

SECTION 6 - TECHNOLOGY SAFETY DATA SHEET

TECHNOLOGY SAFETY DATA SHEET

CARNEGIE MELLON UNIVERSITY

BOA

SECTION 1: TECHNOLOGY IDENTITY	
<p>Manufacturer's Name & Address:</p> <p>Carnegie Mellon University Robotics Institute Field Robotic Center 5000 Forbes Avenue Pittsburgh, PA</p>	<p>Emergency Contact:</p> <p>Carnegie Mellon (412) 268-6884</p> <hr/> <p>Information Contact:</p> <p>Carnegie Mellon (412) 268-6884 (412) 268-5895 (fax) Attn: Hagen Schempf, Ph.D.</p> <hr/> <p>Date Prepared:</p>
<p>Other Names:</p> <p>BOA, Big on Asbestos, Robotic Asbestos Remover</p>	<p>Name of Preparer:</p> <p>Operating Engineers National Hazmat Program 1293 Airport Road, Beaver, WV 25813, phone 304-253-8674, fax 304-253-1384.</p> <p>Under cooperative agreement DE-FC21-95 MC 32260</p>

SECTION 2: PROCESS DESCRIPTION

This system is a self-propelled automated mini-enclosure that removes asbestos insulation from nominal 4" outside diameter piping. The system is designed for two operators, one at the abatement head, and another at the bagging station. Since the abatement head is its own enclosure there is no obvious need for further enclosures to be built.

The abatement head for BOA consists of a system for moving "inch worm-like" down the pipe with three clamps to hold the head in place. Removal takes place by high pressure water jets and endmill cutting heads that cut through all lagging and wire materials. BOA automatically uses water at 1.8 gallons per minute through the three cutting heads to perform the cutting and at 1.2 gallons per minute through separate nozzles to flush the pieces of asbestos into the waste stream.

A high volume vacuum conveys the cut insulation to the bagging operation. A high pressure spray of water cleans the pipe and a spray of encapsulant seals any remaining fibers to the pipe as the unit moves along the pipe. The waste material is directed through a water separator, where the water is separated from the waste material and is filtered and recycled for continued cutting. The waste is vacuumed into the bagging operation where chunks of insulation are dumped into asbestos bags and taped shut. A centrally located control box coordinates all actions to a remote pendant for the operator to supervise and control the abatement process.

SECTION 3: PROCESS DIAGRAM

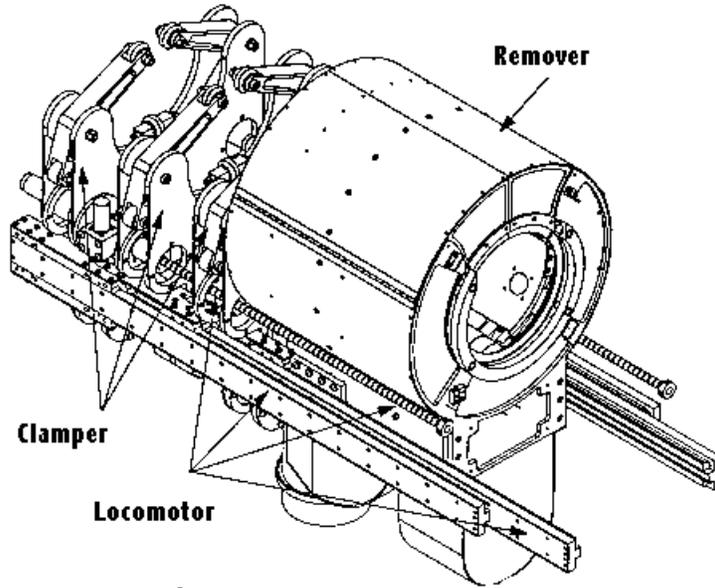


Fig. 3-1 BOA System Abatement Head

SECTION 3: PROCESS DIAGRAM

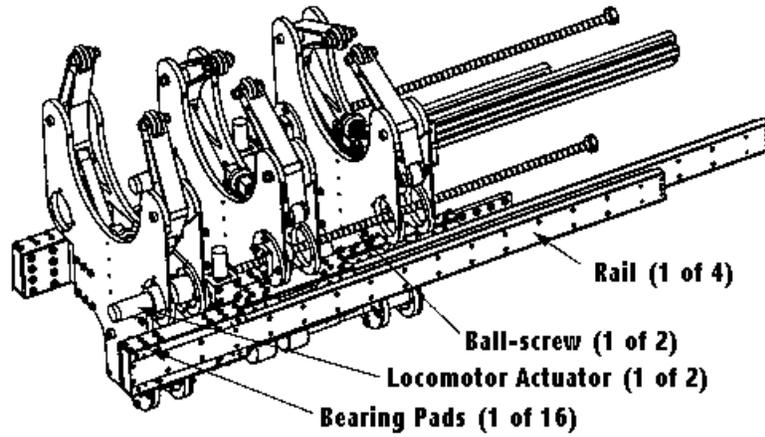


Fig. 3-2 Overview of Locomotor System

SECTION 3: PROCESS DIAGRAM

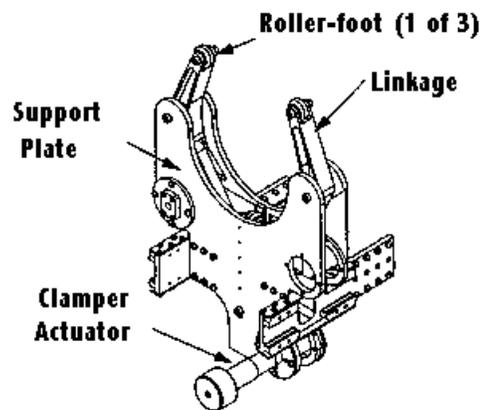


Fig. 3-3 Overview of Clamber System

SECTION 3: PROCESS DIAGRAM

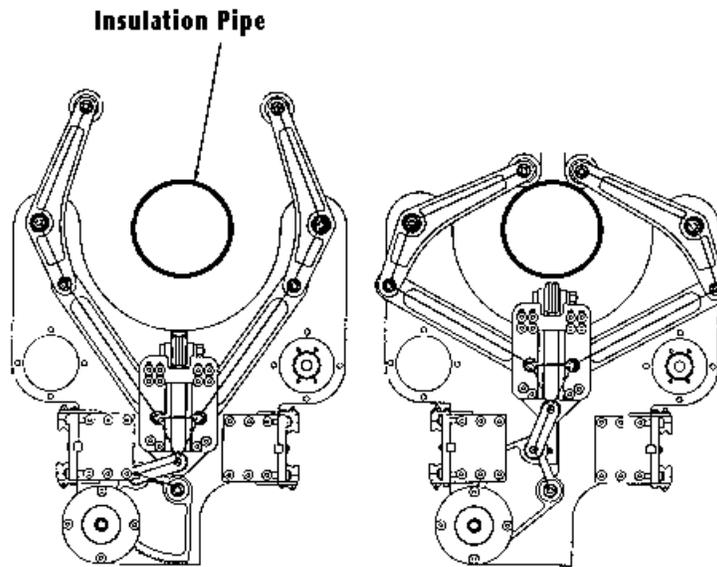


Fig. 3-4 Clasper Overview and Extreme Positions

SECTION 4: CONTAMINANTS AND MEDIA

The contaminant of greatest concern is the asbestos found in the insulation that the system is removing. There are several distinct types of asbestos found in insulation. The majority of asbestos used in the U.S. is chrysolite that has wavy fibers and absorbs water well. Of particular concern is Amosite asbestos that is typically found in insulation on high pressure steam lines. This material does not absorb water nearly as well. Removal of Amosite often results in higher airborne asbestos levels during removal. Irrespective of the type of asbestos, respiratory protection should be worn, at a minimum, whenever maintenance or repair work must be done inside the enclosure doors of the abatement head. If the abatement head is allowed to remain on the pipe over a period of time, asbestos residues can dry out and produce an exposure to asbestos fibers when the head is opened. In addition to asbestos, other contaminants may be present and this must be identified, prior to insulation removal. In most cases this will be determined through the site characterization.

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 is known to be present
- 3 High hazard potential
- 4 Potential for imminent danger to life and health

A. ELECTRICAL (LOCKOUT/TAGOUT)

RISK RATING: 3

BOA operates off of a 208 volt, 3-phase current that runs into a main control box. The connector is waterproof and GFCI protection is part of the system. There are eight power cables that run along the floor from the control box to the various pieces of equipment. Given the presence of water in the operation, the risk of electrical shock is elevated.

B. FIRE AND EXPLOSION

RISK RATING: 1

The asbestos insulation is fire resistant and is wetted for removal. The encapsulant used will not burn in the wet state. The large vacuum unit and an auxiliary generator are diesel powered but require no special practices beyond normal safe fueling. There is no flame used in the operation. Consequently, there is no significant fire and explosion hazard.

C. CONFINED SPACE ENTRY	RISK RATING: N/A
None of this equipment is large enough to allow entry of a worker nor is there any reason for entry. Therefore, confined space entry is not part of this technology.	
D. MECHANICAL HAZARDS	RISK RATING: 4
There is the real risk of amputation of fingers posed by the clamping system. Once activated, the clamping operation cannot be reversed and is not guarded. The operator, if holding the pendant with two hands, should be out of danger, but other workers performing maintenance or repair may be at risk. Additionally, the drive belt on the water pump is unguarded when the main cover is removed, which may be necessary during operation.	
E. PRESSURE HAZARDS	RISK RATING: 3
The high pressure water lines presently do not have safety straps so that an accidental release may cause the lines to whip around for several seconds until the pressure difference is sensed and the system shuts down.	
F. TRIPPING AND FALLING	RISK RATING: 4
There are many hoses and cables of very different sizes that are an integral part of the system and pose a significant tripping hazard. Careful grouping of the hoses and vivid markings would reduce the hazard. Good housekeeping is essential.	
G. LADDERS AND PLATFORMS	RISK RATING: 4
Due to its weight, the system must be mechanically hoisted to high pipe runs where insulation is to be removed. Given the weight of the abatement head and the inability to maintain 3-points of contact, it is too dangerous to attempt to work from a ladder to attach the abatement head. Therefore, some type of platform or manlift must be used. The crane designed to move the abatement head into position might be attached to the platform. Operating this crane from a manlift is difficult and places the workers at risk for falls. The appropriateness of the platform/manlift for this type of application must be evaluated before the job is started. In addition, the need for fall protection must be taken into consideration and fall protection used as appropriate.	

H. MOVING VEHICLES	RISK RATING: 2
<p>This operation can take place indoors or outdoors so vehicles pose a problem. The work areas must be carefully isolated to prevent trucks and cars from running into the operation outdoors and to prevent tow motors and other vehicles from running into workers or man lifts inside buildings. It is possible that a flagperson would be required for exterior work in busy areas. In addition, all vehicles used must have adequate alarms and signals.</p>	
I. BURIED UTILITIES, DRUMS, AND TANKS	RISK RATING: N/A
<p>Not part of this technology.</p>	
J. PROTRUDING OBJECTS	RISK RATING: 2
<p>Each area should be carefully evaluated before work begins to identify objects that can entangle hoses and pose risks to workers.</p>	
K. GAS CYLINDERS	RISK RATING: N/A
<p>Not part of this technology.</p>	
L. TRENCHING AND EXCAVATIONS	RISK RATING: N/A
<p>Not part of this technology.</p>	
M. OVERHEAD LIFTS	RISK RATING: 4
<p>BOA must be lifted onto overhead pipe runs. All hazards associated with the use of a crane for lifting are present. Personnel must not be allowed under the cutting head as it is lifted.</p>	
N. OVERHEAD HAZARDS	RISK RATING: 4
<p>Working under the system during attachment of the abatement head to elevated pipes poses a significant hazard. If the 150 pound unit fell upon a worker it could be fatal, even if the worker was wearing a hard hat. Hard hats are needed but more importantly, attachment of the abatement head and all associated lines should not be performed with workers directly under the unit. In addition, workers should not be directly under the unit during operation.</p>	

SECTION 6: ASSOCIATED HEALTH HAZARDS	
A. INHALATION HAZARD	RISK RATING: 3
<p>The BOA system is designed to remove asbestos under a strong vacuum without direct worker exposure. A sampling plan will need to be developed for asbestos sampling in compliance with 29 CFR 1910.1001 and/or 29 CFR 1926.1101. In addition, the asbestos removal project will need to be in compliance with the regulations/laws of the state where the project is taking place. Other contaminants, in addition to asbestos, may also be present and must be identified and sampled for in addition to the asbestos sampling.</p>	
B. SKIN ABSORPTION	RISK RATING: 2
<p>The encapsulant used by the system can cause irritation to the skin. Appropriate PPE should be worn. MSDS must be provided from the supplier.</p>	
C. HEAT STRESS	RISK RATING: 3
<p>During operation, the heat stress on operators will be less than that for workers physically removing asbestos, but stripping insulation from hot lines may increase the ambient temperature in the work area. Working at elevated levels may increase the risk of heat stress illness. The individual bagging the waste will have a much greater metabolic heat load than the operator and this needs to be considered, particularly if protective clothing is worn. Where conditions warrant, the employer needs to develop and apply a heat stress management program to include, as appropriate, work-rest cycles. These need to be developed for the job in accordance with the recommendations of the ACGIH or other acceptable authority.</p>	
D. NOISE	RISK RATING: 2
<p>Noise measurements indicated that neither the operator nor the bagging worker should be exposed above the OSHA action level of 85 dBA. A good practice is for the operator to stand as far away from the abatement head as the pendant control allows to reduce noise levels well below the OSHA action level. Similarly, the bagging operator should stand back from the unit until it is necessary to fill a bag. The noise readings for the large vacuum unit exceeded the OSHA allowable level of 90 dBA, making it necessary for workers to wear hearing protection whenever they work near the unit. Noise monitoring needs to be conducted where the system is being used, since the environment may change the noise levels.</p>	

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
This technology may be used outdoors in the winter, consequently, routine precautions against cold stress would be necessary.	
H. ERGONOMIC HAZARDS	RISK RATING: 3
Lifting, bending, pulling, pushing, and carrying are all activities necessary for setting up, operating, taking down, and decontaminating BOA. Special care is necessary when attaching all hoses and cables because of the awkward positions involved. A calculation of the NIOSH lifting guide indicated that the weight of the waste should be kept around 30 pounds to avoid causing back injuries for workers. BOA can be programmed to start a new cycle when approximately 30 pounds of insulation (including water) have been sent to the bagging unit.	
I. OTHER	RISK RATING: N/A
No special hazards associated with this technology.	

SECTION 7: PHASE ANALYSIS

A. CONSTRUCTION/START-UP

The vacuum, air, and water hoses needed to operate BOA pose a significant tripping hazard. Given their integral role in the system, they can not be eliminated or easily re-engineered. Less cluttered deployment and marking would be helpful. The hooking of lines requires poor postures - stooping and also overhead reaching - this has the potential to cause back strain/sprain. Ergonomic training needs to be considered.

The VecLoader (vacuum system), with a narrow wheel base is easy to rock and could potentially tip over. The water pump's wheels are fixed which makes it virtually impossible to steer the unit without lifting it at some point. To avoid back injury, move the pump a little bit at a time.

Using a man lift with an 8' X 10' platform and a small crane bolted in the center would allow operators to connect BOA without hanging out of the lift, or working under the cutter head, which could disconnect and fall.

The safety caps for the bagging unit are hanging on a chain at a height of nearly 6 feet. This means that hooking up the hoses requires working at a difficult height. The arrangement with hooking the clamps poses a "pinch hazard" for the fingers.

B. OPERATION

The clamps (arms) that hold the abatement head to the pipe cannot be stopped in mid-cycle and the force of these clamps has the potential to cut off a finger. The operator, if using the pendant control with both hands, would be guarded according to OSHA machine guarding requirements but there is a real danger to others performing maintenance or repair. Training is critical and additional guarding or at least additional warnings may be appropriate.

If the high pressure water hoses release, they could whip and injure someone before the system shuts down. Adding safety straps to the connectors would significantly reduce this possibility.

The high pressure water pump has a cover that eliminates the possibility of hands being caught in the in-running nip points caused by the moving belt. The pump must always be operated with this cover in place.

The large vacuum unit should be operated outdoors and, if operated indoors, needs to have its diesel fumes exhausted outside and should be positioned to reduce noise exposure as much as possible. All noise readings for the vacuum unit exceeded the OSHA level that would require participation in a hearing conservation program and hearing protection if workers needed to be in the area. Additionally, the exhaust of air from this unit could contain asbestos fibers if the filters are not properly placed – another reason to continue to operate this unit outdoors.

C. MAINTENANCE

The abatement head is designed to provide a water wash and then vacuum the residue away automatically. Materials may remain in the cutter head after the water wash and could become dry after residing in the head between removal jobs, releasing asbestos fibers when the abatement head is opened. This means that operators may need to wear a respirator during maintenance on a unit that has been setting and dried.

If cutting heads need to be changed after removal has begun, the residue around the head could become airborne. Additionally, the heads are sharp and should be handled with gloves to prevent cuts. Maintenance work on the abatement head will require a special workbench. The abatement head will be hard to balance on a flat table.

D. DECOMMISSIONING

The BOA can be left attached to a pipe at the end of the day and started up to continue removal the next day. At the end of the job, the system should be flushed thoroughly with water. Similarly, every piece of associated equipment should be flushed out. The large vacuum hoses can be sealed at each end with a cap and duct tape for shipment to the next job. The abatement head should be kept closed and packed carefully in the custom shipping container.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS

A. AIR MONITORING

Depending on the job, the 1910 (general industry) or 1926 (construction) OSHA standards will apply to the air sampling required. Under the OSHA Asbestos Standard, 1926.1101(f)(2), each employer removing asbestos insulation must ensure that a "competent person" conduct an exposure assessment immediately before or at the initiation of the operation to ascertain expected exposures during that operation or workplace. The employer must assure that the worker is not exposed to the PEL, 0.1 fibers per cubic centimeter of air as an 8-hour time weighted average or the excursion limit of 1.0 fibers per cubic centimeter of air as averaged over a sampling period of 30 minutes.

Under the OSHA Asbestos Standard, 1910.1001 (d)(1), determinations of employee exposure shall be made from breathing zone air samples that are representative of the 8-hour TWA and 30-minute short-term exposures of each employee. The employer must assure that the worker is not exposed to PEL, 0.1 fibers per cubic centimeter of air as an 8-hour time weighted average or the excursion limits of 1.0 fibers per cubic centimeter of air as averaged over a sampling period of 30 minutes.

In addition, monitoring may be required for other contaminants in the area where the asbestos removal is taking place. These contaminants should be identified by the site characterization.

B. WORKER TRAINING

Workers must be trained in the specific operation of the system. Additionally, until asbestos sampling data indicates differently, workers should receive training following the EPA Model Accreditation Plan for asbestos workers (40 CFR Part 763, subpart E, Appendix C). Additional training required may include but not be limited to Hazardous Waste Operations and Emergency Response (HAZWOPER), HAZCOM, asbestos worker, respirator, PPE and hearing conservation.

C. EMERGENCY RESPONSE

BOA can alert operators to emergency situations. There is a box near the cutting head that flashes with a bright strobe light whenever the head reaches an obstruction. The system automatically stops abatement and proceeds to encapsulate exposed surfaces. There is an emergency stop button on the electrical box that shuts down the entire system. There is also an emergency button on the pendant control unit. This provides the operator with the ability to immediately shut down the system. A vacuum is maintained in the system throughout any emergency shutdown. Even if the main vacuum unit fails to operate, the auxiliary HEPA vacuum will operate, unless a complete loss of electrical power occurs. In this case, all vacuum power could be lost and the potential exists for exposure to asbestos fibers.

D. MEDICAL SURVEILLANCE

A medical surveillance program is necessary for all employees who for a combined total of 30 or more days per year are engaged in Class I, II and III asbestos work or are exposed at or above the permissible exposure limit. Medical tests should be provided according to 1926.1101(m).

E. INFORMATIONAL PROGRAM

Under OSHA's Hazardous Waste standard, 1910.120, the employer is responsible for providing information on new technologies to the workers who will be using the equipment.

SECTION 9: COMMENTS AND SPECIAL CONSIDERATIONS

OSHA will allow contractors to vary their work practices from the agency's stringent requirements for Class I asbestos removal work. Under 1926.1101(g)(6), *Alternative control methods for Class I work*, OSHA recognizes alternative new techniques such as BOA, as long as two requirements are met:

(1) The control method shall enclose, contain or isolate the processes or source of airborne asbestos dust, or otherwise capture or redirect such dust before it enters the breathing zone of employees.

(2) A certified industrial hygienist or licensed professional engineer who is also qualified as a project designer...shall certify in writing that the planned control method is adequate to reduce direct and indirect employee exposure to below the PELs under worst-case conditions of use, and that the planned control method will prevent asbestos contamination outside the regulated area, as measured by clearance sampling which meets the requirements of EPA's Asbestos in Schools rule issued under AHERA, or perimeter monitoring which meets the criteria in paragraph (g)(4)(ii)(B) of this section.

This last OSHA reference permits an employer to use some other isolation method rather than sealing all critical barriers to the work area (a time consuming and labor intensive process) as long as sampling of perimeters of the regulated areas show no elevations of airborne asbestos above background levels. The BOA system may be able to meet all of these criteria and thus be recognized as an alternate control method. This recognition has not formally been received at this time, however.