CONF-9510108--24

DOE/MC/30165-96/C0578

Remote Operated Vehicle with Carbon Dioxide Blasting (ROVCO$_2$)

Authors:

Andrew M. Resnick

Contractor:

Oceaneering International, Inc.
501 Price George's Boulevard
Marlboro, Maryland 20774

Contract Number:

DE-AC21-93MC30165

Conference Title:

Environmental Technology Development Through Industry Partnership

Conference Location:

Morgantown, West Virginia

Conference Dates:

October 3-5, 1995

Conference Sponsor:

U.S. Department of Energy, Office of Environmental Management,
Morgantown Energy Technology Center

DISCLAIMER

3.6 Remote Operated Vehicle with Carbon Dioxide Blasting ($ROVCO_2$)

Andrew M. Resnick (resnick@adtech1.oceaneering.com; 301-249-3300)
Oceaneering International, Inc.
501 Prince George's Blvd.
Upper Marlboro, MD 20774

The Remote Operated Vehicle with Carbon Dioxide Blasting ($ROVCO_2$), as shown in a front view in Figure 1, is a six-wheeled remote land vehicle used to decontaminate concrete floors. The remote vehicle has a high pressure Cryogenesis blasting subsystem, Oceaneering Technologies (OTECH) developed a CO_2 xY Orthogonal Translational End Effector (COYOTEE) subsystem, and a vacuum/filtration and containment subsystem. Figure 2 shows a block diagram with the various subsystems labeled.

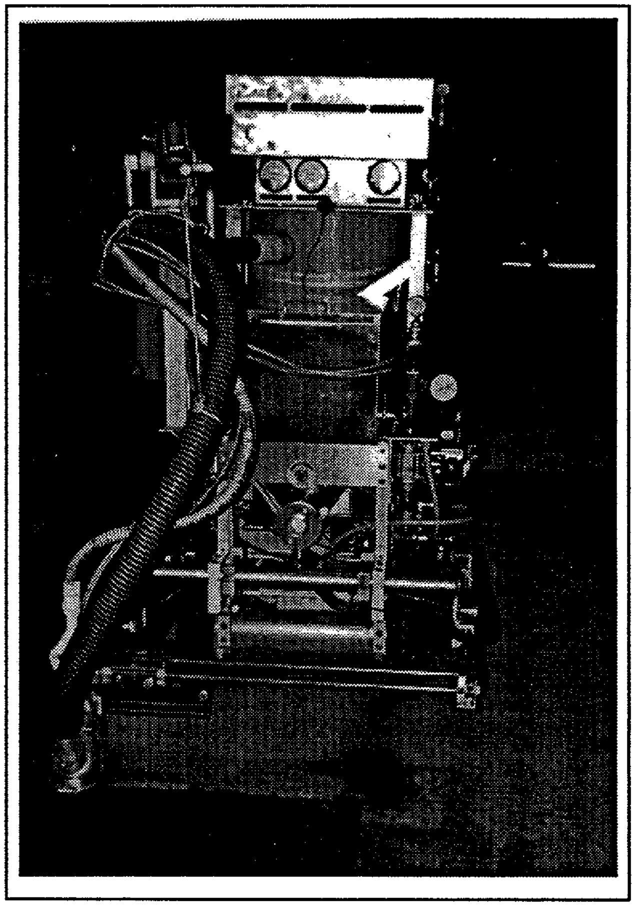

Figure 1: $ROVCO_2$ remote vehicle (front view)

The cryogenesis subsystem performs the actual decontamination work and consists of the dry ice supply unit, the blasting nozzle, the remotely controlled electric and pneumatic valves, and the vacuum work-head. The COYOTEE subsystem positions the blasting work-head within a planar work space and the vacuum subsystem provides filtration and containment of the debris generated by the CO_2 blasting. It employs a High Efficiency Particulate Air (HEPA) filtration unit to separate contaminants for disposal. All of the above systems are attached to the vehicle subsystem via the support structure.

Research sponsored by the U.S. Dept. of Energy's Morgantown Energy Technology Center under Contract DE-AC21-93MC30165 with Oceaneering International, Inc., 501 Prince George's Blvd., Marlboro, MD 20774; (301) 249-3300; telefax: (301) 249-4022.

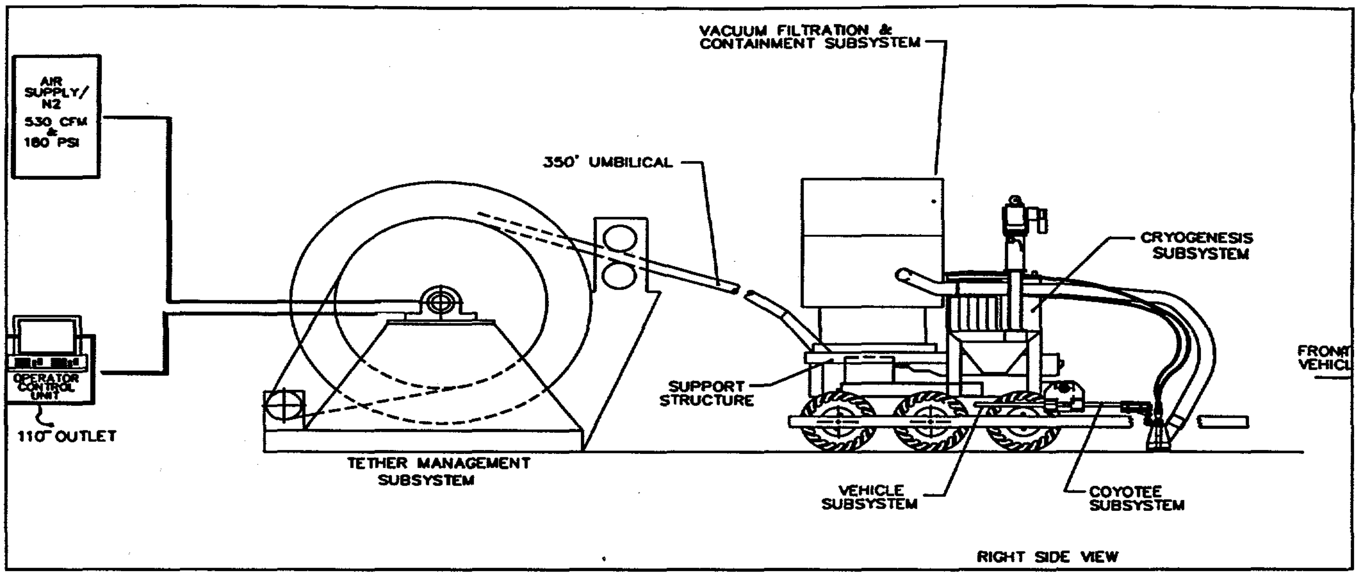

Figure 2: ROVCO_2 block diagram showing subsystems

The vehicle subsystem is a six-wheeled, remote controlled vehicle which provides the transport and power required by all of the vehicle-mounted subsystems and equipment. Two camera/light assemblies, one black and white fixed-position camera and one color camera mounted on a pan and tilt unit, provide viewing for navigation, obstacle avoidance, and operations. The vehicle was procured from a commercial vendor.

Separate from the vehicle are the tether management subsystem and the operator control unit. The tether management system provides an electric winch to manage the vehicle's 300 foot umbilical. The umbilical provides command, data, and power transfer between the vehicle and the control subsystem. Additionally, it provides a delivery system for the compressed gas that is used in the blasting system. The operator control unit provides a single operator, integrated controls, automated repetitive functions, video display, and equipment status feedback.

ROVCO_2 was developed under a Department of Energy (DOE) program at the Morgantown Energy Technology Center in response to a need at the Oak Ridge K-25 site, and other sites, for concrete floor decontamination. The objectives of the ROVCO_2 program were as follows:

- reduction in waste volume,
- faster decontamination of floors,
- improved decontamination effectiveness,
- reduced decontamination costs, and
- reduction in worker exposure to contaminants.

Reduction in Waste Volume

Previous methods of decontaminating included scabbling, shot peen blasting, and chemicals. However, each of these methods had different problems associated with them, especially in waste volume and handling. Scabbling tended to remove a large amount of concrete, shot peen did like wise and created secondary waste, while chemicals, when used in a radioactive environment, created mixed wastes.

$ROVCO_2$ reduced waste volume by using dry ice (drice) pellets as the blasting medium. When the high pressure drice contacts the floor, it subliminates. The impact of the pellet lifts the contaminated material particles off the floor, up into the work-head. These particles are then vacuumed into the collection system and into a drum. The gases pass through a HEPA filter and exhaust. The vacuum system is the Pentek VACPAK, which has been accepted for nuclear use both at DOE sites and power plants. The blasting produces waste material of very fine particles, and no secondary waste material. The small particles compact well into the drum, which can contain eight to twelve hours worth of waste material. The drum can be changed using a maskless procedure, approved at nuclear power plants and it is designed for over packing into 55 gallon drums.

Faster Decontamination

$ROVCO_2$ is intended to operate in an automated blasting mode, requiring only human supervision, providing faster decontamination. This mode of operation allows for higher blasting pressures and more consistent operation, thus speeding cleaning. In addition, because the operator has a supervisory role, they can operate multiple units from a single control area. In all, the system eliminates the need for workers to suit up, reducing worker fatigue.

Improved Decontamination Effectiveness

In addition to reduced waste and faster decontamination, $ROVCO_2$ also provides improved decontamination effectiveness. The nozzle has been designed using Computational Fluid Dynamics (as is used for NASA rocket nozzle design) to produce a maximum pellet velocity of 1100 feet per second. In addition, the containment system engineered to entrain nozzle blast and minimize recontamination of surface. Also, by utilizing the automated features of the vehicle and end effector subsystems, $ROVCO_2$ provides automated, complete blasting coverage of surfaces. This method of decontamination avoids unnecessary overlap or bypassed areas.

Reduced Cost

Another benefit of the $ROVCO_2$ system is its reduced decontamination costs. This reduction is achieved in combination with many of the other benefits. By providing faster decontamination, less overall time is spent on a given area as compared to other methods. Additionally, by minimizing waste production and volume, fewer changeouts are needed, thus increasing the amount of time the unit is operational within the overall time. The automated features of the system allow

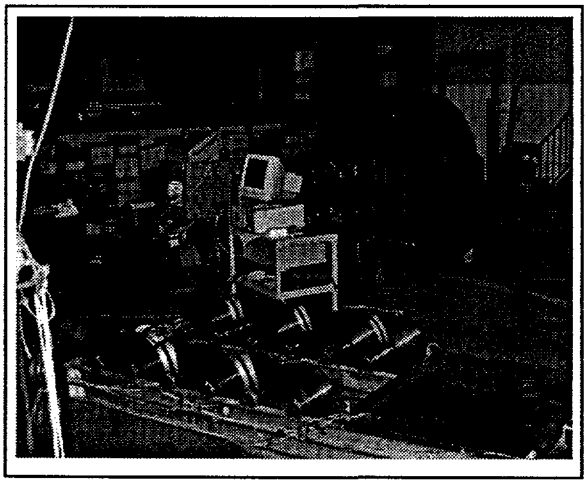

Figure 3: $ROVCO_2$ reliability test stand with Tether Management System winch and Operator Control Unit in the background

large areas to be decontaminated with confidence, minimizing inspection requirements to ensure that the decontamination has been achieved. Finally, the ROVCO_2 system has been designed for high reliability and tested (see Figure 3) to ensure it meets its reliability requirements.

Worker Exposure

Finally. as stated earlier, ROVCO_2 provides reduction in worker exposure. This reduction is accomplished mainly by allowing for blasting via remote control from up to 100 meters away. Only two operations require human intervention for operation: drum changeout and pellet hopper filling; both of these can be accomplished in low radiation areas by driving the vehicle away from any hot areas. Drum changeout is required once every shift, and hopper filling is required four to six times per shift, however, future fillings can be accomplished by providing a solenoid on the hopper to allow remote filling and thus reducing human intervention even further. Also, the demonstrated high system reliability minimizes worker maintenance exposure. A preventive maintenance schedule will be developed that requires maintenance intervention only when the vehicle is in uncontaminated areas.

Status

At the present time, ROVCO_2 is completing its cold testing at Oceaneering in Upper Marlboro, Maryland and is schedule for final system acceptance in October, 1995. Oceaneering is working with DOE to establish an appropriate hot site for initial ROVCO_2 operations. Current choices are the K-29 building at the Oak Ridge K-25 site and the Plutonium Finishing Plant at Hanford.