

Technology Safety Data Sheet

Conjet Robot 363

Section 1: Technology Identity

Technology Name(s):		Emergency Contact:	
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Manufacturer's Name and Address:		Information Contact:	
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Date Prepared:	September, 2002	Date Revised:	Not yet revised

Section 2: Technology Pictures



Figure 1: Operation of the Conjet Robot 363.



Figure 2: Operators Control Panel.

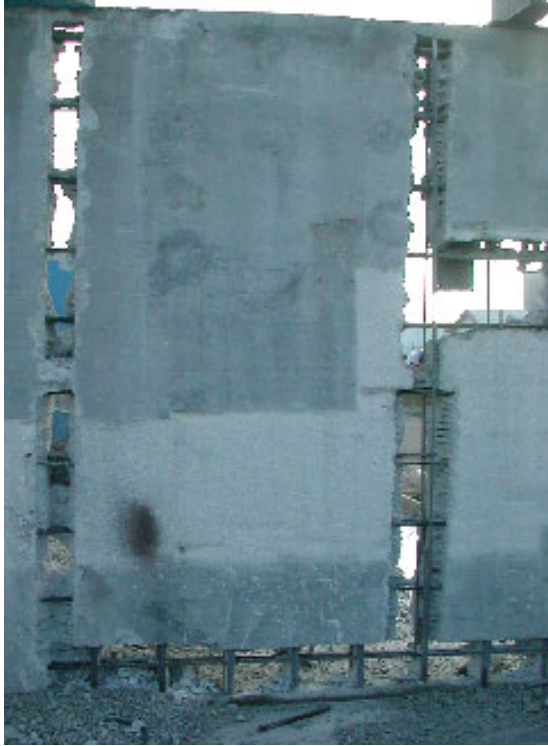


Figure 3: Wall after Hydrodemolition .



Figure 4: Close-up of Concrete after Hydrodemolition.



Figure 5: Hammelmann High-pressure Water Pump and Diesel Engine.

Section 3: Technology Description

The Conjet Robot 363 is a robotically operated technology. Using high-pressure water at 16,680 pounds per square inch (psi) with a flow rate of 62 gallons per minute (gpm), the Conjet Robot is able to remove damaged concrete from almost any surface orientation. Using a multi purpose 18-foot arm allows concrete removal from roofs, walls, floors, and bridge decks (from above or below). While removing concrete, the robot cleans steel reinforcement bars (rebar) and structural steel beams without any compromise in structural strength. Using a computerized control panel, the operator is able to precisely control the depth of concrete removed from a surface. The Conjet Robot 363 can provide surface scarification for increased adhesion of new concrete or complete concrete removal. The robot uses an 11-kilowatt electric motor to power the arm rotors and the oscillation tool containing the high-pressure water orifices. The oscillation tool is track mounted within a trough and moves the high-pressure water jet in a sweeping motion across a surface to remove concrete.

Section 4: Safety Hazards

Hazard Category:

(Adapted from Appendix A to MIL-STD-882D, February 10, 2000, Department of Defense Standard Practice for System Safety.)

- 4 - Could result in death or permanent total disability
- 3 - Could result in permanent partial disability or injuries or occupational illness that may result in hospitalization of at least three persons
- 2 - Could result in injury or occupational illness resulting in one or more lost work days
- 1 - Could result in injury or illness not resulting in a lost work day
- N/A - Is not applicable to this technology and poses no appreciable risk

A. Buried Utilities, Drums, and Tanks	Hazard Rating: N/A
This hazard is not applicable to this technology.	
B. Chemical (Reactive, Corrosive, Pyrophoric, etc)	Hazard Rating: N/A
This hazard is not applicable to this technology.	
C. Confined Space	Hazard Rating: 1
The technology is capable of operating in a confined space. Confined space work requires knowledge and preparation to limit use of personnel within the confined space for technology maintenance or retrieval. Air monitoring is required before confined space entry and while occupied. Struck-by hazards from projectiles will increase within a confined space.	
D. Electrical	Hazard Rating: 2
The technology operates on 480-volt three-phase alternating current. Wet conditions will increase the likelihood of electric shock. Electric cable inspection is important to prevent electric shock from a damaged cord. Electrical connections for use in wet locations are required. Equipment grounding is vital to prevent electric shock. Lockout/tagout procedures must be used during any robot maintenance.	
E. Explosives	Hazard Rating: N/A
This hazard is not applicable to this technology.	
F. Fire Protection	Hazard Rating: N/A
This hazard is not applicable to this technology.	
G. Gas Cylinders	Hazard Rating: N/A
This hazard is not applicable to this technology.	

H. Ladders/Platforms	Hazard Rating: 1
<p>Use three points of contact when descending and ascending ladders. Use a haul rope when moving materials. When platforms are used, assure sufficient footing area free of tripping hazards. Assure proper tie-off points when working on an elevated working surface. Personnel need to prevent any water accumulation on walking or working surfaces to prevent slip hazards.</p>	
I. Lockout/Tagout	Hazard Rating: 2
<p>Use lockout/tagout procedures when servicing any of the system components. A keyed switch on the control panel should allow control of the robot and high-pressure water pump. All sources of potential energy must be controlled by a lock or keyed switch. Water, air pressure, and electrical energy are sources of potential energy with the Conjet Robot 363 technology. All sources of potential energy must be controlled by a lock, key-code, or keyed switch. The desired effect of lockout/tagout is to disable and safely release sources of potential energy, such as air and water pressure, to prevent injury.</p>	
J. Mechanical Hazards	Hazard Rating: 2
<p>The Robot has a large freedom of movement and is capable of autonomous operation. The area of operation should be barricaded to prevent site personnel from inadvertently entering the work area. Maintenance on the robotic arm may be necessary at multiple angles. The arm does not have a mechanical locking device to prevent arm components from movement by gravity. When possible rotate the arm to place the trough containing the water jet on the floor. Keep personnel from under the arm and trough to prevent possible crush and impact injuries.</p>	
K. Moving Vehicles	Hazard Rating: 2
<p>The Conjet Robot 363 is a mobile technology and is capable of autonomous operation. The area of operation should be barricaded to prevent site personnel from inadvertently entering the work area. Audible and visual alarms are needed to warn of impending robot movement.</p>	
L. Overhead Hazards	Hazard Rating 2
<p>removes concrete on any surface including overhead surfaces. When occurs on an overhead surface loose sections of concrete will fall. Assure overhead sections of concrete will not fall on personnel. Use ceiling supports to decrease the likelihood of ceiling collapse until desired. When working at heights, use proper safety precautions for the work area. Use proper PPE such as fall protection and hardhat.</p>	

M. Pressure Hazards	Hazard Rating: 3
<p>High-pressure water at 16,680 psi at 62 gpm, requires caution. Water pressures at the orifice and beyond can be hazardous. The orifice size determines the effective pressure of the water stream. The Conjet Robot 363 uses an eighth-inch orifice at the cutting tip. The use of the small orifice significantly increases the potential energy of the water stream erupting from the high-pressure water hose. An eighth-inch orifice allows water to flow rapidly while maintaining its cutting and pushing ability. Body contact with a small water column such as this will act as a cutting and blunt instrument. This explains the ejection of concrete projectiles farther than 50 feet. Body contact with the water stream from the orifice or a hole in a high-pressure water hose will result in instantaneous cutting; however, more damage to the human body will result from water simultaneously traveling through veins and arteries. If water does travel through veins and arteries, the affected area may become infected and require amputation.</p> <p>Water hoses present a potential struck-by hazard upon rupture or disconnection. High-pressure water hoses need safety straps at all connection fittings to prevent whipping in the event of a hose disconnection. Proper hose selection, assembly, and inspection are required. Lockout/tagout of the high-pressure water source and controlled pressure release is necessary before any intended contact with or proximity to the orifice or hose connections.</p> <p>No audible or visual alarm warns of high-pressure water activation. Both visual and audible alarms are needed to protect personnel in the operational area and in areas adjacent to operation since concrete projectiles can travel farther than 50 feet.</p>	
N. Slips/Trips/Falls	Hazard Rating: 1
<p>The Conjet Robot 363 requires a high-pressure water hose and electric and communication cables for operation. Grouping the hose and cables together and neatly laying them out in one location, to the extent possible, will reduce tripping hazards. Additionally, the hose and cables all connect at the rear of the robot and require constant movement by the operator.</p>	
O. Suspended Loads	Hazard Rating: N/A
<p>This hazard is not applicable to this technology.</p>	
P. Trenching/Excavation	Hazard Rating: N/A
<p>This hazard is not applicable to this technology.</p>	
Section 5: Health Hazards	
A. Inhalation	Hazard Rating: 1
<p>Personnel exposure is greatly dependent upon the site of operation. Air monitoring may be warranted depending upon the likelihood of contaminants being present. Exhaust fumes from the diesel engine will be present. If the diesel engine is used inside, air monitoring for diesel exhaust should be performed. A fine dry spray mist may occur when water jetting. This mist has the potential to contain any contaminants found on or within the surface undergoing water jetting. Air sampling is recommended. If the robot is used in a confined space, personnel entry may be required, but should not occur until a site-specific evaluation is conducted and necessary air monitoring of the confined space is conducted.</p>	

B. Skin Absorption	Hazard Rating: 1
Contaminants in the surface coating or the surface material such as lead or radionuclides will be forced away by the water jet. Personnel should wash exposed body parts before eating or drinking. Specific PPE may be required to protect against specific contaminants and radionuclides.	
C. Noise	Hazard Rating: 3
The Conjet Robot 363 process produces excessive noise. The noise levels measured were intensified by the concrete floor, walls, and ceiling of the demonstration bay. These measurements were probably representative of those found in actual work environments because the Conjet Robot 363 is designed to remove concrete. The noise level from the Conjet Robot 363 greatly exceeded the Occupational Safety and Health Administration (OSHA) action level of 85 dBA and the OSHA Permissible Exposure Limit of 90 dBA. The Conjet Robot 363 operator wore earplugs; but dual hearing protection may be required. Additional noise sampling is necessary to assure operators use proper hearing protection. Noise monitoring of the water pump in an outdoor location has shown sound pressure levels may exceed the OSHA Permissible Exposure Limit for an eight-hour work shift if work is performed within 25 feet of the water pump or air compressor.	
D. Heat Stress/Cold Stress	Hazard Rating: 1
Technology does not produce a hazard but ambient conditions need to be considered and monitored. Personal Protective Equipment requirements for entering a work zone will increase the risk of heat stress.	
E. Ergonomics	Hazard Rating: 2
The operator must constantly move the hose and cables connected to the Conjet Robot 363 to prevent the robot from backing over them. The operator does little but manage the hose and cables when the robot is advancing forward, because the robot drags the hose and cables behind itself. A new hose and cable configuration would greatly reduce the time the operator spends on moving the hose and cables versus paying attention to the , especially when the robot is in automatic operation. A seven foot arching arm, with 180 degrees of freedom, from the rear of the robot from which the hose and cables could hang would enable the robot to move forward and backward while the hose and cables are dragged parallel to the robot versus behind it. Grouping of the hose and cables and attaching wheeled dollies to them would greatly help reduce hose and cable wear and reduce the ergonomic stresses involved in managing the hose and cables. Additionally, the likelihood of an electrical shock from wear to the electric cable will be reduced. Pulling on hoses will stress the lower back. When hoses are moved, use proper lifting techniques.	
F. Ionizing Radiation	Hazard Rating: N/A
This hazard is not applicable to this technology.	
G. Non-ionizing Radiation	Hazard Rating: N/A
This hazard is not applicable to this technology.	
H. Biological Hazards	Hazard Rating: N/A
This hazard is not applicable to this technology.	

I. Other	Hazard Rating: 3
<p>Pieces of the substrate, concrete chunks, become projectiles during . Concrete pieces rapidly eject and become a potential struck-by hazard. The area around the water jetting operation needs barricading and labeling to prevent personal injury.</p>	
<p>Section 6: Phase Analysis</p>	
<p>A. Construction/Start-up</p>	
<p>A vehicle is required to position the air compressor and generator. A fork truck or crane may be needed to unload the high-pressure water pump. Crush and caught between injuries are possible during unloading. Only properly trained personnel should operate heavy equipment. Muscular/back injury is possible while moving water and air hoses. Water and air hoses can cause slips/trips/falls. The high-pressure water system presents pressure hazards.</p>	
<p>B. Operation</p>	
<p>The area surrounding the Conjet Robot 363 operations needs barricades and labels. Assure operator training on the Conjet Robot 363, PPE, and water jetting hazards. Assure adequate workspace free of tripping hazards. Operators need to prevent any water accumulation on walking or working surfaces to prevent slip hazards.</p>	
<p>C. Maintenance (Emergency and Routine)</p>	
<p>Use lockout/tagout procedures when maintenance is performed on any system component. Maintenance on the robotic arm may be necessary at multiple angles. The arm does not have a mechanical locking device to prevent arm components from movement by gravity. When possible, rotate the arm to place the trough containing the water jet on the floor. Keep personnel from under the arm and trough to prevent possible crush and impact injuries.</p>	
<p>D. Shutdown (Emergency and Routine)</p>	
<p>The high-pressure water and air systems of the Conjet Robot 363 need devices to control, lockout, and release the system pressures in the event of an emergency. The Conjet Robot 363 technology does not create any additional need for shutdown procedures once all sources of potential energy are controlled.</p>	
<p>E. Decontamination/Decommissioning</p>	
<p>Decontamination of the Conjet Robot 363 technology would require sampling to determine the extent to which contamination has spread throughout the water supply. The use of a one-way valve would help reduce the likelihood of system component contamination. Given the spread of projectiles and over spray from water jetting, the entire robot and its onboard components would be contaminated if operated in such an environment. Decontamination of the Conjet Robot 363 would require extensive efforts depending upon the type of contamination.</p>	

Section 7: Worker Protection Measures

A. Exposure Monitoring

Personnel need periodic monitoring for noise exposure. Assure that proper hearing protection is in use, as needed. Air sampling is advised when is used to remove concrete with a coating or subsurface that contains or has the potential to contain a contaminant. The spray mist near the area of Conjet Robot 363 operation is dry rather than wet. The intense pressure of the water jet combined with warm ambient conditions, dry the spray mist. It appears the mist is wet at times but at higher pressures, the mist dries rapidly. This mist has the potential to carry contaminants; therefore, personal and area air sampling is advised to assure operator protection.

B. Worker Training

Personnel require training on high-pressure water operation techniques. Operators require specific training on the Conjet Robot 363 operation and the forces generated by the water jet. Training on the Conjet Robot 363 process should include proper PPE usage, lockout/tagout, hazard communication, hearing conservation, and hazard assessment.

C. Medical Surveillance

A general health screening with emphasis on the back and cardiovascular/respiratory system is warranted. Depending on the contaminant present in the surface or substrate, airborne levels, and the need for respiratory protection/PPE, medical surveillance may be required by OSHA standards. A hearing conservation program needs to be in place. In addition, annual audiograms may be warranted depending upon typical daily working conditions.

D. Engineering Controls

- The robot needs unique visual and audible alarms to warn of impending high-pressure water activation and robot movement
- A keyed lock or electronic entry code on the robot control panel for use during lockout/tagout procedures is needed.
- The arm holding the cradle for the control box is short. Increasing its length will decrease the likelihood of the operator backing over himself during robot movement.
- An arm on the rear of the robot or such device is needed to better manage the hose and cables from the rear of the robot.
- Attaching wheeled dollies to grouped hose and cables would reduce hose and cable wear and reduce ergonomic stresses involved in their movement.
- The robot arm does not have a mechanical locking device to prevent arm components from movement by gravity. Installation of such a device would prevent possible crush and impact injuries.
- Reduction in the sound pressure levels emanating from the high-pressure water pump would reduce noise levels.

E. Administrative Controls

- Consider instituting a policy of remote operation of the robot, at a safe distance, during and disallowing with the control panel in the cradle is advised to better protect operators.
- The robot arm does not have a mechanical locking device to prevent arm components from movement by gravity. When possible, standard operating procedures should include rotating the arm to place the trough containing the water jet on the floor. Personnel should not be permitted under the arm and trough to prevent possible crush and impact injuries.
- Due to high noise levels, when in close proximity to the pump and robot, hearing protection is required. Placement of the pump, robot operation, and the operator's location is of importance. Separating the three by a distance greater than sixty feet, when used in an open location, may not require the operator at the workstation to wear hearing protection. Noise sampling needs to be conducted at each worksite to confirm this, and the distance may vary depending upon site conditions.

F. Personal Protective Equipment

PPE is required for Conjet Robot 363 operation, which consists of earplugs and earmuffs. Depending on noise levels, face shield, steel-toed boots, hardhat, leather gloves, rain suit, and respirator, are needed depending on presence of airborne contaminants.

Section 8: Emergency Preparedness

The Conjet Robot 363 does not create any additional need for emergency preparedness.

Section 9: Comments, Lessons Learned, & Special Considerations

None

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