The Feed unit is a portable pneumatically powered device for propelling the cleaning media against surfaces to be cleaned or otherwise prepared. A hopper, mounted on top of the unit, holds the cleaning media. The size and weight are such that it will fit through standard doors and passenger elevators. Wheels are provided for ease of transportation. The media is fed by an auger device into a metering chamber, which mixes the cleaning media with compressed air. The mixture is transported using standard abrasive blasting hose through a standard abrasive blasting nozzle to the surface to be cleaned or prepared. By varying the unit air pressure and

grade of cleaning media, the system can remove soot from a wall surface, or can remove fully cured high-performance protective coatings from steel, brick and concrete surfaces. The unit is powered entirely by compressed air.

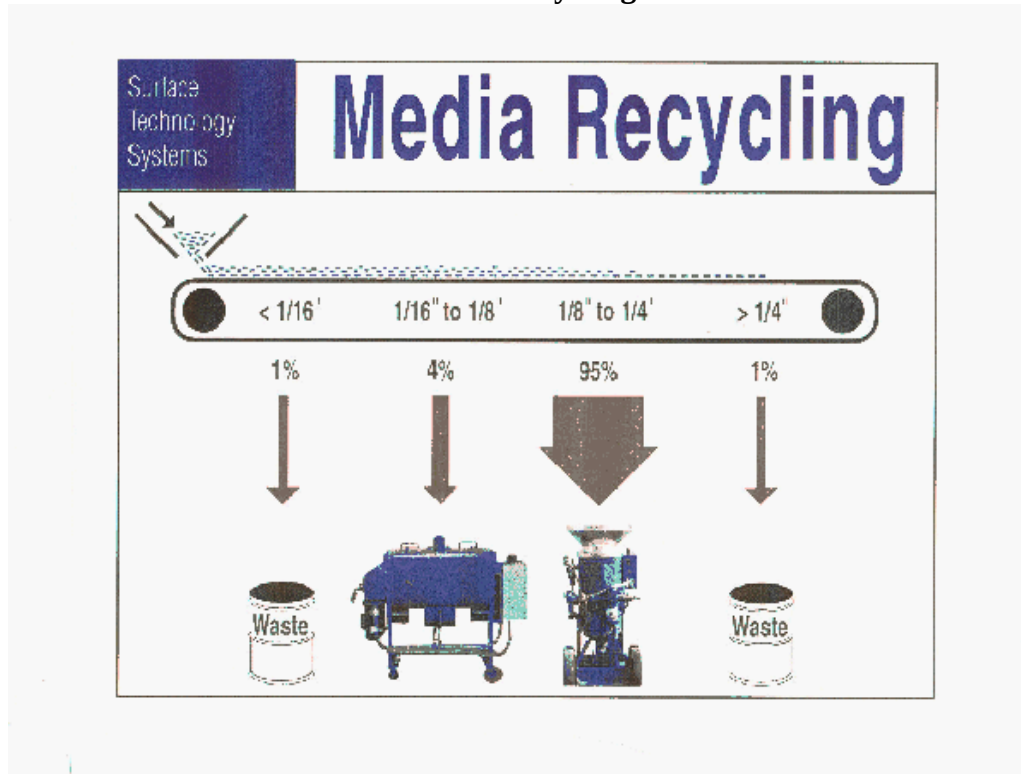
Screening Unit 1.8 x 0.8 x 1.8 m, 182kg(72" x 32" x 72", 400 lbs.)

The Screening Unit is used to mechanically remove large debris and powdery residues from the cleaning media after each use. The cleaning media is collected in the work area and placed into the electrically powered (115v) screener. The unit vibrates causing the used media to pass vertically downward through a series of separation screens. Any coarse materials, such as paint flakes, rust particles, etc. are collected in the first and coarsest screen. Next, the fine dust and removed surface material drops through a screen into a waste collection container. The remaining media is transferred to the top of the feed unit and reused. This waste stream contains most of the activity removed from the surface which prevents the concentration from becoming too high in the stream that is reused. Typically, there is 10 times more activity in the waste stream than the reusable media. Fines from media used absorb radioactive contaminants are disposed as radioactive waste. The numerous reuses of the re-screened media drastically reduces the waste generated per square foot of the surface treated. Both the feed and shifter units are designed to be easily cleaned. Motors are sealed and enclosed parts are readily accessible for cleaning. Surfaces are typically painted metal. The combined Feed and Screening Units are shown in Figure 1. The media is reused several times as shown in Figure 2.

Photo 1
FeedUnit/Sifter Unit



Figure 1
Media Recycling



ARGONNE NATIONAL LABORATORY, CP5 Demonstration

Objective

The decontamination of radioactively contaminated concrete is a concern during the decontamination and decommissioning (D&D) process. The primary decontamination objectives were to: (1) reduce surface contamination levels to reduce potential personnel and environmental exposure, and (2) the reduction of surface contamination levels to meet DOE Order 5400.5 for unrestricted use.

Demonstration

The demonstration tested the ARMS technology for its ability to decontaminate approximately 24.3 m² (262 ft²) of concrete flooring by coating removal. The testing was performed on the service floor of the ANL, Chicago Pile 5 (CP-5) facility as part of the Large Scale Demonstration project funded by DOE's Federal Energy Technology Center.

Performance

The ARMS technology cleaned the 24.2m² (262 ft²) of concrete flooring at a rate of 3.9 m² (41.9 ft²) per hour. The demonstration required a crew of three people due to the limited space. A typical crew has one person operating the feed unit, one gathering and shifting media and one moving a surveying material. At the beginning of the demonstration, 90.9 kg (200 lb.) of new media with a volume of 0.21m³ (7.52 ft³) media feed unit. This media was then used to clean the floor, manually collected using plastic shovels, sifted and recycled approximately sixteen (16) times during the demonstration. At the end of the demonstration, a total of 0.022 m³ (0.8

ft³) of spent fines and large debris had been collected as waste and 0.11 m³ (4 ft³) of reusable media remained. The media becomes more dense after it is used and this accounts for the volume reduction from the initial amount. Radiological contamination prior to the demonstration included fixed beta/gamma ranging from 3,200 to 263,200 dpm/100cm². After the demonstration, the contamination was localized to four hotspots which ranged from 4,000 to 19,000 dpm/100cm². During the actual cleaning process no quality assurance measurements were done so the remaining hot spots were not located until after the demonstration. During production work, surveys are done before the equipment leaves the area so any required rework can be performed. After the demonstration, the radiation level of spent fines was 3,000 dpm and the remaining reusable media levels were 300-500 dpm.

FLORIDA INTERNATIONAL UNIVERSITY

Objective

The two primary decontamination objectives for metal decontamination are: (1) a reduction in the surface contamination levels to reduce potential personnel and environmental exposure and (2) the reduction of surface contamination levels to meet DOE Order 5400.5 for unrestricted use. Decontamination objectives are developed on a project- and/or site specific basis. The decontamination of steel in the majority of the cases is surface cleaning, the removal of surface coating, and/or rust removal. The decontamination technologies tested were required to perform a surface cleaning, achieve a white metal surface, or reach some point between the two conditions.

Demonstration

The demonstration compared three technologies the NELCO Porta Shot Blast JHJ-2000, the YAG ERASER and the Advanced Recyclable Media System.

Surrogates consisted of 15 x 23 cm (6"x9") I-beams cut to be approximately 3m (10 ft) in length, and steel plates of a minimum 0.6 cm (.25") thickness cut approximately 1.2 x 1.2 m (4 x4 ft) square. The I-beams were prepared and coated using a standard industrial coating. I-beams that exhibited a rusted condition, like those found at many DOE sites, were also prepared/collected. The steel plates were prepared and painted with a coating typically used in chemically exposed environments. Steel plates that exhibited a rusted condition, like the ones found at many DOE sites, were also prepared/collected.

The following paint specification were used to develop the painted surrogates:

- *I-beam Specification.* (1) Prepare metal according to the Michael A. Bruder & Son (M.A.B.) technical data and application instructions. (2) Apply Rust-O-Lastic Anti-Corrosive Primer 3 mils wet to obtain 1 ½ - mils dry film thickness. (3) Wait 24 hours, then apply a finish coat of Rust-O-Lastic finish coating at 3 mils wet to obtain 1 ½ - mils dry film thickness.
- *Plate Specification.* (1) Prepare metal according to the M.A.B. technical data and application instructions. (2) Apply Ply-Mastic at 8 mils wet to obtain a 7 – mils dry

film thickness. (3) Wait 24 hours, then apply finish coat of Ply-Thane 890 coating at 3 mils wet to obtain 1 ½-mils dry film thickness.

Performance

To ensure that the results of this test were applicable to the different decontamination objectives and to other environmental restoration sites, the technologies were used in the most efficient manner as directed by the vendor. The end point was compared to a set of established surface finish standards. A surface end point definition for different surface conditions was then given based on the review of the specifications of the Steel Structures Painting Council, USA, and the National Association of Corrosion Engineers, USA. The specifications are as follows:

- *Solvent-Cleaned Surface*
- *Brush-Off Cleaned Surface*
- *Commercially Cleaned Surface*
- *Cleaned Near-White Metal Surface (Arms performance)*
- *Cleaned White Metal Surface*

CONCLUSIONS

Cleaning Rates

The ARMS™ technology consistently performs at very high production rates independent of the surface.

- **Concrete Surfaces**
 - Concrete Flooring(CP5) – 4.1 m² (41.9ft²) per hour
 - Concrete walls and ceilings(FIU) 11.8 m² (127 ft²) per hour
- **Metal Surfaces**
 - Painted Plate – 2.8 m² (30.4 ft²) per hour
 - Rusted Plate – 7.0 m² (75.29 ft²) per hour
 - Painted I-beam – 7.0 m² (75.47 ft²) per hour
 - Rusted I-beam – 7.6 m² (81.94 ft²) per hour
- **Waste Generation Rates**
 - **Argonne National Laboratory, CP5**
 - Concrete Flooring – 0.0009 m³/m² (0.003 ft³/ft²)
 - **Florida International University**
 - Painted Plate – 0.0063 m³/m² (0.021 ft³/ft²)
 - Rusted Plate – 0.0015 m³/m² (0.005 ft³/ft²)
 - Painted I-beam – 0.0015 m³/m² (0.005 ft³/ft²)
 - Rusted I-beam – 0.0015 m³/m² (0.005 ft³/ft²)

Table I
Cleaning and Waste Disposal Rates

Rates	Painted Plate	Rusted Plate	Painted I-beam	Rusted I-beam	Painted Single Pass	Concrete Multi Pass
Cleaning m2/hr	2.8	7	7	7.6	11.78	4.07
Waste m3/m2	.0009	.0015	.0015	.0015		

Health Physics Issues

- **Argonne National Laboratory, CP5**
 - Airborne radiological measurements measured outside the enclosure tent were at or below background levels.
 - There was no surface contamination of either employees or equipment.

- Noise levels range from 90 to 100 dBA at the nozzle. Hearing protection is required.
- Worker safety issues from tripping caused by multiple hoses.
- **Florida International University**
 - Airborne dust was visible during the demonstration
 - Maximum noise at the nozzle was 132.5 dBA
 - Worker safety issues from pieces of sponge flying around in blast chamber

Costs

- **Argonne National Laboratory, CP5**
ARMS - \$ 3.63 per square foot cleaned
- **Florida International University**
ARMS - \$ 3.19 per square foot cleaned (average)
\$0.90 to \$1.20 \$/kg (\$0.40 to \$0.50/pound)

References:

1. L.E. LAGOS et al, "Evaluation of Coating Removal and Aggressive Surface Removal Technologies Applied to Concrete Walls, Brick Walls, and Concrete Ceilings," Control Number: 2500-RP-0020-REV O, Hemispheric Center for Environmental Technology
2. Technology Demonstration Summary Sheet, Advanced Recyclable Media System Decontamination, CP-5 large Scale Demonstration Project, Strategic Alliance.
3. M.A. EBADIAN, Ph.D., "Decision Analysis Science Modeling for Application and Fielding Selection Applied to Metal Decontamination Technologies, Hemispheric Center for Environmental Technology.

Figure 2
Metal Production Rate

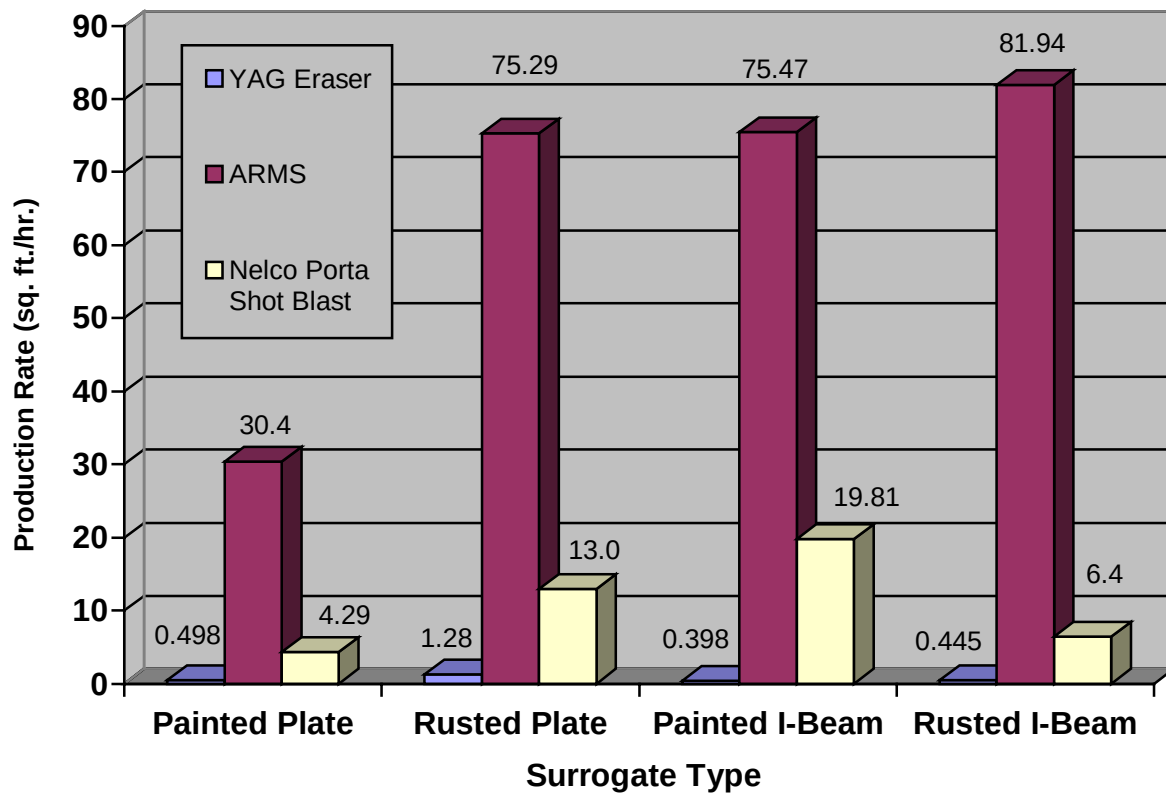


Figure 3
Concrete Production Rate

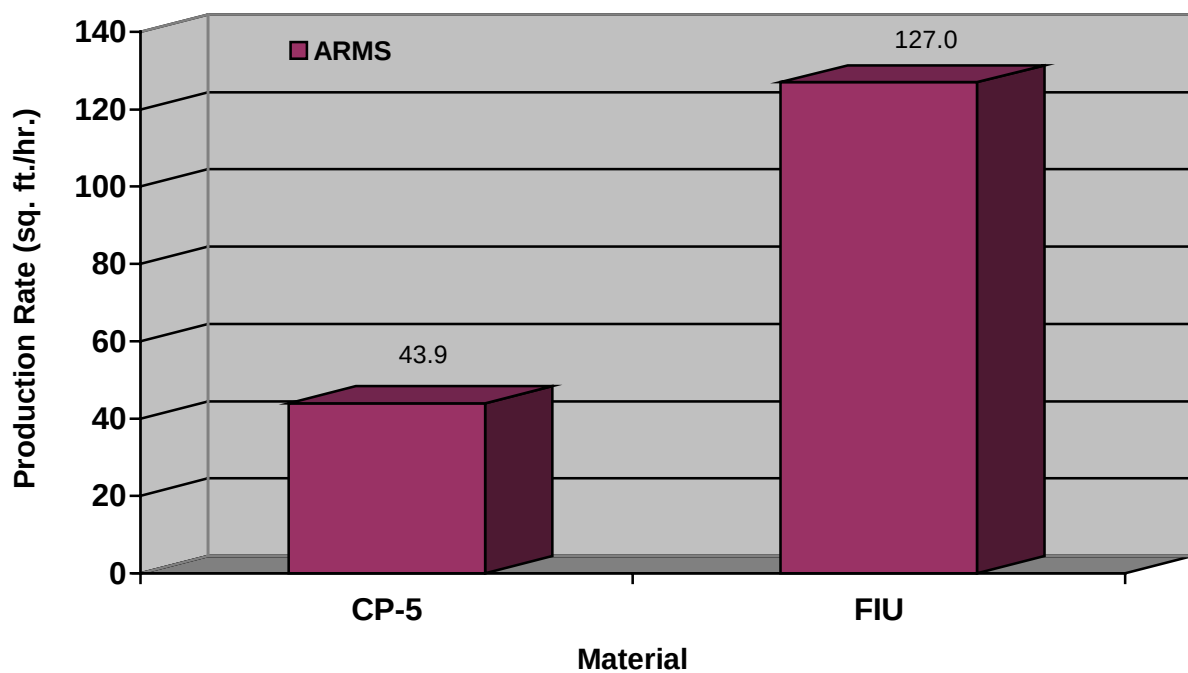


Figure 4
Waste Generation Rate

