D&D TECHNOLOGY

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The ANL-E D&D Program is an integrated effort focused on addressing all technical facets of the D&D problem. The extensive operations and project execution experience of the ANL-E D&D staff, coupled with the Laboratory's strong foundation in research and development, provides a uniquely integrated approach to identifying and overcoming the issues arising from a burgeoning D&D marketplace. Through its comprehensive field experience, Argonne has developed unique insight and understanding into the critical role technology plays in project execution and in overcoming barriers to success encountered by using new and innovative techniques for solving D&D problems.

The Technology portion of the ANL-E D&D Program comprises four major areas:

- **Identification** - Knowledge of and experience with the technologies and methodologies currently available for performing D&D is crucial to having a clear understanding of how best to perform D&D activities. This knowledge base is integral to determining the applications and limitations of current technologies, as well as effectively allocating limited research and development funding. By its proven abilities in information management and distribution through multiple mechanisms, Argonne serves as a conduit through which this information flows.

- **Development** - If, through the identification process, there are needs that cannot be met with existing technologies or there are suitable technologies that could be used with certain modifications and improvements, Argonne's extensive capabilities in scientific and technological problem solving can be brought to bear on the problem.

- **Demonstration** - The tightly regulated and monitored environment in which the nuclear industry operates presents unique challenges for the utilization of innovative or improved technologies. To be used in this highly regimented environment, it is critical that new and innovative technologies are processed through a robust, independent, and industry accepted and recognized demonstration process. Argonne has a proven record in this area as manifested by its participation in the CP-5 Large Scale Demonstration Project.

- **Deployment** - In order to ensure that the most effective technologies are utilized by the D&D user community, a vigorous technology information-sharing system is critical. A thorough understanding of the limitations of D&D technologies in the marketplace is a crucial aspect of the deployment issue. Argonne's experience in the entire spectrum of technology deployment is invaluable to ensure that innovative technologies are deployed in the most effective manner.

CP-5 LARGE SCALE DEMONSTRATION PROJECT

In 1996, ANL-E teamed with 3M, Duke Engineering & Services, ICF Kaiser, Commonwealth Edison and Florida International University to form the Strategic Alliance for Environmental Restoration.* Under the sponsorship of the U.S. Department of Energy, the mission of the Strategic Alliance is to select innovative, "field test ready" D&D technologies, demonstrate those technologies in a large-scale demonstration environment and compare the results against existing commercial technologies with the intent of showing that significant benefits can be achieved through the utilization of enhanced D&D technologies or verifying that existing technology practices are the most cost effective.

The D&D needs of the DOE Complex were evaluated, and the problem areas appropriate to demonstration at CP-5 were grouped into four areas:

- Characterization
- Decontamination
- Robotics/Dismantlement
- Worker Health and Safety

*Connect to **http//www.strategic-alliance.org** for more information on the Strategic Alliance for Environmental Restoration

TECHNOLOGIES/VENDORS LISTING

Twenty-three technologies were demonstrated at the CP-5 Reactor and the JANUS Reactor as part of the DOE EM-50 funded Large Scale Demonstration Project; a complete listing with vendor acknowledgments is provided below. Accompanying pages provide brief descriptions and photographs of some of the technologies.

CHARACTERIZATION

Field-Transportable Beta Counter-Spectrometer, developed by Argonne National Laboratory and Triangle Research Ltd.

GammaCam™ Radiation Imaging System, developed by AIL Systems, Inc.

In-Situ Object Characterization System (ISOCS), supplied by Canberra Industries, Inc.

Mobile Automated Characterization System (MACS), developed by Oak Ridge National Laboratory and the Savannah River Technology Center for the U.S. Department of Energy's Robotics Technology Development Program.

Pipe Crawler Radiological Surveying System, developed by Radiological Services, Inc.

Pipe Explorer System™, developed by Science & Engineering Associates, Inc.

Portable X-Ray Fluorescence Detector, supplied by TN Spectrace.

Surface Contamination Monitor and Survey Information Management System, supplied by SRA, Inc.

DECONTAMINATION

Advanced Recyclable Media System (ARMS™), provided by Surface Technology Systems, Inc.

Centrifugal Shot Blast, provided by Concrete Cleaning, Inc.

Empore™ Membrane Separation Cartridge, developed and provided by 3M.

MOOSE® Remotely Operated Scabbler, supplied by Pentek, Inc.

Pegasus Coating Removal System (PCRS), developed by Pegasus International, Inc.

Rotary Peening with Captive Shot, provided by 3M Company and EDCO

Roto-Peen Scaler, supplied by Pentek, Inc.

Starboldt™ Flashlamp System, supplied by Polygon Industry.

ROBOTICS/DISMANTLEMENT

Dual Arm Work Platform, provided by a consortium of national laboratories and industry manufacturers. Individual components and subassemblies were purchased from or provided by Schilling Robotics Systems, Redzone Robotics, Inc., Oak Ridge National Laboratory, the Idaho National Environmental and Engineering Laboratory and Sandia National Laboratories.

Remote Controlled Concrete Demolition System, manufactured by Holmhed Systems AB of Sweden and supplied by Duane Equipment Corp.

Rosie Mobile Robot Work System, supplied by RedZone Robotics, Inc.

Swing-Reduced Control and Remote Crane Operation Upgrades, supplied by Convolve, Inc. Installation and upgrades were funded by DOE's Robotics Technology Development Program.

WORKER HEALTH AND SAFETY

FRHAM-TEX Anti Contamination Suit, supplied by FRHAM Safety Products.

NuFab Anti Contamination Suit, supplied by the G/O Corporation.

Characterization - Mobile Automated Characterized System (MACS)

The Mobile Automated Characterization System (MACS) was developed by Oak Ridge National Laboratory and the Savannah River Technology Center for the U.S. Department of Energy's Robotics Technology Program. It is a commercially available, battery-powered, autonomous robot base supplemented by a laser positioning system and a scintillation detector array. MACS can detect alpha and beta contamination and moves over floors at a speed of one inch per second.

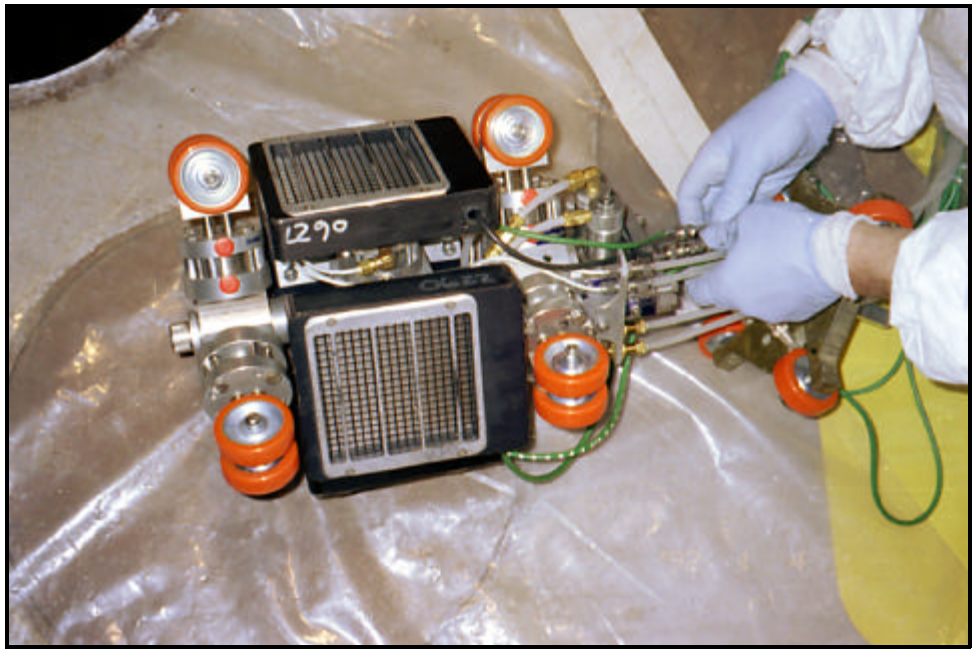
MACS was tested on a concrete area of the service floor of the CP-5 Research Reactor, where portions of the floor contained fixed contamination. Here, two ANL-E Health Physics technicians are performing a survey just prior to the unit being transferred offsite.

Characterization - Mobile Automated Characterization System (MACS)

Vendors and test engineer overseeing
MACS perform a floor survey

MACS performing a floor survey,
with support equipment in the background

Characterization - Pipe Crawler Radiological Surveying System



The Pipe Crawler was developed by Radiological Services, Inc., for use as part of a turn-key pipe inspection, decontamination and survey service. The technology consists of a wheeled robot, or mule, on which is mounted an array of thin Geiger-Müller detectors. The crawler is manually transported through pipes using flexible fiberglass rods.

Pipe Crawler was tested at the CP-5 Research Reactor in December 1996. Surveys were conducted by the test engineer and vendors in the rod storage holes and in portions of the 12-inch vent lines servicing the reactor area. Here the Pipe Crawler is being prepared for insertion. Prior to the survey, but without the benefit of any pipe pre- decontamination, a recorded video inspection was made.

Characterization - Pipe Crawler Radiological Surveying System

Vendors and test engineer
inserting Pipe Crawler for demonstration

Pipe Crawler inserted into rod storage hole

Characterization - Pipe Explorer System™

The Pipe Explorer System™ was developed by Science & Engineering Associates, Inc. (SEA) as a method for transporting characterization tools into pipes and ducts. The system uses a pneumatically operated tubular membrane to tow radiation detectors and video cameras into pipes. The plastic membrane provides a clean conduit through which the senors travel.

The Pipe Explorer™ technology was demonstrated at the CP-5 Research Reactor. Here vendors are preparing the Pipe Explorer™ membrane prior to characterizing buried pipes at the CP-5 facility.

Characterization - Pipe Explorer System™

The Pipe Explorer™ performed alpha surveys of the internal area of three 5-inch pipe-lined holes in the CP-5 rod storage area. These pipes are embedded in the structure of the building. This picture shows the piping insertion hookup.

The demonstration involved the first field use of the system's alpha detection capability. Also, a video inspection and a beta-gamma survey of a 3-inch drain line in the CP-5 yard area were completed. The Pipe Explorer™ System had been demonstrated previously at other sites using beta-gamma detectors and video cameras.

Decontamination - Advanced Recyclable Media System (ARMS™)

The Advanced Recyclable Media System (ARMS™), provided by Surface Technology Systems, Inc., is an open blast technology which uses a soft recyclable medium consisting of a urethane foam matrix. ARMS™ is divided into three units: the media feed unit, the sifter unit, and the media remake unit. The media is propelled from the feed unit toward the surface to be cleaned by a portable blast unit. The used media is then manually collected and placed into the sifter unit. Large debris (>1/4 inch) and small fines (<1/16 inch) are discarded as waste; the remaining media can be used for media remake or can be fed back into the feed unit for recycling.

Decontamination - Advanced Recyclable Media System (ARMS^{TM})

The ARMS™ technology was tested on its ability to decontaminate approximately 260 square feet of concrete flooring on the service floor of the CP-5 Research Reactor. The demonstration required a crew of three people.

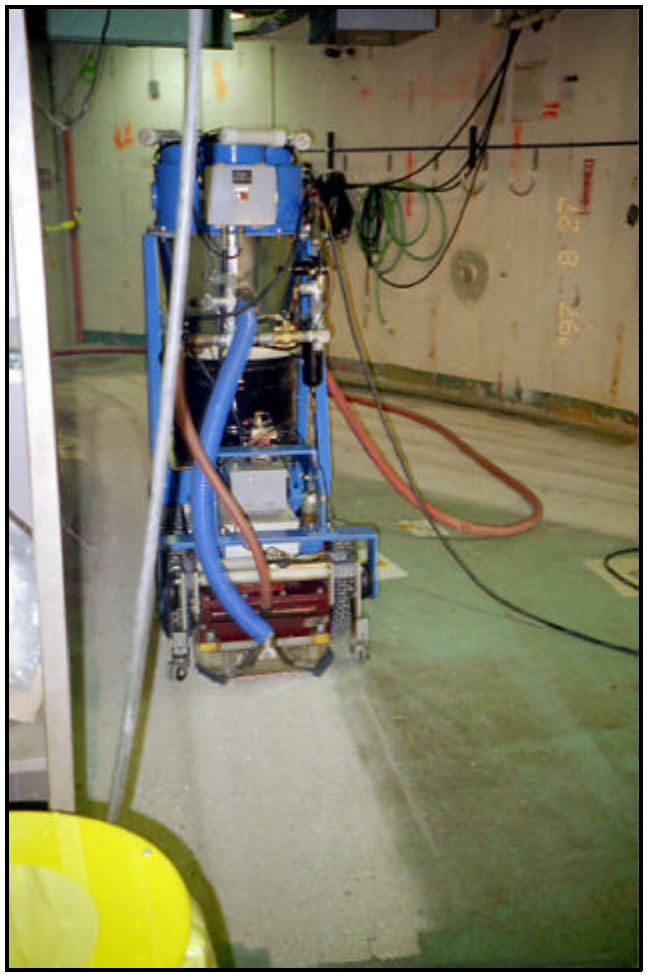
Here a worker is setting up the ARMS™ media delivery unit prior to its demonstration.

Decontamination - MOOSE®

MOOSE®, Pentek, Inc.'s remotely operated scabbling technology, is designed to scarify large concrete floors and slabs. The MOOSE® scabbler comprises three integral sub-systems: the scabbling head assembly, the onboard HEPA vacuum system, and the six-wheeled chassis. Here workers are replacing the 23-gallon drum where dust and debris are captured by the two-stage positive filtration HEPA vacuum system.

The technology's ability to decontaminate approximately 620 square feet of concrete flooring by removing concrete up to a 1/4-inch depth was tested at the CP-5 Research Reactor.

Decontamination - MOOSE®



During its demonstration at the CP-5 Research Reactor, MOOSE® was operated remotely via a 50-foot power and control tether. The operator and control panel were located outside the demonstration area, where the operator could work without the need for personal protective equipment.

MOOSE® is very maneuverable and easy to operate. It is capable of scabbling within 6 inches from walls. Independent skid steering allows the MOOSE® to pirouette 360 degrees about its geometric center.

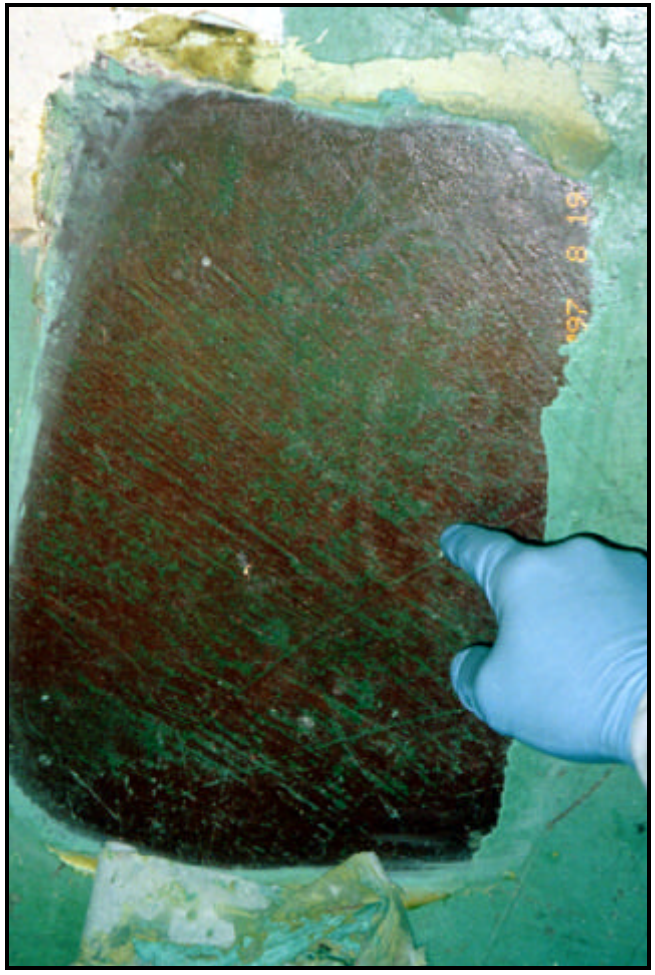
Decontamination - Pegasus Coating Removal System

The Pegasus Coating Removal System (PCRS) is a chemical-based coating removal system developed by Pegasus International, Inc. The PCRS is applied using either long- or short-handled spreaders, trowels, rollers or a spray applicator. The material is left on the surface for a predetermined period of time and allowed to interact with the coating. After the specified dwell time, the PCRS and floor coating are then removed using scrapers and/or large plastic shovels.

The demonstration tested Pegasus' ability to decontaminate approximately 500 square feet of concrete flooring at the CP-5 Research Reactor. Here a worker and the test engineer are receiving a final briefing prior to the test.

Decontamination - Pegasus Coating Removal System

A worker applying Pegasus coating



Condition of floor after removal
of chemicals

Decontamination - Roto Peen

Roto Peen technology, provided by 3M Company, uses heavy-duty Roto Peen flaps to remove concrete and coatings from concrete floors. The flaps are mounted on an EDCO model CPM-4 floor unit and outfitted with a Pb Sentry from West Environmental which will shut off electrical power to the concrete planer should the detected vacuum drop below a safe threshold.

Captive tungsten carbide shot, supported on flexible flaps, is rotated against the contaminated surface, mechanically fracturing coatings. The particles removed are simultaneously collected in a drum by a vacuum system (VAC-PAC® provided by Pentek, Inc.) fitted with a HEPA filter.

Here, workers and an engineer are receiving a final briefing and checkout on the Roto Peen technology from the vendor.

Decontamination - Roto Peen

Roto Peen's ability to decontaminate concrete floors by removing the enamel coating was tested in March 1997 on an area of approximately 500 square feet at the CP-5 Research Reactor. With one operator, the technology removed a uniform layer of concrete and coating at a rate of approximately 71 square feet per person-hour. The depth of removal was about one sixteenth of an inch. Approximately 2.1 cubic feet (120 pounds) of waste in the form of powdery concrete and paint chips was generated. Due to the captive shot, only what was removed from the floor is what entered the waste stream.

Here a final checkout of the HEPA system and decontamination unit is made prior to performing the demonstration.

Decontamination - Starboldt™ Flashlamp

The Starboldt™ flashlamp system, developed by Polygon Industry, is a self-contained proprietary system for coatings removal and decontamination that uses xenon flashlamps to remove surface coatings from substrates. The system operates by pulsing an electric current at a rate of 4 to 7 Hertz to a xenon flash lamp. The emitted light is concentrated with a reflector housing and projected onto the surface coating. The coating absorbs the light energy, decomposes into a fine ash and is removed from the surface with a debris scrubber and vacuum filter system attached to the head.

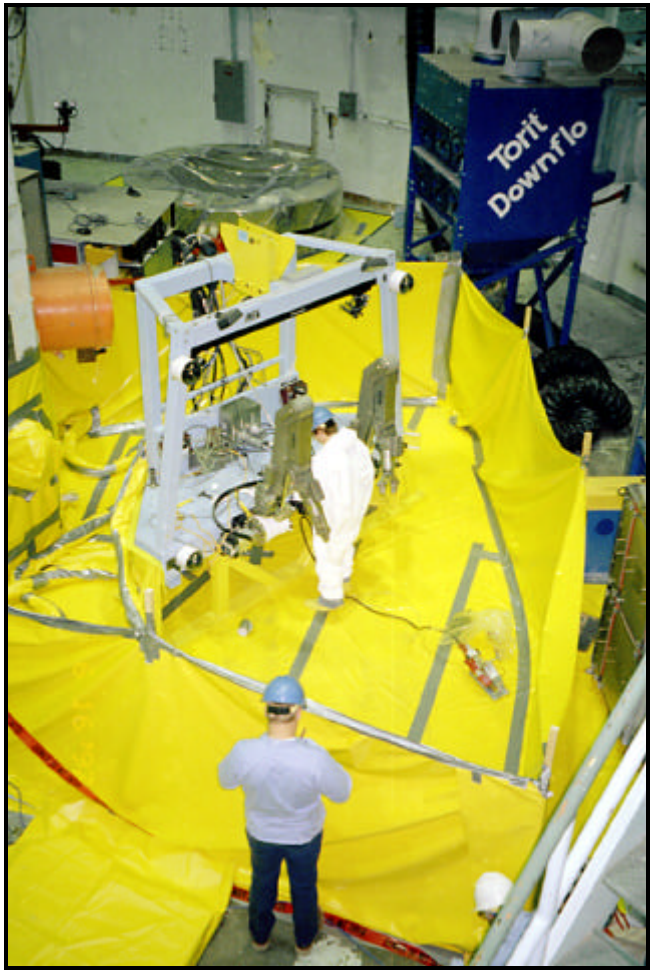
Here the vendor and test engineer are performing final checks on the Starboldt™ flashlamp system prior to its demonstration at the CP-5 Research Reactor.

Decontamination - Starboldt™ Flashlamp

The Polygon Industry's Starboldt™ flashlamp technology demonstration was conducted in May 1997 on the service floor of the CP-5 Research Reactor. The technology was tested on its ability to decontaminate approximately 600 square feet of concrete flooring by removing the coating layer without removing the concrete.

Here a worker is performing the decontamination demonstration.

Robotics/Dismantlement - Dual Arm Work Platform (DAWP)

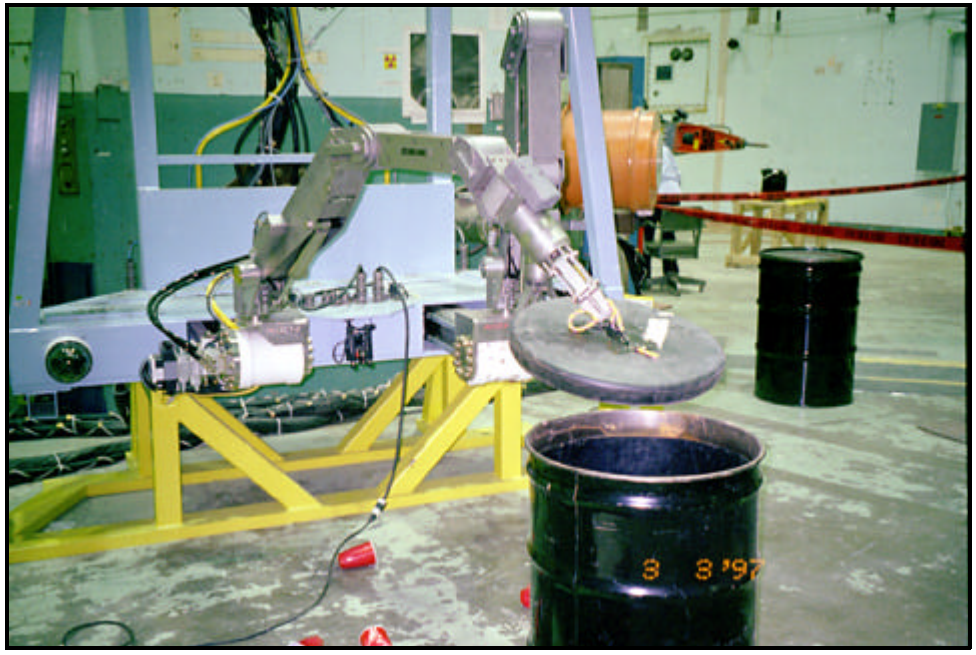


The DAWP was tested at the CP-5 Research Reactor from June through September 1997. Its ability to remotely cut and dismantle the aluminum reactor tank; disassemble the boral, steel and aluminum subassemblies; and transfer these materials to a staging area was demonstrated.

The DAWP was controlled by two operators working in an adjacent control room. In this way, personnel could maintain a safe distance from the radiation. By using this remote system, significant radiation exposure to workers was avoided.

Here a worker is performing maintenance on the DAWP.

Robotics/Dismantlement - Dual Arm Work Platform (DAWP)



The DAWP is designed to be suspended from a crane for remote positioning. The platform houses various electrical and hydraulic systems needed to operate the two Schilling manipulator arms and provides support for the tooling and end effectors. The current system can be operated by someone approximately 250 feet away without direct line-of-sight.

The DAWP's ability to remotely handle many tasks was demonstrated at the CP-5 Research Reactor. Here the DAWP, equipped with the Schilling manipulator arm, is putting a lid on a radioactive waste drum. The DAWP will be deployed to complete the disassembly of the CP-5 reactor complex.

Robotics/Dismantlement - Remote Controlled Concrete Demolition System

The Brokk BM 150, manufactured by Holmhed Systems AB of Sweden and supplied by Duane Equipment Corp., uses a remotely operated, articulated hydraulic boom with various tool head attachments to perform work. It can be operated by someone 400 feet away or in a different room using a TV monitor.

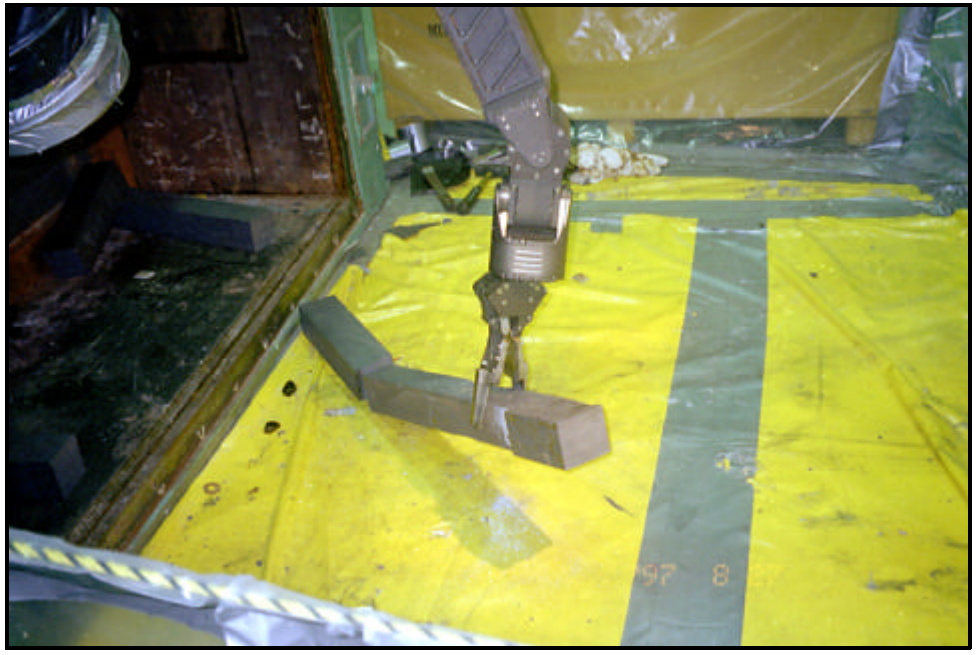
The Brokk was demonstrated at the JANUS Reactor Facility in August and September 1997. Outside the facility, the JANUS D&D crew was given a brief overview of the unit just after it arrived. Once inside the facility, the Brokk was outfitted with a hydraulic hammer. It dismantled the reinforced concrete biological shield walls and reactor pedestal. The hammer was replaced by an excavating bucket, and the Brokk loaded the rubble into shipping containers.

Robotics/Dismantlement - Remote Controlled Concrete Demolition System

Working in a containment tent, the
Brokk BM 150 breaking up reinforced concrete
in the JANUS biological shield.

Operator controlled the Brokk from
outside of the tent.

Robotics/Dismantlement - Rosie Mobile Robot Work System for D&D (Rosie)



Rosie was tested at the CP-5 Research Reactor from June through September 1997. Its ability to remotely remove graphite with the Predator arm, move radioactive materials from the reactor assembly to a staging area using a specially designed steel transfer can, and position video cameras in strategic locations to support reactor dismantlement efforts was demonstrated.

As with the DAWP, Rosie was typically controlled by an operator working in an adjacent control room, thus avoiding a significant amount of personnel exposure.

With the Predator arm fitted with modified gripper paddles, Rosie was used to remove highly activated graphite blocks.

Robotics/Dismantlement - Rosie Mobile Robot Work System for D&D (Rosie)

Rosie includes a tethered robot, a power distribution unit (PDU) and a control console for robot operation. The mobile base (locomotor) supports a telescoping boom (heavy manipulator). The locomotor is a hydraulically powered base with onboard tether management, and it provides a mobile platform for the system. The heavy manipulator was used to support a single manipulator arm or a large demolition hammer and/or lift a payload up to 2000 pounds throughout its approximate 25 foot range of motion.

Rosie was outfitted with a Predator manipulator arm built by Kraft TeleRobotics, Inc., as shown in this picture The arm, attached to a mounting plate bolted onto the end of the heavy manipulator, is capable of lifting 200 pounds.

Robotics/Dismantlement - Swing-Reduced Control and Remote Crane Operation Upgrades

DOE's Robotics Technology Development Program (RTDP) funded the installation of a swing-reducing crane control system (Swing-Free Crane) and other upgrades to the polar crane at the CP-5 Research Reactor. No-Sway™ crane control, supplied by Convolve, Inc., is a digital control system that adjusts the bridge and trolley motion of the crane to limit the induced sway in the load. The system uses AC vector motors and drives in place of the original bridge and trolley AC motors.

The crane is operated remotely, as shown here. The operator is on a catwalk located over the CP-5 reactor structure.

Robotics/Dismantlement - Swing-Reduced Control and Remote Crane Operation Upgrades

The Swing-Free Crane was tested at the CP-5 Research Reactor from October 1996 through February 1997. Personnel measured the reduction in swing as it was used during critical lifts and during placement of the Dual Arm Work Platform (DAWP).

As shown here, a vendor is inspecting the rotating hook attachment.