SECTION 6 - TECHNOLOGY SAFETY DATA SHEET

TECHNOLOGY SAFETY DATA SHEET
Bartlett Services Inc.
Robotic Climber™

<table>
<tr><th colspan="2">SECTION 1: TECHNOLOGY IDENTITY</th></tr>
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Under cooperative agreement DE-FC21-95 MC 32260</td></tr>
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SECTION 2: PROCESS DESCRIPTION
The Robotic Climber^{TM} uses an ultra high pressure water jetting within a contained vacuum shroud to remove and capture surface contaminants during surface decontamination, coating removal, and concrete scabbling. The technology offers several major advantages. One major advantage of the Robotic Climber^{TM} is that the system can be operated remotely which means the operator controls the blasting from a portable console which is much less physically tiring than handling a standard blast nozzle. It also reduces, through distance, the operators exposure to dust and noise. The Robotic Climber^{TM} H-1 model is a remote controlled, free climbing robot using ultra high pressure water jetting within a contained vacuum shroud. This technology employs a self-propelled, remotely operated robotic device designed for surface decontamination, coating removal, and concrete “scabbling”. Variable water pressure (0 to 36,000 psi) at low consumption rates is the medium used by this H-1 model. Adhesion to the surface is achieved using vacuum, enabling the robot to perform on vertical or inverted surfaces as well as horizontal flats and sloped surfaces. This vacuum also serves to capture the water from the removal process as well as the waste. Once captured the waste/water is transported to a holding tank for future treatment or processing.

SECTION 3: TECHNOLOGY PHOTOS

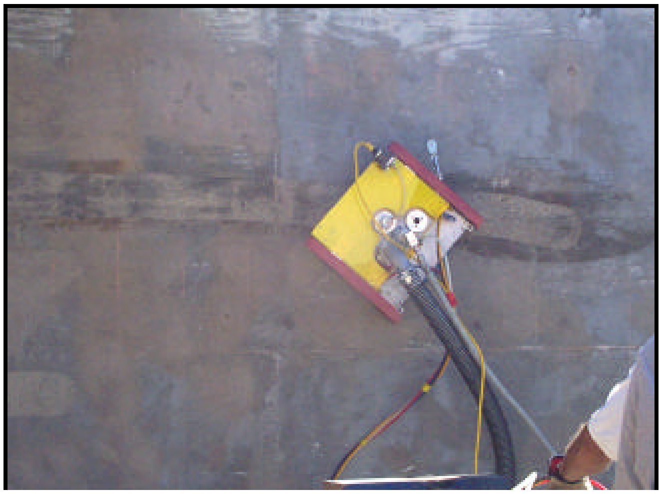

Figure 1. Robotic ClimberTM operating on test wall.

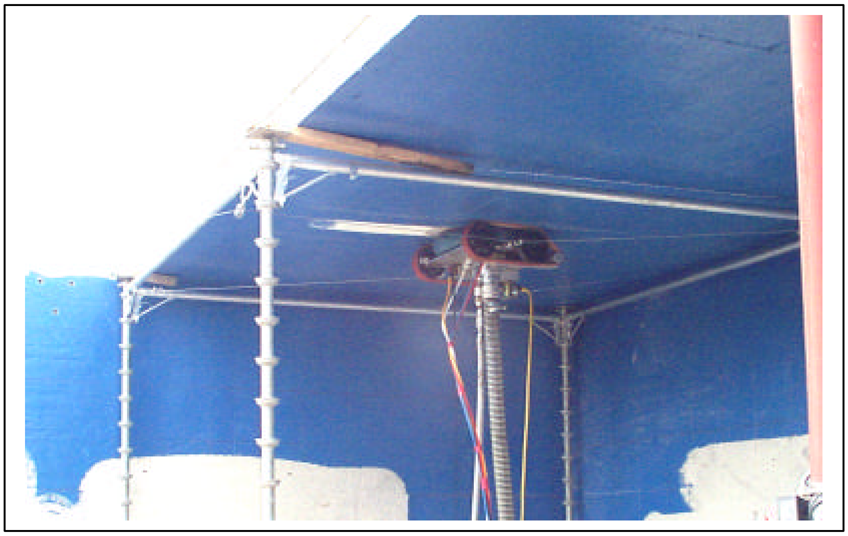

Figure 2. Robotic Climber™ operating on test ceiling.

SECTION 4: CONTAMINANTS AND MEDIA
Dust from the blasting operation is well contained by the strong vacuum created to hold the Robotic Climber^{TM} to the work surfaces. The dust generated may contain coating, subsurface, and blasting material. The possible contaminants will need to be identified as part of a site characterization prior to the beginning of the job. A monitoring plan will need to be considered on a site-by-site and job-by-job basis. Since the Robotic Climber^{TM} is a wet process, the possibility of dust generation is negligible.

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: 2
The operation of the Robotic Climber^{TM} uses a 12 volt system for the emergency stop. There are however, other hazards that must be considered for lockout/tagout during maintenance activities, compressed air and high pressure water.	
B. FIRE AND EXPLOSION	RISK RATING: 1
There is little risk from the normal operation of the Robotic Climber^{TM} but the equipment is not intrinsically safe and could not be used in a potentially explosive atmosphere. The wet process and the immediate removal of dusts effectively eliminates the potential for a dust explosion.	
C. CONFINED SPACE ENTRY	RISK RATING: 4
Working with the Robotic Climber^{TM} in any work area that meets the definition of a confined space provides the potential for serious harm. All such projects must be planned carefully and compliance with OSHA standards is essential to protect workers.	
D. MECHANICAL HAZARDS	RISK RATING: 4
Operating the Robotic Climber^{TM} vertically or upside down poses increased risks of the blaster releasing from the surface and falling on workers. The safety cables are there to prevent this but must be rigged properly to provide the appropriate safety margin. There should be a fall arrest brake on the wench used to tighten the safety cables. Additionally, on vertical and inverted horizontal surfaces, workers need to stay back from the blasting unit during operation to avoid mechanical hazards.	

SECTION 5: ASSOCIATED SAFETY HAZARDS (Continued)	
E. PRESSURE HAZARDS	RISK RATING: 3
The blast hose and the large vacuum lines present a potential struck-by hazard if they were to rupture or disconnect. The compressed air supply also presents a potential hazard.	
F. TRIPPING AND FALLING	RISK RATING: 4
The large vacuum, high pressure hoses, and tether line are tripping hazards that routinely change position. In addition, this is a wet process and proper precautions need to be taken when walking on wet surfaces.	
G. LADDERS AND PLATFORMS	RISK RATING: 2
The Robotic Climber^{TM} eliminates the need for ladders and scaffolds associated with normal blasting but it may still be necessary to work on ladders occasionally, particularly when rigging the safety cables. This is a wet process, therefore, ladders should have anti-slip feet and steps.	
H. MOVING VEHICLES	RISK RATING: 3
The presence of multiple pieces of mobile equipment (which may be needed to unload and load 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 used. Several of the pieces of the Robotic Climber^{TM} require large forklifts to safely handle the load. OSHA's industrial lift truck standard must be complied with to avoid incidents during the loading and unloading of the Robotic Climber^{TM}. The technology vendor did have a 10 feet radius area around the operating robot as a standard operating procedure.	
I. BURIED UTILITIES, DRUMS, AND TANKS	RISK RATING: N/A
Not part of this technology.	
J. PROTRUDING OBJECTS	RISK RATING: 1
If any of the ancillary equipment, such as the high pressure pump is located on a trailer, hitches should be clearly marked to avoid running into them.	
K. GAS CYLINDERS	RISK RATING: 1
Gas cylinders on the high pressure pump should be covered with caps while they are not in use, during transportation, and/or when being changed. Cylinders should be clearly marked and labeled and appropriately stored.	
L. TRENCHING AND EXCAVATIONS	RISK RATING: N/A
Not part of this technology.	

SECTION 5: ASSOCIATED SAFETY HAZARDS (Continued)	
	RISK RATING: 3
Unloading and loading of technology may require overhead lifts or the use of a forklift. Proper precautions indicated.	
	RISK RATING: 4
The operation of the Robotic Climber™ vertically or upside-down on the undersides of horizontal surfaces requires great diligence because of the heightened possibility of accidental loss of suction and release of the blast unit. Even with proper safety cable rigging, the unit can drop enough to hurt workers immediately adjacent to the operation. If the cables are improperly rigged, the unit could fall completely, potentially killing someone underneath. Consequently, good work practices must be emphasized. Workers must be kept out from underneath the Robotic Climber™ at all times.	

SECTION 6: ASSOCIATED HEALTH 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. INHALATION HAZARD	RISK RATING: 1
Dust exposure is greatly reduced during the operation of the Robotic Climber™, due to the wet technique and the strong vacuum used.	
B. SKIN ABSORPTION	RISK RATING: 1
There is no significant risk for skin absorption posed by operating the Robotic Climber™. Since this is a wet process, consideration does need to be given to the type of personal protective equipment. Cotton anti-contamination suits may allow radiation to get to the skin from soaking through the cotton garment.	
C. HEAT STRESS	RISK RATING: 1-4
Given the closed-loop design of the Robotic Climber™, workers should be able to operate the system wearing limited personal protective equipment. This should greatly reduce the heat stress level compared to standard blasting. The work environment can still be hot, however, and heat stress precautions should be taken.	

SECTION 6: ASSOCIATED HEALTH HAZARDS (Continued)	
D. NOISE	RISK RATING: 4
Noise exposure at the point of operation is excessive. Noise monitoring has shown values well in excess of the OSHA Permissible Exposure Limit for an 8-hour work shift. The remote operation of the Robotic Climber™ is an engineering control that clearly reduces exposure. The critical factor is the distance. The need to inspect the quality of the work may require the operator to be overexposured. Therefore, other feasible engineering controls, administrative controls, and hearing protection may be needed. Workers may 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: 3
The remote operation of the Robotic Climber™ greatly reduces the stresses and strains on the body that are a normal part of blasting. Regularly moving the large vacuum hose and pressure lines, however, introduces increased risk of back problems because of the poor postures involved with the lift and the bulkiness of the items. Design of some of the robots controls could contribute to repetitive motion injuries. There is also potential for back/neck/shoulder strain while lifting the Robotic Climber to the wall or ceiling surface. Mechanical lifting devices should be used whenever possible.	
I. OTHER	RISK RATING: 2
There are communication problems due to the noise generated by operation of the technology. Workers need to receive training to ensure that everyone understands the key hand signals involved in safely operating the Robotic Climber™.	

SECTION 7: PHASE ANALYSIS
A. CONSTRUCTION/START-UP
The set-up phase requires the unloading of several pieces of equipment. This must be done with large forklifts, given the size of several pieces of the equipment. Given that most of this will be done on construction sites, there are significant risks associated with vehicles moving on uneven ground with large loads. Setting up the system also involves connecting hoses for the vacuum and blasting. There is also considerable hoisting and rigging needed to attach the safety cables to the robot blaster. This phase presents several hazards including struck-by/caught between hazards, pinch points, slips/trips/falls, muscular/back injury, high pressure hazards, and burn hazards from the high pressure water being hot.
B. OPERATION
The operational phase presents several hazards including: ▪ Potential exposure to contaminants, ▪ Noise hazards, ▪ Risks from high pressure, ▪ Burn hazards from high pressure water being hot, ▪ Fall from above hazards (robot releases from wall/ceiling), ▪ Ergonomic hazards -- moving vacuum and high pressure hoses, ▪ Potential for repetitive motion injures from robot controls.
C. MAINTENANCE
Routine maintenance may require respiratory protection, depending on the toxicity of the contaminant and the part of the system that is being worked on. Any maintenance work is particularly hazardous if the blasting unit is still suspended on a vertical surface. Lockout/tagout programs must be carefully followed to avoid a serious injury. There are also numerous pinch point areas when changing the rubber tube seal and/or the track.
D. DECOMMISSIONING
The decommissioning phase presents several hazards including exposure to the contaminants, pinch points, slips/trips/falls, and muscular/back injury.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS

(If this technology is used on hazardous waste sites, the following information should be included in the written Health and Safety Plan that is required by OSHA under 29 CFR1910.120.

A. AIR MONITORING

Air monitoring of personnel exposures to toxic substances is warranted; the results can document the effectiveness of the wet process and the strong suction on the blast unit. Air monitoring is particularly critical when the surfaces to be removed are contaminated with radioactive materials or highly toxic agents. Airborne contamination coul be a problem if the O-ring tube-type seal loses contact with the surface being blasted.

B. WORKER TRAINING

Worker training is an important element in preventing injuries. Training in the operation of the Robotic Climber™ is obviously important. Special emphasis should be placed on training workers to operate the controls of the remote station because operation is not intuative. Other safety and health training that may prove helpful for the workers includes but may not be limited to:

- Hoisting and rigging the safety cables for the robot blaster,
- 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,
- High pressure hazards,
- Lockout/Tagout,
- Hand Signal Communication, and
- Construction Safety (OSHA 500).

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. The worst-case scenarios at each site should be discussed by the crew and plans should be made on how to deal with each scenario.

D. MEDICAL SURVEILLANCE

A general screening of worker's health with emphasis on the back and cardiovascular/respiratory system is usually warranted. Depending on the contaminant present, medical surveillance may be required by OSHA standards. Initial and annual audiograms may also be required because of the noise levels.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS (Continued)
(If this technology is used on hazardous waste sites, the following information should be included in the written Health and Safety Plan that is required by OSHA under 29 CFR1910.120.
E. INFORMATIONAL PROGRAM
Workers must be trained in specific operation of equipment before use.

SECTION 9: COMMENTS AND SPECIAL CONSIDERATIONS
The Robotic Climber^{TM} technology is more protective of workers than standard blasting in many ways. But only personnel who have been adequately trained should attempt to operate the technology. Attaching the safety cables requires expertise in hoisting and rigging. Failure to hook the cables correctly can potentially cause the unit to fall during operation, resulting in serious injuries or possibly death.