

***OPERATING ENGINEERS NATIONAL
HAZMAT PROGRAM***

**INTERNATIONAL ENVIRONMENTAL TECHNOLOGY &
TRAINING CENTER**

**SURFACE TECHNOLOGY SYSTEMS (STS)
ADVANCED RECYCLABLE MEDIA SYSTEM
(ARMS™)
WALL/CEILING**

HUMAN FACTORS ASSESSMENT

MARCH, 1998

SURFACE TECHNOLOGY SYSTEMS (STS)
ADVANCED RECYCLABLE MEDIA SYSTEM (ARMSÔ)
(WALL/CEILING)

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ACKNOWLEDGEMENTS

The human factors assessment of Surface Technology Systems Advanced Recyclable Media System (Wall/Ceiling) was conducted under support of the U.S. Department of Energy's Federal Technology Center, under cooperative agreement DE-FC21-95MC32260 with the Operating Engineers National Hazmat Program. The Operating Engineers National Hazmat Program would like to thank the following people for their participation on the "research action team" and the professional expertise they provided for this assessment:

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EXECUTIVE SUMMARY

The ARMS™ uses a soft media that is highly absorptive and can be used either dry or wetted to capture, adsorb, and remove surface contaminants, such as oils, grease, lead compounds, chemicals, and radionuclides. Steam may also be used to provide for dust control without creating a liquid waste stream.

The system consists of transportable modules. The feed unit is a portable pneumatically powered device for propelling the cleaning media against the surface to be cleaned. A hopper, mounted atop the unit, holds the cleaning media. The media is fed by the 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 nozzle, to the surface to be cleaned. By varying the unit air pressure and grade of cleaning media, the system can remove surface contamination from soot to fully cured high-performance protective coatings from steel and concrete surfaces.

The sifter 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 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 reusable media is collected on the finer screen. Finally, any dust particles pass through the screener for proper collection and disposal.

The system requires that a containment area be built where the ARMS™ is to be used. During the testing demonstration the containment was built using 2X4's as a frame and heavy plastic was attached to the frame to complete the containment. An air mover, which provided general ventilation at approximately 2000 cfm (according to the technology developer), was installed in the containment. The air from inside the containment was filtered by a high efficiency particulate air (HEPA) filter before being exhausted outside the containment.

The media used for blasting during the testing demonstration was ARMS™ Aluminum Oxide Fiber Media which is classified as a dry abrasive sponge. It is composed of alpha alumina and titanium dioxide. The percent of each is not provided on the material data sheet (MSDS) but is listed as a proprietary composition.

During the assessment sampling was conducted for dust and noise and general observational techniques were conducted for ergonomics. Due to the nature of the job, coating removal from a wall and ceiling, the operator conducted blasting from ground level and from a scaffolding. There are ergonomic hazards associated with both of these locations. Regardless of the location, the main ergonomic concern is the posture

the arms (of the operator) must be in while holding the weight of the blast nozzle. This has the potential to cause sprain/strain/fatigue to the arms, shoulders, and upper and lower back. Reducing the weight of the nozzle or mounting the nozzle on an adjustable frame so it can be moved where needed would help to reduce and/or alleviate these ergonomic concerns.

Personal and area dust sampling were conducted for total dust. There were three operators and they changed out of the containment every 20-30 minutes. Therefore, area sampling was conducted to determine the potential exposures over a longer period of time.

The personal samples for two of the operators showed values of 2729.8 mg/m³ and 232.6 mg/m³. Area dust sampling showed values of 997.⁸ mg/m³, 1931.⁸ mg/m³, 2476.2 mg/m³, 1836.6 mg/m³, 1687.00 mg/m³, and 1501.8 mg/m³.

All of the air sampling values were in excess of the OSHA PEL and the ACGIH TLV of 15 mg/m³ and 10 mg/m³, respectively for total dust. It must also be noted that at the end of each sampling period, there was ¼ - ¾ inch of dust on the sampling filter. These dust levels indicate the possible need for air-line respirators or SCBAs when working inside the containment area.

Personal noise monitoring was conducted on two of the operators. Monitoring showed noise doses of 651.84% which gives a time-weighted average (TWA) of 103.5 dBA for operator number 1 and a noise dose of 1431.56% (TWA – 109.2 dBA). Area noise monitoring showed noise doses of 92.47% (TWA – 89.4 dBA), 41.36% (TWA – 83.7 dBA), 267.23% (TWA – 97.1 dBA), and 366.15% (TWA – 99.4 dBA).

The OSHA allowable PEL for noise is a 100% dose or an 8-hour TWA of 90 dBA. The above noise doses and TWA's show noise to be an exposure hazard for the operator of the ARMS™. Feasible engineering controls, administrative controls, and personal protective equipment (hearing protection devices) need to be used as appropriate. Operators would be required to be included in a hearing conservation program.

Recommendations for improved worker safety and health during use of the ARMS™ include: 1. keeping all hoses and lines as orderly as possible in compliance with good housekeeping requirements; 2. ergonomic training to include techniques in lifting, bending, stooping, twisting, etc.; 3. PPE compatible with the level of exposure; 4. GFCI and appropriate grounding on all electrical connections; 5. warning lights for communication in the containment area; 6. one worker in the containment area at a time; and 7. engineering and administrative controls as well as hearing protection devices to reduce noise exposure.

SURFACE TECHNOLOGY SYSTEMS (STS)
ADVANCED RECYCLABLE MEDIA SYSTEM
(ARMSTM) (WALL/CEILING)
Human Factors Assessment

SECTION 1 - SUMMARY

TECHNOLOGY DESCRIPTION

The Surface Technology Systems (STS) Advanced Recyclable Media System (ARMSTM) was tested and is being evaluated at Florida International University (FIU) as a baseline technology. In conjunction with FIU's evaluation of efficiency and cost, this report covers the hazard analysis and safety evaluation. It is a commercially available technology that has been used for various projects at locations throughout the country.

The ARMSTM uses a soft media that is highly absorptive and can be used either dry or wetted to capture, adsorb, and remove surface contaminants, such as oils, grease, lead compounds, chemicals, and radionuclides. Steam may also be used to provide for dust control without creating a liquid waste stream. The ARMSTM equipment consists of a feed and sifter unit.

KEY RESULTS

The safety and health evaluation during the testing demonstration focused on two main areas of exposure: dust and noise. Dust and noise exposure were significant. Both were in excess of the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PEL) and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV). Other safety and health hazards found were ergonomics, heat stress, tripping hazards, electrical hazards, and lockout/tagout.

SECTION 2 - SYSTEM OPERATION

The ARMS™ uses a soft media that is highly absorptive and can be used either dry or wetted to capture, adsorb, and remove surface contaminants, such as oils, grease, lead compounds, chemicals, and radionuclides. Steam may also be used to provide for dust control without creating a liquid waste stream.

The system consists of transportable modules. The feed unit is a portable pneumatically powered device for propelling the cleaning media against the surface to be cleaned. A hopper, mounted atop the unit, holds the cleaning media. The media is fed by the 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 nozzle, to the surface to be cleaned. By varying the unit air pressure and grade of cleaning media, the system can remove surface contamination from soot to fully cured high-performance protective coatings from steel and concrete surfaces.

The sifter 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



Figure 1. ARMS™ inside containment where wall decontamination is taking place.

and placed into the electrically-powered screener. The unit vibrates causing the used media to pass vertically downward through a series of separation screens. Any coarse materials, such as point flakes, rust particles, etc., are collected in the first and coarsest screen. Next, the reusable media is collected on the finer screen. Finally, any dust particles pass through the screener for proper collection and disposal.

The system requires that a containment area be built where the ARMS™ is to be used. During the testing demonstration the containment was built using 2X4's as a frame and heavy plastic was attached to the frame to complete the containment. An air mover, which provided general ventilation at approximately 2000 cfm (according to the technology developer), was installed in the containment. The air from inside the containment was filtered by a high efficiency particulate air (HEPA) filter before being exhausted outside the containment.



Figure 2. Containment being built around wall decontamination area.

The media used for blasting during the testing demonstration was ARMS™ Aluminum Oxide Fiber Media which is classified as a dry abrasive sponge. It is composed of alpha alumina and titanium dioxide.

The percent of each is not provided on the material safety data sheet (MSDS) but is listed as a proprietary composition.

SECTION 3 - HEALTH AND SAFETY EVALUATION

GENERAL SAFETY AND HEALTH CONCERNS

Personnel where the ARMS™ technology is being used need to be concerned with safety and health issues. Issues that personnel need to be cognizant of may be divided into two categories. Core issues are those that are based on current safety and health regulatory requirements. Best management practices are related to issues that are not based on current safety and health regulations, but are key elements in preventing worker injury and illness on the job.

Safety and health issues of concern with the ARMS™ blaster technology included:

Core Issues:

- ◆ Housekeeping - The high pressure lines, water line, electrical lines, and abrasive blasting hose and nozzle are necessary for system operation but are tripping hazards. Stringent housekeeping must be addressed.
- ◆ Fall hazards - Due to the nature of the job (wall and ceiling coating removal), the blaster was operated from a scaffolding. Compliance with the OSHA scaffold standard needs to be assured.
- ◆ Electrical hazards - The sifter and HEPA filter unit require 110 volt 20 amp circuits and the vapor generator requires a 220 volt 30 amp circuit for operation. They may present electrical hazards and the need for ground fault circuit interrupters (GFCI) and grounding must be evaluated. The electrical lines in the area of the vapor generator unit present additional concerns due to the water in the area.
- ◆ Lockout/Tagout - Before any maintenance or decontamination activities are conducted hazardous energy sources need to be eliminated. A lockout/tagout program will need to be developed, if the user does not have one.
- ◆ Personal Protective Equipment (PPE) - PPE must be chosen based on both the hazard and the severity of the hazard. The total dust levels measured during the testing demonstration indicate that Level B respiratory protection, an air-line respirator/or self-contained breathing apparatus (SCBA), may be the minimum requirement for workers inside the containment area.

- ◆ Noise - Noise levels were found to be excessive during the operation of the blasting system. This will be discussed in greater detail in the Industrial Hygiene section of this report.
- ◆ Dust - Dust levels were found to be excessive during the operation of the blasting system. When blasting was being conducted, the equipment and the operators inside the containment were not visible. This was due to the dust being generated inside the containment.

Best management practices:

- ◆ Struck-by hazards - The blasting media bounces off of the surface being cleaned and strikes other surfaces and workers inside the containment. Since anyone inside the containment must wear appropriate PPE, this is not a concern but should be noted. This may, however, cause the spread of contamination to all surfaces inside the containment.
- ◆ Compressed Air - There is the potential for injury from the compressed air itself or the air hoses if an accidental disconnect, rupture, or leak occurs.
- ◆ Diesel exhaust - Operation of the ARMS™ requires an air compressor. If a diesel generated air compressor is used the potential exists for exposure to diesel exhaust. Diesel should not be exhausted indoors or where the exhaust can be pulled into an air intake.
- ◆ Heat stress - Workers are subjected to an increase in heat stress due to the need to utilize PPE. The user will need to develop a heat stress program for the environment in which the blaster is being used, taking into consideration any PPE that may need to be utilized, ambient temperatures, etc.
- ◆ Ergonomics - There are ergonomic stressors associated with the use of the ARMS™. The main concern is the posture, particularly with the arms, that must be assumed while holding the blast nozzle, which has considerable weight.
- ◆ Communication - Due to the noise generated by the technology during operation, communication was difficult. Hand signals may be beneficial but due to the high levels of dust and therefore, low visibility inside the containment, they would be of limited value. Other types of signals may be necessary inside the containment such as flashing lights.

INDUSTRIAL HYGIENE MONITORING

During the testing demonstration with the STS ARMS™, sampling was conducted for dust and noise. In addition, the wet-bulb globe temperature was monitored to evaluate heat stress and observational evaluation was conducted for ergonomics.

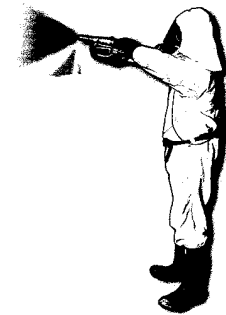


Figure 3. Worker using ARMS™ to blast surface.

Through general observational techniques the potential for ergonomic stressors was evaluated during the testing demonstration. Due to the requirements of the job, coating

removal from a wall and ceiling, the operator conducted blasting from ground level and from a scaffolding. There are ergonomic hazards associated with both of these locations. Regardless of the location the main ergonomic concern is the posture the arms (of the operator) must be in while holding the weight of the blast nozzle. This has the potential to cause sprain/strain/fatigue to the arms, shoulders, and upper and lower back. Reducing the weight of the nozzle or mounting the nozzle on an adjustable frame so it can be moved where needed would help to reduce and/or alleviate these ergonomic stressors.

When standing at ground level and blasting low on the wall, there is the potential for sprain/strain to the back, knees, legs, and ankles due to the bending, stooping, and kneeling required to blast the lower wall. When standing at ground level and blasting higher on the wall, there is the potential for sprain/strain to the back, neck, shoulders, and arms due to holding the nozzle at an upward angle, bending backwards, and looking upward. When blasting the very top of the wall and the ceiling from the scaffolding, there is the potential for sprain/strain to the back, neck, shoulders, and arms. This is from holding the blast nozzle at an upward angle, bending backwards, and looking upwards. This posture causes severe extension of the neck when blasting the ceiling. At times the operator would hold the blast nozzle over the shoulder to support it instead of supporting it with the arms only. While this posture relieves some of the stress on the arms, it increases the stress on the neck and shoulders.

As previously stated, many of these stressors could be lessened or eliminated by reducing the weight of the blast nozzle and by mounting the nozzle to an adjustable/moveable frame.

Heat stress parameters were monitored using a Quest QuestTemp°15 Heat Stress Monitor. The wet-bulb globe temperature was used to determine the work/rest regimen in accordance with the American Conference of Governmental Industrial Hygienists (ACGIH) recommendations. The wet-bulb globe temperature was adjusted in accordance with ACGIH recommendations for the type of clothing, including PPE, that

the worker was wearing. While heat stress will be increased when wearing PPE, the overall heat stress response will vary from worker to worker. Each situation in which the technology is used will need to be evaluated for the heat stress potential, taking into consideration the wet-bulb globe temperature, PPE in use, physical condition of the worker, and amount of worker acclimatization.

Dust monitoring was conducted with a sampling train consisting of an SKC IOM Inhalable dust sampler coupled with an MSA Escort Elf air sampling pump. Pre- and post-sampling calibration were accomplished using a BIOS International DryCal DC1 primary calibration system. Sampling filters were desiccated pre- and post-sampling and weighed on an OHAUS Scout Electronic Balance. Sampling was conducted in accordance with National Institute of Occupational Safety and Health (NIOSH) method 0500.

Personal and area dust sampling were conducted for total dust. There were three operators and they changed out of the containment every 20-30 minutes. Therefore, area sampling was conducted to determine the potential exposures over a longer period of time. In addition to monitoring for total dust, respirable dust, coating constituents, and/or concrete constituents, consideration needs to be given to monitoring for the constituents of the blasting media. The media is broken down as it is continually used to blast the contaminated surface.

Personal samples for two of the operators showed values of 2729.8 mg/m³ and 232.6 mg/m³. The higher value was obtained for the operator who was assisting, shoveling blasting media, and feeding the media back into the hopper. The lower value was obtained for the operator of the blasting nozzle. Area dust sampling showed values of 997.8 mg/m³, 1931.8 mg/m³, 2476.2 mg/m³, 1836.6 mg/m³, 1687 mg/m³, and 1501.8 mg/m³. See Appendix B for air sampling results.

All of the air sampling values were in excess of the OSHA PEL and the ACGIH TLV of 15 mg/m³ and 10 mg/m³ respectively for total dust. It must also be noted that at the end of each sampling period, there was a 1/4-3/4 inch of dust on the sampling filter. These dust levels indicate the possible need for air-line respirators or SCBAs when working inside the containment area.

Personal and area noise monitoring was conducted during the operation of the blaster. As with dust sampling, since the operators were changing every 20-30 minutes, area monitoring was conducted to determine the potential for exposure to noise over a longer period of time. Noise monitoring was conducted using Metrosonic db-3100 data logging noise dosimeter. Calibration was conducted pre- and post-monitoring using a Metrosonics CL304 acoustical calibrator.

Personal noise monitoring was conducted on two of the operators. Monitoring on Operator No. 1 was conducted for 1.3 hours (80 minutes) and on Operator No. 2 for 4.2 hours (254 minutes). Monitoring showed a noise dose of 651.84% for Operator No. 1. This gives an 8-hour time-weighted average (TWA) of 103.5 dbA. If the operator continued to have the same level of noise exposure during the 8-hour shift, the projected noise dose would be 3864.14% (TWA 116.4 dbA). Monitoring for Operator No. 2 showed a noise dose of 1431.56% (TWA 109.2 dbA). If the operator continued to have the same level of noise exposure during the 8-hour shift, the projected noise dose would be 2702.17% (TWA 113.8 dbA).

During operation, the noise levels were averaged for each one-minute period of time. An overall average was calculated, yielding an average exposure level of 116.3 dB for Operator No. 1 and 113.8 db for Operator No. 2. The maximum sound level observed during the measurement period was 129.2 dB for Operator No. 1 and 136.9 dB for Operator No. 2. The highest instantaneous sound pressure level was greater than 140.0 dB for both operators.

Area noise measurements were taken for 1.01 hours (61 minutes), 0.71 hours (43 minutes), 4.2 hours (253 minutes), and 3.5 hours (209 minutes). This gave 8-hour noise doses of 92.47% (TWA-89.4 dBA), 41.36% (TWA-83.7 dBA), 267.23% (TWA-97.1 dBA), and 366.15% (TWA-99.4 dBA). If these noise levels were the same over an 8-hour period, projected noise doses would be 719.08% (TWA-104.2 dBA), 457.74% (TWA-101.0 dBA), 506.93% (TWA-101.7 dBA), and 839.22% (TWA-105.3 dBA). During these time periods the noise levels were averaged for each one-minute period of time. An overall average was calculated yielding an average exposure level of 104.2 dB, 101.0 dB, 101.7 dB, and 105.3 dB. The maximum sound levels during the sampling periods were 118.1 dB, 110.1 dB, 115.9 dB, and 119.7 dB. The highest instantaneous sound pressure level was greater than 140.0 dB, 124.0 dB, 129.2 dB, and 131.8 dB. The amount of time spent at each loudness level that comprised the exposures can be seen in Appendix B.

The OSHA allowable PEL for noise is a 100% dose or an 8-hour TWA of 90 dBA. The above noise doses and TWA's show noise to be an extreme exposure hazard for the operator of the ARMS™. The TWA's are at a level where the operator would be required to be included in a hearing conservation program. Feasible engineering controls, administrative controls, and PPE-hearing protection devices need to be used as appropriate.

HUMAN FACTORS INTERFACE

The need to utilize different levels of personal protective equipment, such as Level A, B, C, or D will depend on the contaminants associated with the wall/ceiling being decontaminated and the amount of dust being generated. Contaminants should be

identified by the site characterization prior to the start of the wall decontamination job. The amount of dust being generated will be identified by air sampling conducted during operation of the ARMS™.

The level of protection being utilized has the potential to cause several human factors interface problems. These may include but not be limited to visibility, manual dexterity, tactile sensation, an increase in heat stress, and an overall increase in physical stress.

The ergonomic stressors the operator was exposed to during operation of the ARMS™ creates an additional human factors interface issue. It is recommended that further evaluation of these ergonomic stressors be evaluated.

TECHNOLOGY APPLICABILITY

The technology produced an excessive amount of dust and noise during operation. All dust samples were in excess of the OSHA PEL and the ACGIH TLV. The ventilation system (filter unit) used in the containment needs to be evaluated to determine what needs to be done to improve the system. All noise monitoring indicated that workers would be overexposed in accordance with the OSHA PEL and the ACGIH TLV.

The ARMS™ will need to be disassembled to be decontaminated. This will not necessarily guarantee that the equipment will be “clean”. Parts of the system may need to be considered consumables. There is a special concern with the recycling of the blasting media and spreading contamination to the internal parts of the equipment.

SECTION 4 - JOB SAFETY ANALYSIS

JOB SAFETY ANALYSIS SURFACE TECHNOLOGY SYSTEMS (STS) ADVANCED RECYCLABLE MEDIA SYSTEM (ARMS™) (WALL/CEILING)

HAZARD	CORRECTIVE ACTION
UNLOADING EQUIPMENT/SETUP	
* Pinch points	<ul style="list-style-type: none"> * Use of hand protection * Use proper hand tools for the job * Never place hand or finger inside the blast pot to assure media flow
* Slips/Trips/Falls	<ul style="list-style-type: none"> * Awareness of specific hazards * Organization of materials (housekeeping) * Walking around areas that are congested/slippery when possible * Walking around tripping hazards when possible * Marking, isolating, bunching together tripping hazards such as air lines
* Struck-by/Caught between	<ul style="list-style-type: none"> * Awareness of where equipment is being moved at all times * Prohibit worker from being between moving and stationary objects at all times * Keep personnel clear of moving objects
* Muscular/back injury (from setting up equipment and loading media into hopper)	<ul style="list-style-type: none"> * Ergonomic training to include safe lifting techniques * Use of equipment such as forklift or crane for unloading * Use mechanical lifting device to load media into hopper

* Electrical Hazards	<ul style="list-style-type: none"> * Inspect all cords before using * Keep all cords out of wet areas, do not place in water, inspect water line before connecting (to assure does not leak) * Assure grounding of all equipment, assure use of GFCI
OPERATION OF THE ARMS™	
* Struck-by hazard (from air-line)	<ul style="list-style-type: none"> * Inspect all air lines and secure with safety pin before operation * Use of safety line (in addition to pin) between male and female ends of connectors
* Electrical hazards	<ul style="list-style-type: none"> * Inspect all cords before using * Keep all cords out of wet areas, do not place in water, inspect water line before connecting (to assure does not leak) * Assure grounding of all equipment, assure use of GFCI's
* Injury from hitting self or co-worker with blast of abrasive sponge from blast nozzle	<ul style="list-style-type: none"> * Do not allow workers to place body parts in front of blast nozzle * Do not allow operator of nozzle to turn from surface being blasted while trigger is engaged * Do not set nozzle down until the system is completely turned off
* Exposure to noise	<ul style="list-style-type: none"> * Assess ARMS™ for feasible engineering controls * Use administrative controls * Use of proper hearing protection device * Worker included in a hearing conservation program
* Exposure to contaminant	<ul style="list-style-type: none"> * Evaluation of system for engineering controls * Use of proper PPE, including respiratory protection
* Restricted Communication (associated with noise generated)	<ul style="list-style-type: none"> * Use of hand signals as SOP's * Use other signals such as flashing lights when hand signals of limited use

* Back injury/strain/sprain (from lifting/moving waste drum and from putting reclaimed blasting media back into hopper)	* Ergonomic training to include proper lifting techniques * Use of mechanical method to lift/move the drum of waste * Use of mechanical method to reload media into hopper
* Fall hazard	* Training for scaffolding safety * Compliance with OSHA scaffold standard
* Fall from above hazard	* Assure scaffolding has kick boards, as required * Require all personnel working in area of scaffolding to wear hard hats
MAINTENANCE	
* Exposure to contaminants	* Use appropriate PPE, including respiratory protection
* Injury from accidental activation of moving parts	* Assure appropriate lockout/tagout program is used before any maintenance is conducted
* Pinch Points	* Use of hand protection * Use of hand-held tools appropriate for the job * Use of appropriate lockout/tagout procedures
* Slips/Trips/Falls	* Awareness of the specific hazards * Organization of materials (housekeeping) * Walking around areas that are congested/wet/slippery when possible * Walking around tripping hazards when possible
* Ergonomics stressors	* Limit duration of work * Use proper lifting techniques * Ergonomic training to include proper lifting techniques
DECONTAMINATION OF SYSTEM	
* Exposure to contaminants	* Use of appropriate PPE, including respiratory protection

* Injury from accidental activation of moving parts	* Assure appropriate lockout/tagout program is used before any decontamination activities are conducted
* Pinch Points	* Use of hand protection * Use of hand-held tools appropriate for the job * Use of appropriate lockout/tagout procedures
* Slips/Trips/Falls	* Awareness of the specific hazards * Organization of materials (housekeeping) * Walking around areas that are congested/slippery when possible * Walking around tripping hazards when possible
* Ergonomics stressors	* Limit duration of work * Use proper lifting techniques * Ergonomic training to include proper lifting techniques
LOADING/TEAR DOWN	
* Pinch points	* Use of hand protection * Use proper hand tools for the job
* Slips/Trips/falls	* Awareness of specific hazards * Organization of materials (housekeeping) * Walking around areas that are congested/slippery when possible * Walking around tripping hazards when possible
* Struck-by/Caught between	* Awareness of where equipment is being moved at all times * Prohibit worker from being between moving and stationary objects at all times * Keep personnel clear of moving objects
* Muscular/back injury	* Ergonomic training to include safe lifting techniques * Use of equipment such as forklift or crane for loading

SECTION 5 - FAILURE MODE AND EFFECTS ANALYSIS

FAILURE MODE AND EFFECTS ANALYSIS SURFACE TECHNOLOGY SYSTEMS (STS) ADVANCED RECYCLABLE MEDIA SYSTEM (ARMS™) (WALL/CEILING)

FAILURE MODE	EFFECT
* Air line ruptures or disconnects	* Injury to worker from being struck by air line * Injury to worker from being struck by high pressure air
* Safety pin on air line breaks	* Injury to worker from being struck by air line * Injury to worker from being struck by high pressure air
* Water line ruptures or disconnects	* Injury to worker from slipping/falling on surface with water on it * Electrical hazards to workers from water coming into contact with electrical lines
* Water supply container (for the steam generator) overflows/spills	* Injury to worker from slipping/falling on surface with water on it * Electrical hazards to workers from water coming into contact with electrical lines
* Steam generator fails and does not generate steam	* Increased exposure to contaminants due to more dust being produced
* Vapor generator overpressurizes and pop-off by-pass fails	* Injury from vapor releasing violently * Injury from explosive release of built up pressure
* Filter on ventilation system clogs	* Increased exposure to contaminant due to less air being pulled out of containment * Release of contaminant from the containment (through seams and openings) because of loss of negative

FAILURE MODE	EFFECT
	pressure inside containment

* Ventilation system fails	* Increased exposure to contaminant due to less air being pulled out of containment * Release of contaminant from the containment (through seams and openings) because of loss of negative pressure inside containment
* Dead man switch on blast nozzle fails	* Injury to workers from being struck by the blast media and air because fails to shut off if nozzle dropped or otherwise accidentally released by the operator

SECTION 6 - TECHNOLOGY SAFETY DATA SHEET

**TECHNOLOGY SAFETY DATA SHEET
SURFACE TECHNOLOGY SYSTEMS (STS)
ADVANCED RECYCLABLE MEDIA SYSTEM (ARMS™)
(WALL/CEILING)**

SECTION 1: TECHNOLOGY IDENTITY	
<p>Manufacturer's Name and Address:</p> <p>Surface Technology Systems 75 East Market Street Akron, OH 44308</p>	<p>Emergency Contact:</p> <p>Steven M. Pocock (330) 849-6695 (330)376-2700</p>
	<p>Information Contact:</p> <p>Steven M. Pocock (330) 849-6695 (330)376-2700</p>
	<p>Date Prepared:</p>
<p>Other Names:</p> <p>ARMS™</p>	<p>Signature of Preparer:</p> <p>Operating Engineers National Hazmat Program 1293 Airport Road, Beaver, WV 25813, phone 304-253-8674, fax 304-253-7758.</p> <p>Under cooperative agreement DE-FC21-95 MC 32260</p>

SECTION 2: PROCESS DESCRIPTION

The ARMS™ uses a soft media that is highly absorptive and can be used either dry or wetted to capture, adsorb, and remove surface contaminants, such as oils, grease, lead compounds, chemicals, and radionuclides. Steam may also be used to provide for dust control without creating a liquid waste stream.

The system consists of transportable modules. The feed unit is a portable pneumatically powered device for propelling the cleaning media against the surface to be cleaned. A hopper, mounted atop the unit, holds the cleaning media. The media is fed by the 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 nozzle to the surface to be cleaned. By varying the unit air pressure and grade of cleaning media, the system can remove surface contamination from soot to fully cured high-performance protective coatings from steel and concrete surfaces.

The sifter 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 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 reusable media is collected on the finer screen. Finally, any dust particles pass through the screener for proper collection and disposal.

The system requires that a containment area be built where the ARMS™ is to be used. During the testing demonstration the containment was built using 2X4's as a frame and heavy plastic was attached to the frame to complete the containment. An air mover, which provided general ventilation at approximately 2000 cfm (according to the technology developer), was installed in the containment. The air from inside the containment was filtered by a high efficiency particulate air (HEPA) filter before being exhausted outside the containment.

Various blasting media may be used with the ARMS™ and the media needs to be identified prior to the start of the job.

SECTION 3: PROCESS DIAGRAMS



Figure 1. ARMS™ inside containment where wall decontamination is taking place.



Figure 2. Containment being built around wall decontamination area.

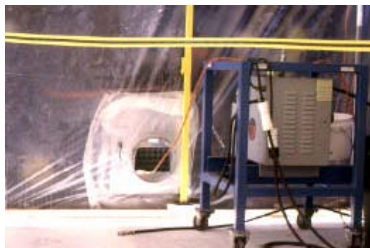


Figure 3. Filter unit in containment where wall decontamination is taking place.

SECTION 4: CONTAMINANTS AND MEDIA

The blasting operation creates an extreme amount of dust. The dust generated may contain coating, subsurface, and blasting media contaminants. These will need to be identified by the site characterization prior to the beginning of the job. A monitoring plan will need to be developed on a site-by-site job-by-job basis.

SECTION 5: ASSOCIATED SAFETY HAZARDS

Probability of Occurrence of Hazard:

- 1 Hazard may be present but not expected over background level
- 2 Some level of hazard above background level known to be present
- 3 High hazard potential
- 4 Potential for imminent danger to life and health

A. ELECTRICAL (LOCKOUT/TAGOUT)**RISK RATING: 3**

The technology has the potential to present electrical hazards. Electrical connections in the area of the steam unit present additional concerns due to the water in the area. Assure proper grounding and the use of GFCI on all equipment. Compliance with applicable electrical standards and codes and lockout/tagout procedures must be followed to assure the safety of personnel.

B. FIRE AND EXPLOSION**RISK RATING: 1**

Normal fire and explosion hazards in association with electrical powered equipment. The equipment is not intrinsically safe and could not be used in a potentially explosive atmosphere.

C. CONFINED SPACE ENTRY**RISK RATING: N/A**

Not part of this technology.

D. MECHANICAL HAZARDS**RISK RATING: 3**

The ARMS™ has moving parts which may cause severe injury from pinch points. The auger for feeding media is of particular concern. The area needs to be guarded and labeled as a potential hazard.

E. PRESSURE HAZARDS**RISK RATING: 2**

The air lines and the high pressure air present a potential struck-by hazard if they were to rupture or disconnect.

F. TRIPPING AND FALLING**RISK RATING: 3**

The water lines, air lines, and blasting hose present tripping hazards in the area where they are being used.

G. LADDERS AND PLATFORMS	RISK RATING: 3
Due to the nature of the work associated with the technology, i.e. wall decontamination, it is necessary to work at a height. This presents the potential for an object falling from above to injure workers at ground level as well as a fall hazard to workers on the platform/scaffold. Proper precautions must be taken.	
H. MOVING VEHICLES	RISK RATING: 3
The presence of multiple pieces of mobile equipment (which may be needed to unload and load the technology) in relationship to a small area of operation may pose a significant danger. Sufficient warning devices such as horns, bells, lights, and back up alarms should be utilized. Personnel should be trained to work with and around moving equipment.	
I. BURIED UTILITIES, DRUMS, AND TANKS	RISK RATING: N/A
Not part of this technology.	
J. PROTRUDING OBJECTS	RISK RATING: N/A
Not part of this technology.	
K. GAS CYLINDERS	RISK RATING: N/A
Not part of this technology.	
L. TRENCHING AND EXCAVATIONS	RISK RATING: N/A
Not part of this technology.	
M. OVERHEAD LIFTS	RISK RATING: 4
Unloading and loading of technology may require overhead lifts or the use of a forklift. Proper precautions indicated.	
N. OVERHEAD HAZARDS	RISK RATING: 1
Would only be present if a crane were required to unload or load equipment.	

SECTION 6: ASSOCIATED HEALTH HAZARDS	
A. INHALATION HAZARD	RISK RATING: 4
Dust exposure is excessive during the operation of the ARMS™. Air monitoring samples have shown values well in excess of the OSHA PEL and the ACGIH TLV. Air sampling filters have shown 1/4 to 3/4 inch of dust on them at the end of the sampling period. It is recommended that workers inside the containment wear air-line respirators or SCBAs. Additional PPE that is compatible with the identified contaminants needs to be utilized as appropriate.	

B. SKIN ABSORPTION	RISK RATING: 4
The dust from the blasting media may be a skin irritant and unless the PPE worn is impervious to it, skin irritation may occur. PPE appropriate for the contaminants needs to be utilized.	
C. HEAT STRESS	RISK RATING: 4
The need to wear PPE inside the containment area has the potential to increase the heat stress placed on the worker. Ambient conditions correlated with PPE levels, work rate, etc. must be considered.	
D. NOISE	RISK RATING: 4
Noise exposure is excessive during the operation of the ARMS™ blasting nozzle. Previous noise monitoring has shown values in excess of the OSHA PEL and ACGIH TLV. In addition to feasible engineering controls, administrative controls, and adequate hearing protection must be incorporated during operation. Workers will need to be included in a hearing conservation program.	
E. NON-IONIZING RADIATION	RISK RATING: N/A
Not part of this technology.	
F. IONIZING RADIATION	RISK RATING: N/A
Not part of this technology.	
G. COLD STRESS	RISK RATING: 1
Technology does not produce a hazard but ambient conditions need to be considered.	
H. ERGONOMIC HAZARDS	RISK RATING: 4
There is potential for ergonomic stressors when operating the ARMS™ blasting nozzle. The main ergonomic concern is the static posture the arms (of the operator) must be in while holding the weight of the blast nozzle. This has the potential to cause sprain/strain/fatigue to the arms, shoulders, upper back, and lower back. The need to hold the blast nozzle over the shoulder to support it instead of supporting it with the arms increases the stress on the neck and shoulders.	
I. OTHER	RISK RATING: 3
There are communication problems due to the noise generated by the technology during operation. Hand signals may be beneficial but due to the high levels of dust and therefore, low visibility inside the containment, they would be of limited value. Consideration needs to be given to installing other types of signals such as flashing lights. Since workers inside the containment may not be able to see each other well enough to avoid each other, it may also be necessary to limit the number of workers inside the containment to one.	

SECTION 7: PHASE ANALYSIS
A. CONSTRUCTION/START-UP
The set-up/start-up phase presents several hazards including struck-by/caught between hazards, pinch points, slips/trips/falls, struck by/caught between, falling from above hazards and muscular/back injury, and electrical hazards.
B. OPERATION
The operational phase presents several hazards including exposure to contaminant (extreme dust generation), noise hazards (extreme noise generation), hazards associated with the air lines, muscular/back injury, poor communication (between workers) due to operating conditions, and electrical hazards. Fall hazards may also be associated with the operation of the ARMS™ when the worker must be on scaffolding while operating it.
C. MAINTENANCE
The maintenance phase presents several hazards including pinch points, slips/trips/falls, struck by/caught between, muscular/back injury, electrical hazards, exposure to contaminants, and accidental activation of moving parts.
D. DECOMMISSIONING
The decommissioning phase presents several hazards, including exposure to contaminants, pinch points, slips/trips/falls and muscular/back injury.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS
A. AIR MONITORING
Operation of the ARMS™ generates an excessive amount of dust. An air monitoring plan will need to be developed for total and respirable dust, contaminants of the coating being removed, contaminants and constituents of the subsurface, and constituents of the blasting media.
Noise generated during operation of the ARMS™ is excessive. A noise monitoring plan is essential.

B. WORKER TRAINING

Training that would apply in this case may include but not be limited to: HAZWOPER (Hazardous Waste Operations and Emergency Response), HAZCOM (Hazard Communication), Respiratory Protection, Hearing Conservation, Ergonomics (proper lifting, bending, stooping, kneeling), Heat Stress (learning to recognize signs and symptoms), Personal Protective Equipment, Emergency Response/Bloodborne Pathogens, Lockout/Tagout, Hand Signal Communication, Construction Safety (OSHA 500), and/or General Industry Safety (OSHA 501). Scaffolding safety is required if the work is to be conducted with the use of a scaffold.

C. EMERGENCY RESPONSE

Emergency response planning for a site needs to assure adequate coverage for hazards described in the TSDS. Having at least one worker per shift trained in CPR and first aid is recommended.

D. MEDICAL SURVEILLANCE

Evaluation of personnel's general health with emphasis on the back and cardiovascular/respiratory system. Medical surveillance as required by the OSHA standards must be conducted. Initial and annual audiograms.

E. INFORMATIONAL PROGRAM

Workers must be trained in specific operation of equipment before use.

SECTION 9: COMMENTS AND SPECIAL CONSIDERATIONS

Only personnel who have been adequately trained in the operation of the ARMS™ should be permitted to operate the system.

Consideration needs to be given to the compatibility of the PPE with specific contaminants and the exposure level of the contaminants.

SECTION 7 - EMERGENCY RESPONSE/PREPAREDNESS

The use of the ARMS™ would not be applicable to emergency response situations.

Emergency response/preparedness must be part of every hazardous waste site safety and health plan. In addition to credible site emergencies, site personnel must plan for credible emergencies in connection with the ARMS™.

All precautions used when responding to an emergency situation at the site will apply. Before entering an area where the centrifugal shot blaster is being used, the equipment needs to be completely shut down (de-energized).

This technology does not appear to present any conditions other than those associated with the use of high pressure air that would lead to out of the ordinary emergencies.

SECTION 8 - REGULATORY/POLICY ISSUES

The site safety and health personnel where the ARMS™ technology is being used need to be concerned with safety and health regulations applicable to the issues discussed above. Regulations that apply may be divided into four categories. Core requirements are those regulations that would apply to any hazardous waste work site, regardless of the type of job. Technology specific requirements are those regulations that apply due to the specific technology being used. Special requirements are standards and policies that are specific to the technology itself and are required by reference in a regulation. Best management practices are not required, but are recommended by organizations such as the American National Standards Institute (ANSI), NIOSH, Department of Energy (DOE), National Fire Protection Association (NFPA), etc. These regulations/standards may include but not be limited to the following:

Core requirements:

- ◆ OSHA 29 CFR 1926.25 Housekeeping
- ◆ OSHA 29 CFR 1910.141 Sanitation (1910.141(a)(3) covers housekeeping)
- ◆ OSHA 29 CFR 1926 Subpart Z Toxic and Hazardous Substances
- ◆ OSHA 29 CFR 1910 Subpart Z Toxic and Hazardous Substances
- ◆ OSHA 29 CFR 1926.59 Hazard Communication
- ◆ OSHA 29 CFR 1910.1200 Hazard Communication

- ◆ OSHA 29 CFR 1926.64 Process Safety Management of Highly Hazardous Chemicals
- ◆ OSHA 29 CFR 1910.119 Process Safety Management of Highly Hazardous Chemicals
- ◆ OSHA 29 CFR 1926.65 Hazardous Waste Operations and Emergency Response
- ◆ OSHA 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response
- ◆ Occupational Safety and Health Act 1970(5)(a)(1) General Duty Clause

Technology Specific Requirements:

- ◆ OSHA 29 CFR 1926 Subpart L Scaffolding
- ◆ OSHA 29 CFR 1910.28 Safety Requirements for Scaffolding
- ◆ OSHA 29 CFR 1926 Subpart K Electrical
- ◆ OSHA 29 CFR 1910 Subpart S Electrical
- ◆ OSHA 29 CFR 1910 Subpart O Machinery and Machine Guarding
- ◆ OSHA 29 CFR 1910.147 The Control of Hazardous Energy (Lockout/Tagout)
- ◆ OSHA 29 CFR 1926.52 Occupational Noise Exposure
- ◆ OSHA 29 CFR 1910.95 Occupational Noise Exposure
- ◆ OSHA 29 CFR 1926.103 Respiratory Protection
- ◆ OSHA 29 CFR 1910.134 Respiratory Protection
- ◆ OSHA 29 CFR 1926.102 Eye and Face Protection
- ◆ OSHA 29 CFR 1910.133 Eye and Face Protection
- ◆ OSHA 29 CFR 1926.28 Personal Protective Equipment
- ◆ OSHA 29 CFR 1910.132 General Requirements (Personal Protective Equipment)

- ◆ OSHA 29 CFR 1926.23 First Aid and Medical Attention
- ◆ OSHA 29 CFR 1910.151 Medical Services and First Aid

Best Management Practices:

- ◆ ACGIH Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

In addition to the above regulations and policies, it is imperative that all workers have appropriate and adequate training for the task and associated safety and health conditions. Training that would be required may be divided into four categories. Core training is that which is required for anyone entering a hazardous waste site to perform work, regardless of the type of job. Technology specific training is that training that is specific to the technology and required by safety and health standards. Special training is that which is specific to the technology to assure the worker is adequately trained for the task, but is not necessarily required by safety and health standards. Best management practices are trainings that while not mandated by health and safety standards, provide information and knowledge to the worker that will allow the worker to perform his/her job safely. Training to be applied for the centrifugal shot blast technology may include but not be limited to:

Core Training Requirements:

- ◆ HAZWOPER
- ◆ HAZCOM

Technology Specific Training:

- ◆ Scaffolding Safety
- ◆ Respiratory Protection
- ◆ Hearing Conservation
- ◆ Personal Protective Equipment
- ◆ Electrical Safety
- ◆ Lockout/Tagout

Special training:

- ◆ Job specific training for equipment operation

Best Management Practice training:

- ◆ Ergonomics (proper lifting, bending, stooping, kneeling, and static postures)
- ◆ Heat stress (learning to recognize signs and symptoms)
- ◆ CPR/First Aid/Emergency Response/Blood-borne Pathogens
- ◆ Hand Signal Communication
- ◆ Construction Safety (OSHA 500) and/or General Industry Safety (OSHA 501)

SECTION 9 - OPERATIONAL CONSIDERATIONS & RECOMMENDATIONS

Recommendations made in this section for improved worker safety and health take into consideration the operation of the ARMS™ without the use of a steam spray. Specific recommendations include:

- ◆ It needs to be assured that workers are aware of the tripping hazards associated with air and blasting hoses that are necessary to operate the equipment. Keeping these as orderly as possible in compliance with good housekeeping regulations will help avoid injury due to tripping.
- ◆ If a fitting on an air line fails, the flying hose has the potential to cause severe injury. A safety line connected to the male and female parts of the fitting would keep the hose from becoming a flying object.
- ◆ It must be noted that a ladder (which was not used during the testing demonstration) would not be appropriate for this type of work. Three-points of contact could not be maintained while using the blast head.
- ◆ The hose, which is 1½ - 2 inches in diameter and is attached to the back of the blasting nozzle (which was being used from the scaffolding), added weight to the nozzle and pulled in a downward direction. This increases ergonomic stressors placed on the worker. Some type of hook on the railing of the scaffolding to support the hose and keep it from pulling would help with this problem.

- ◆ There are electrical hazards associated with the sifter unit and HEPA filter unit which require 110 volt 20 amp circuits and the vapor generator which requires a 220 volt 30 amp circuit for operation. They need GFCI and appropriate grounding. The steam unit hoses burst several times during the testing demonstration spilling water over the area. This presents additional problems and concerns for the electrical lines that are in the area. Placing the drum with the water supply in a containment which will capture the water should the hoses rupture will eliminate the water hazards in the area of the steam unit electrical lines.

- ◆ The filter unit in the containment frequently became clogged and the HEPA filter had to be changed often. Additionally, when the filter became clogged and therefore, air movement through the unit was stopped, dust leaked from the containment through the screened viewing window and at several of the seams in the containment. The filter system needs to be evaluated for use with the type of dust being generated.



Figure 4. Filter unit in containment where wall decontamination is taking place.

- ◆ There are communication problems due to the noise generated by the technology during operation. Hand signals may be beneficial but due to the high levels of dust and therefore, low visibility inside the containment, they would be of limited value. Consideration needs to be given to installing other types of signals such as flashing lights. Since workers inside the containment may not be able to see each other well enough to avoid each other, It may also be necessary to limit the number of workers inside the containment to one.

An additional concern due to the decreased visibility and the difficulties with verbal communication is the potential for the operator to strike himself/herself or another worker in the area with the blast from the nozzle. This could cause severe injury to the workers. This is another reason to limit the number of workers inside the containment.

- ◆ PPE must be chosen that is compatible with the hazards and the job. The dust levels in the containment indicate that air purifying respirators do not provide adequate protection and air-line respirators or self contained breathing apparatus are necessary. The cotton coveralls worn by the operators during the testing demonstration were often soaked with perspiration and therefore provided a route for the dust that was accumulated on them to get to the workers skin. At a minimum, tyvek coveralls may be necessary for anyone working inside

the containment. The specific level of PPE will need to be determined on a site-by-site job-by-job basis. The specific contaminants for the job also need to be taken into consideration when choosing the appropriate PPE.

- ◆ There is potential for ergonomic stressors when operating the ARMS™ blasting nozzle. Due to the requirements of the job, coating removal from a wall and ceiling, the operator conducted blasting from ground level and from a scaffolding. There are ergonomic issues associated with both of these locations. Regardless of the location, the main ergonomic concern is the posture the arms (of the operator) must be in while holding the weight of the blast nozzle. This has the potential to cause sprain/strain/fatigue to the arms, shoulders, upper and lower back, and neck.

When standing at ground level and blasting low on the wall, there is the potential for sprain/strain to the back, knees, legs, and ankles due to the bending, stooping, and kneeling required to blast the lower wall. When standing at ground level and blasting higher on the wall, there is the potential for sprain/strain to the back, neck, shoulders, and arms due to holding the nozzle at an upward angle, bending backwards, and looking upward. When blasting the very top of the wall and the ceiling from the scaffolding, there is the potential for sprain/strain to the back, neck, shoulders, and arms. This is from holding the blast nozzle at an upward angle, bending backwards, and looking upwards. This posture causes severe extension of the neck when blasting the ceiling. At times the operator would hold the blast nozzle over the shoulder to support it instead of supporting it with the arms only. While this posture relieves some of the stress on the arms it increases the stress on the neck and shoulders.

It is recommended that weight of the blast nozzle be reduced and an engineering design be considered where the nozzle is mounted to an adjustable/moveable frame. Both of these would help to lessen or eliminate most of the ergonomic concerns discussed above.

- ◆ Dust exposure was excessive during the operation of the ARMS™. All air monitoring samples showed values well in excess of the OSHA PEL and the ACGIH TLV. All air sampling filters had ¼ to ¾ inch of dust on them at the end of the sampling period. It is recommended that workers inside the confinement wear air-line respirators or self contained breathing apparatus. It is also recommended that engineering controls be evaluated to control the dust levels produced by the blasting process. This may include capture of the dust as blasting is conducted or a better ventilation system (with air filtration) for the containment.

Noise exposure was excessive during the operation of the ARMS™. All noise monitoring showed values in excess of the OSHA PEL and ACGIH TLV. It is

recommended that engineering controls be evaluated to control the noise levels the operator is exposed to during operation. In addition to feasible engineering controls, administrative controls and adequate hearing protection must be incorporated during operation.

The safety and health issues discussed throughout this report could be reduced and, in some cases, eliminated if this type of wall/ceiling decontamination technology could operate remotely.

APPENDIX A REFERENCES

Occupational Safety and Health Standards for General Industry, 29 CFR Part 1910, Occupational Safety and Health Administration United States Department of Labor

Occupational Safety and Health Standards for the Construction Industry, 29 CFR Part 1926, Occupational Safety and Health Administration United States Department of Labor

Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs), American Conference of Governmental Industrial Hygienists, 1995-1996

The NIOSH compendium of hearing protection devices, U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention, October 1994

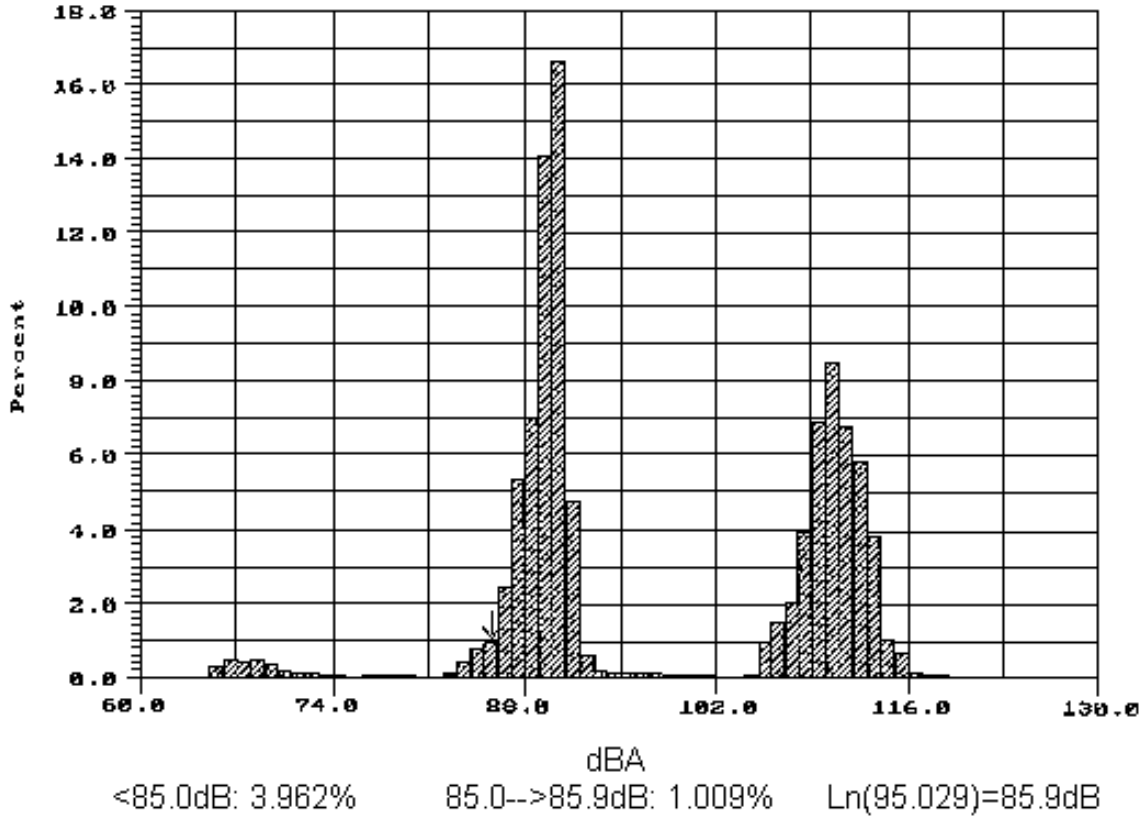
APPENDIX B IH SAMPLING DATA

STS ARMS™ Total Dust Sampling			
Date	Sample Number	Analyte	* Results
7/21/97	072197-FIU-007	Total dust	232.6 mg/m ³
7/21/97	072197-FIU-008	Total dust	2729.8 mg/m ³
7/21/97	072197-FIU-009	Blank	.01 grams
7/22/97	072297-FIU-001	Total dust	1931.8 mg/m ³
7/22/97	072297-FIU-002	Total dust	997.8 mg/m ³
7/22/97	072297-FIU-003	Blank	0.00 grams
7/23/97	072397-FIU-004	Total dust	2476.2 mg/m ³
7/23/97	072397-FIU-006	Total dust	1836.6 mg/m ³
7/23/97	072397-FIU-009	Blank	.01 grams
7/24/97	072497-FIU-011	Total dust	1687.0 mg/m ³
7/24/97	072497-FIU-012	Total dust	1501.8 mg/m ³
7/24/97	072497-FIU-010	Blank	0.00 grams

* The OSHA PEL for total dust is 15 mg/m³ and the ACGIH TLV is 10 mg/m³. Current sampling was conducted for total dust. The need to sample for respirable dust and silica has to be considered during concrete decontamination and decommissioning activities.

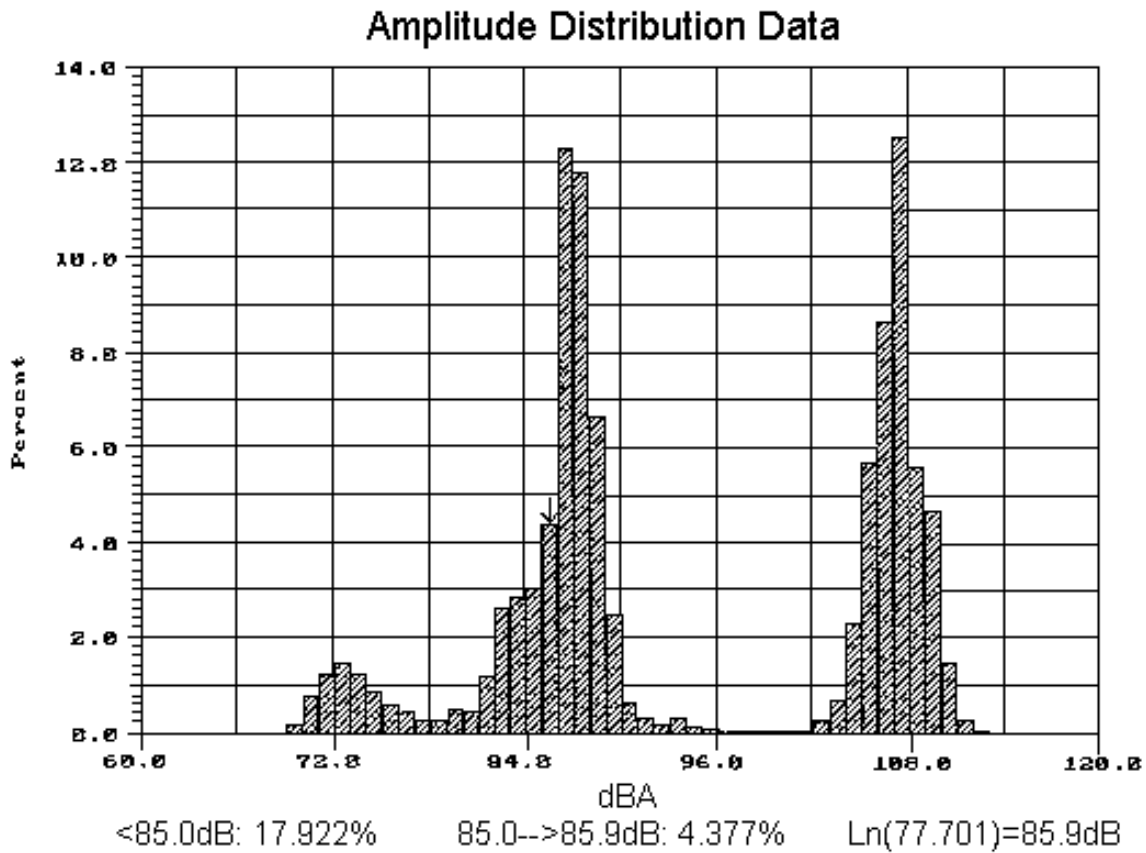
NOISE SAMPLING

Amplitude Distribution Data



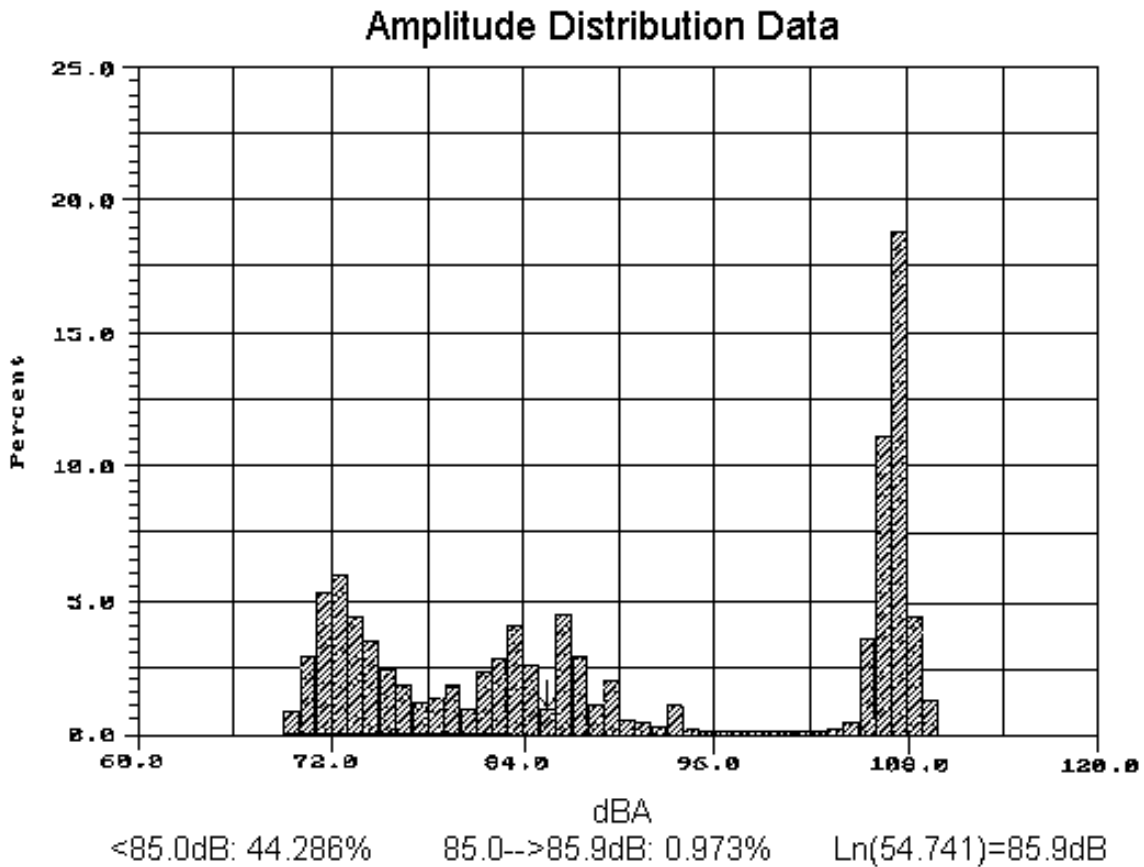
The percentage of time spent at each decibel level can be obtained from the graph. As shown, 3.962% of the time the noise exposure was less than 85 dBA which means 96.038% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

NOISE SAMPLING



The percentage of time spent at each decibel level can be obtained from the graph. As shown, 17.922% of the time the noise exposure was less than 85 dBA which means 82.078% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

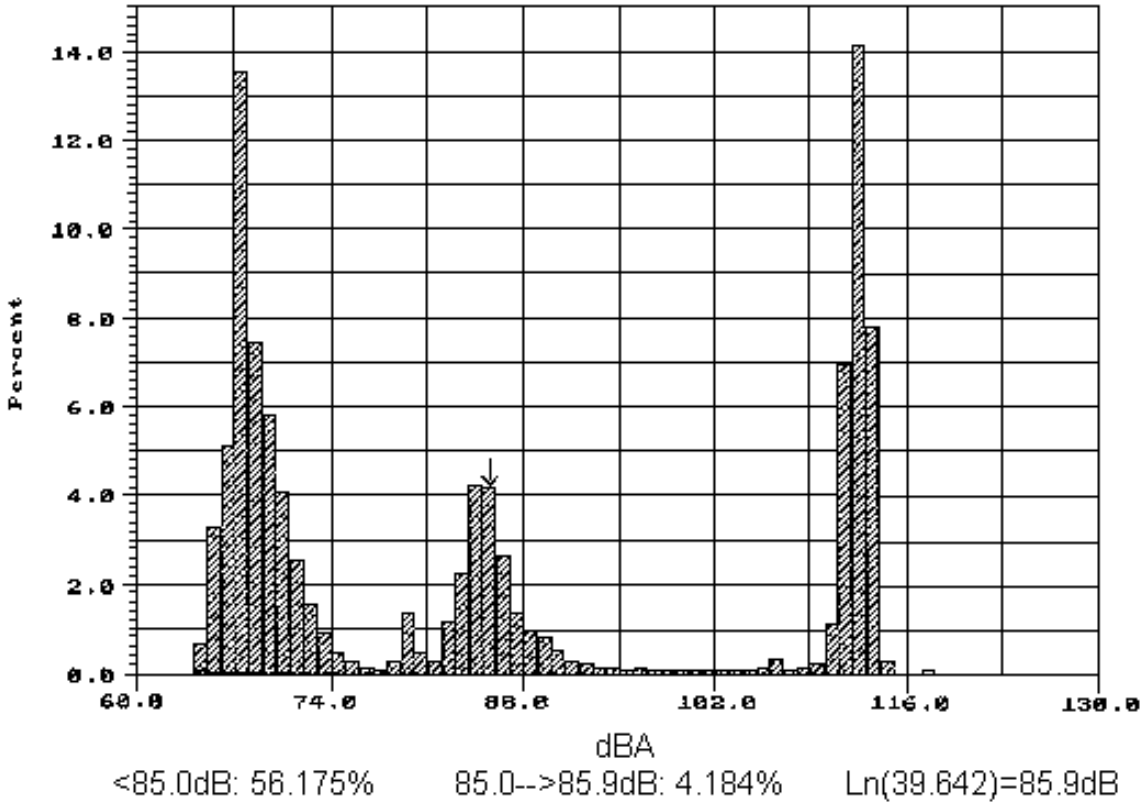
NOISE SAMPLING



The percentage of time spent at each decibel level can be obtained from the graph. As shown, 44.286% of the time the noise exposure was less than 85 dBA which means 55.714% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

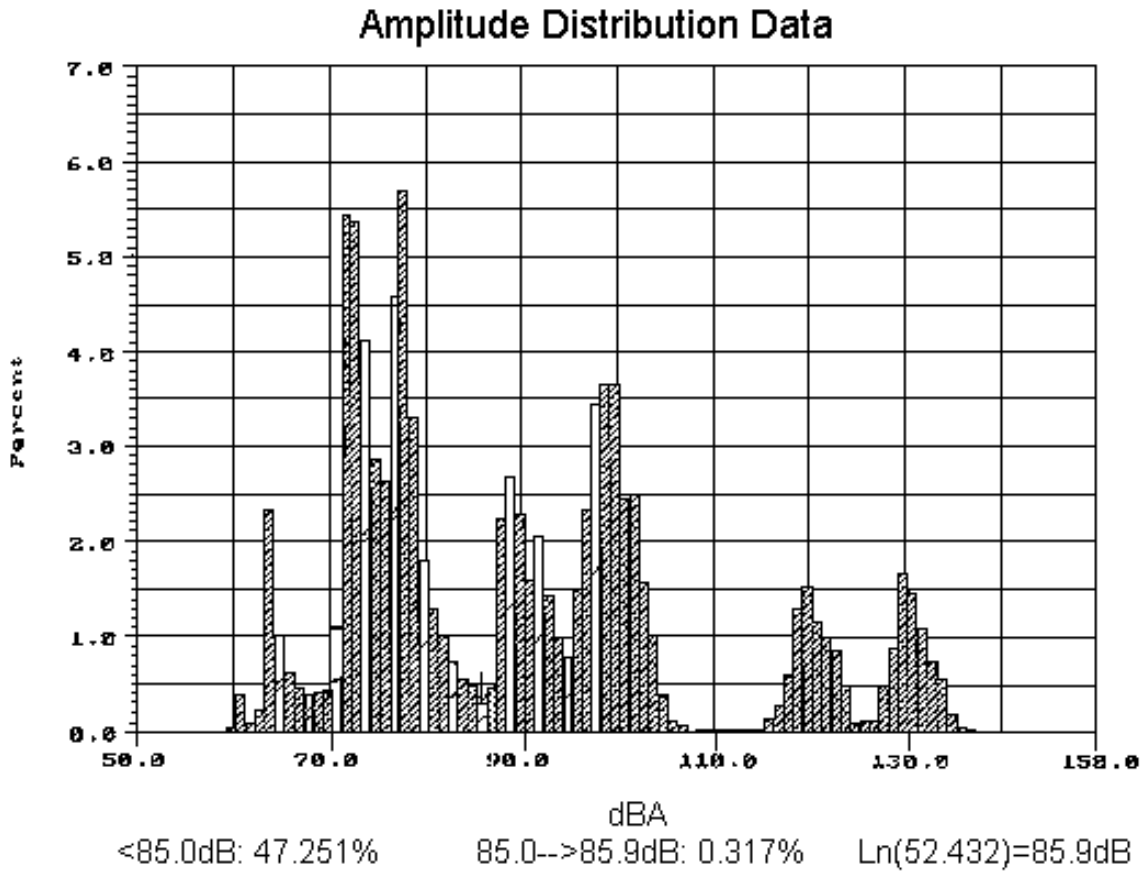
NOISE SAMPLING

Amplitude Distribution Data



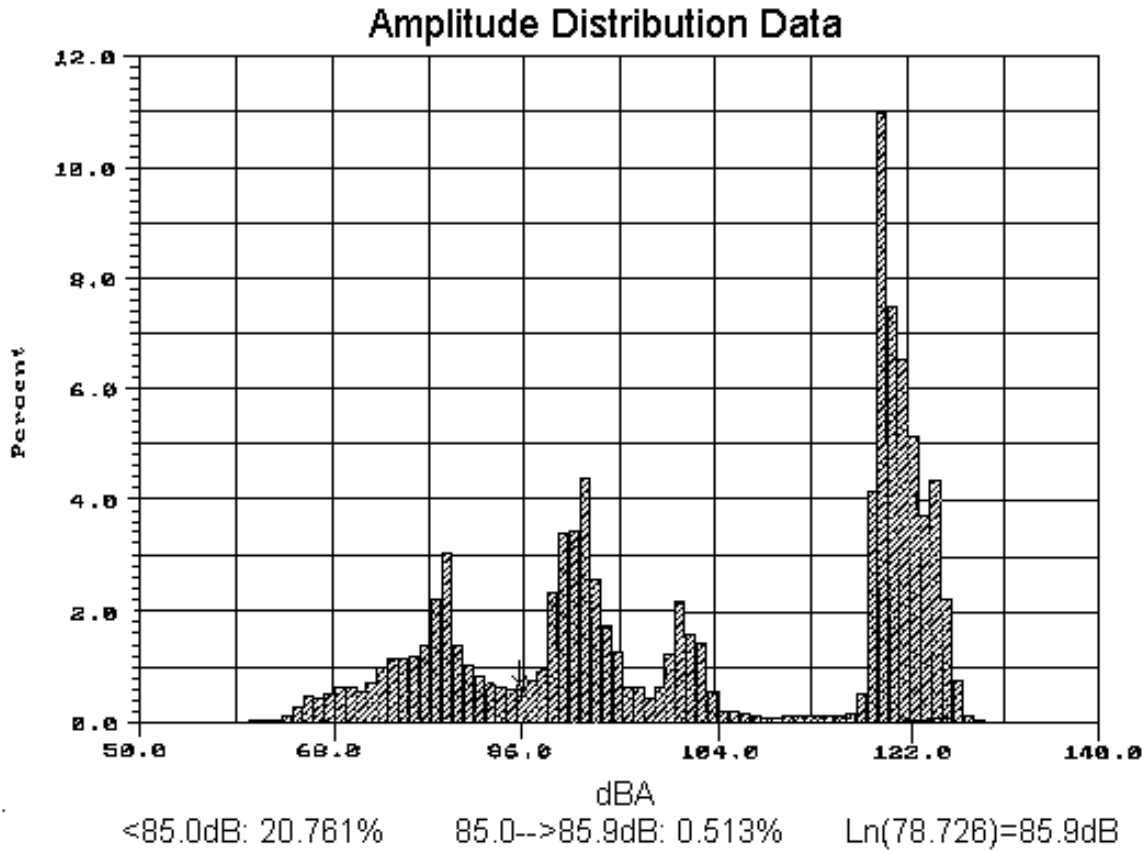
The percentage of time spent at each decibel level can be obtained from the graph. As shown, 56.175% of the time the noise exposure was less than 85 dBA which means 43.285% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

NOISE SAMPLING



The percentage of time spent at each decibel level can be obtained from the graph. As shown, 47.251% of the time the noise exposure was less than 85 dBA which means 52.749% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

NOISE SAMPLING



The percentage of time spent at each decibel level can be obtained from the graph. As shown, 20.761% of the time the noise exposure was less than 85 dBA which means 79.239% of the time was spent at sound levels above 85 dBA. OSHA requires that a hearing conservation program be initiated if the 8-hour TWA is 85 dBA.

APPENDIX C ACRONYMS

ACGIH	-	American Conference of Governmental Industrial Hygienists
ANSI	-	American National Standards Institute
ARMS	-	Advanced Recyclable Media System
CFR	-	Code of Federal Regulations
CFM	-	cubic feet per minute
DOE	-	Department of Energy
FIU	-	Florida International University
GFCI	-	ground fault circuit interrupters
HAZWOPER	-	Hazardous Waste Operations and Emergency Response
HAZCOM	-	Hazard Communication
HEPA	-	high efficiency particulate air (filter)
MSDS	-	Material Safety Data Sheet
NFPA	-	National Fire Protection Association
NIOSH	-	National Institute of Occupational Safety and Health
OSHA	-	Occupational Safety and Health Administration
PEL	-	permissible exposure limit
PPE	-	personal protective equipment
SCBA	-	self contained breathing apparatus
SOPs	-	standard operating procedures
STS	-	Surface Technology Systems
TLV	-	threshold limit value
TWA	-	time weighted average