SECTION 6 - TECHNOLOGY SAFETY DATA SHEET

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Mitsubishi Heavy Industries (MHI)
En-vac Robot Blasting System

<table>
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SECTION 2: PROCESS DESCRIPTION

The En-vac robot uses abrasive blasting to remove the upper surfaces from floors and walls of industrial and commercial structures. The En-Vac Robot Blasting System consists of the En-vac robot, a recycling unit, a filter unit and a vacuum unit. The system uses abrasive steel grit or steel shot. The robot sticks to working surfaces by a strong vacuum contained in the sealed blasting chamber and moves using individual motors for each wheel. The vacuum is created by the vacuum unit. The air pressure holding the robot to the working surface is so strong that the robot and its hoses can work on horizontal, vertical, inclined, and curved surfaces. It can even work upside down on the underside of horizontal surfaces, within specified limits. The vacuum draws away the materials blasted so there is little dust released during blasting, a major advantage over normal abrasive blasting. The other major advantage is that the operator works away from the robot, controlling the unit from a hand-held panel that can be kept as much as 300 feet away. The remote operation may eliminate dust exposures or noise exposures over the OSHA Action Level. All operations are contained in a closed loop. The system concurrently separates the removed surface from the removal media. The removal media is recycled continuously with no interruption in system operation. The waste is collected in a storage container within the recycling unit.

SECTION 3: TECHNOLOGY PHOTOS

Envac-Operating on test wall.

En-vac operating on test wall. Note proper bundling of hoses and rollers for moving hoses.

SECTION 4: CONTAMINANTS AND MEDIA

Dust from the blasting operation is well contained by the strong vacuum created to hold En-vac 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. En-vac can use mineral slag and a range of steel grit, although SAE G50 steel grit is recommended by the developer. Steel shots often contain small amounts of manganese which can cause metal fume fever and nerve problems. Silica, a lung hazard, may also be present in small amounts. Preventing release of dust during blasting is important.

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: 4

The operation of the En-vac system requires 440 volts, 3 phase. For most construction jobs, this means a large portable generator. Given the presence of water on many construction jobs, the potential exists for serious electrical shock and possible electrocution. Proper grounding and use of ground fault circuit interrupters are essential 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: N/A

There is little risk from the normal operation of En-vac but the equipment is not intrinsically safe and could not be used in a potentially explosive atmosphere. The immediate removal of dusts effectively eliminates the potential for a dust explosion.

C. CONFINED SPACE ENTRY	RISK RATING: 4

Working with En-vac 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: 3

Operating En-vac 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. Additionally, on 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 is rated at 100 pounds per square inch.	
F. TRIPPING AND FALLING	RISK RATING: 4
The large vacuum hose must be tended regularly as the En-vac unit moves along the work surface. Small wheeled platforms are attached under the hose to allow the hose to be dragged. The constant moving of this hose and the hose carrying the abrasive means that there are tripping hazards that routinely change position and require adjustment.	
G. LADDERS AND PLATFORMS	RISK RATING: 2
En-vac eliminates the need for ladders and scaffolds associated with normal abrasive blasting but it may still be necessary to work on ladders occasionally, particularly when rigging the safety cables.	
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 En-vac 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 En-vac.	
I. BURIED UTILITIES, DRUMS, AND TANKS	RISK RATING: N/A
Not part of this technology.	
J. PROTRUDING OBJECTS	RISK RATING: 2
En-vac's blast gun has a sweeping motion that could catch hands.	
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: 3
Unloading and loading of technology may require overhead lifts or the use of a forklift. Proper precautions indicated.	

SECTION 5: ASSOCIATED SAFETY HAZARDS (CONTINUED)	
N. OVERHEAD HAZARDS	RISK RATING: 4
The operation of En-vac 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 En-vac 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: 2
Dust exposure is greatly reduced during the operation of En-vac, particularly compared to standard abrasive blasting.	
B. SKIN ABSORPTION	RISK RATING: N/A
There is no significant hazards from skin absorption posed by operating En-vac.	
C. HEAT STRESS	RISK RATING: 3
Given the closed-loop design of En-vac, workers should be able to operate the system wearing limited personal protective equipment. This should greatly reduce the heat stress level compared to standard abrasive blasting. The work environment can still be hot, however, and heat stress precautions should be taken.	
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 En-vac 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 accept noise overexposures. 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.	

SECTION 6: ASSOCIATED HEALTH HAZARDS (CONTINUED)	
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 En-vac greatly reduces the stresses and strains on the body that are a normal part of abrasive blasting. The regularly moving of the large vacuum hose, however, introduces increased risk of back problems because of the poor postures involved with the lift and the bulkiness of the item.	
I. OTHER	RISK RATING: 2
There are communication problems due to the noise generated by the technology during operation. Workers need to receive training to ensure that everyone understand the key hand signals involved in safely operating En-vac.	

SECTION 7: PHASE ANALYSIS

A. CONSTRUCTION/START-UP

The set-up phase requires the unloading of several flatbed trucks. 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 establishing electrical connections and 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, and electrical hazards.

B. OPERATION

The operational phase presents several hazards including:

- Potential exposure to contaminants, particularly during emptying of the waste from the dust,
- Noise hazards,
- Risks from excessive pressure,
- Electrical shock, and
- Pinch points associated with the sweeping motion of the blast gun.

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.

SECTION 7: PHASE ANALYSIS (CONTINUED)

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 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.

B. WORKER TRAINING

Worker training is an important element in preventing injuries. Training in the operation of En-vac is obviously important. Special emphasis should be placed on training workers to operate the controls of the remote station because operation of the joysticks is not obvious. Other safety and health training that may prove helpful for the workers include:

- 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,
- Electrical Safety,
- 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.

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.)
D. MEDICAL SURVEILLANCE
A good general screening of the crew's health with emphasis on the back and cardiovascular/respiratory system is usually warranted. Depending on the contaminant present and the airborne levels, medical surveillance may be required by OSHA standards. For instance, exposures about the Action Level for lead may require collection of blood samples to measure blood-lead levels. Initial and annual audiograms may also be required because of the noise levels.
E. INFORMATIONAL PROGRAM
Workers must be trained in specific operation of equipment before use.

SECTION 9: COMMENTS AND SPECIAL CONSIDERATIONS
The En-vac technology is more protective of workers than standard abrasive 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.