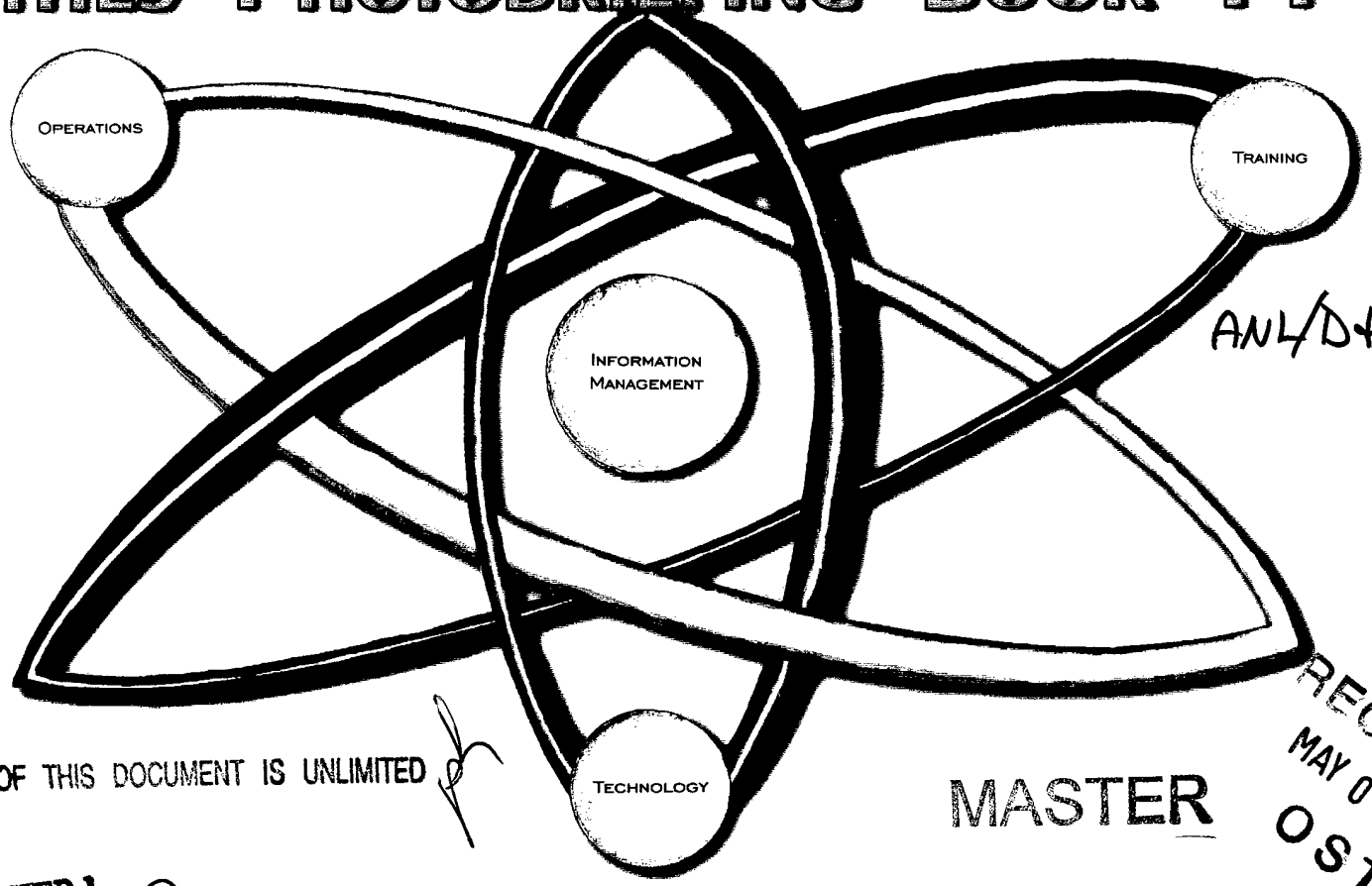
42

DECONTAMINATION & DECOMMISSIONING ACTIVITIES PHOTOBRIEFING BOOK FY 1997



ANL/D&D--98-1

ARGONNE NATIONAL LABORATORY - EAST
TECHNOLOGY DEVELOPMENT DIVISION
DECONTAMINATION & DECOMMISSIONING PROGRAM

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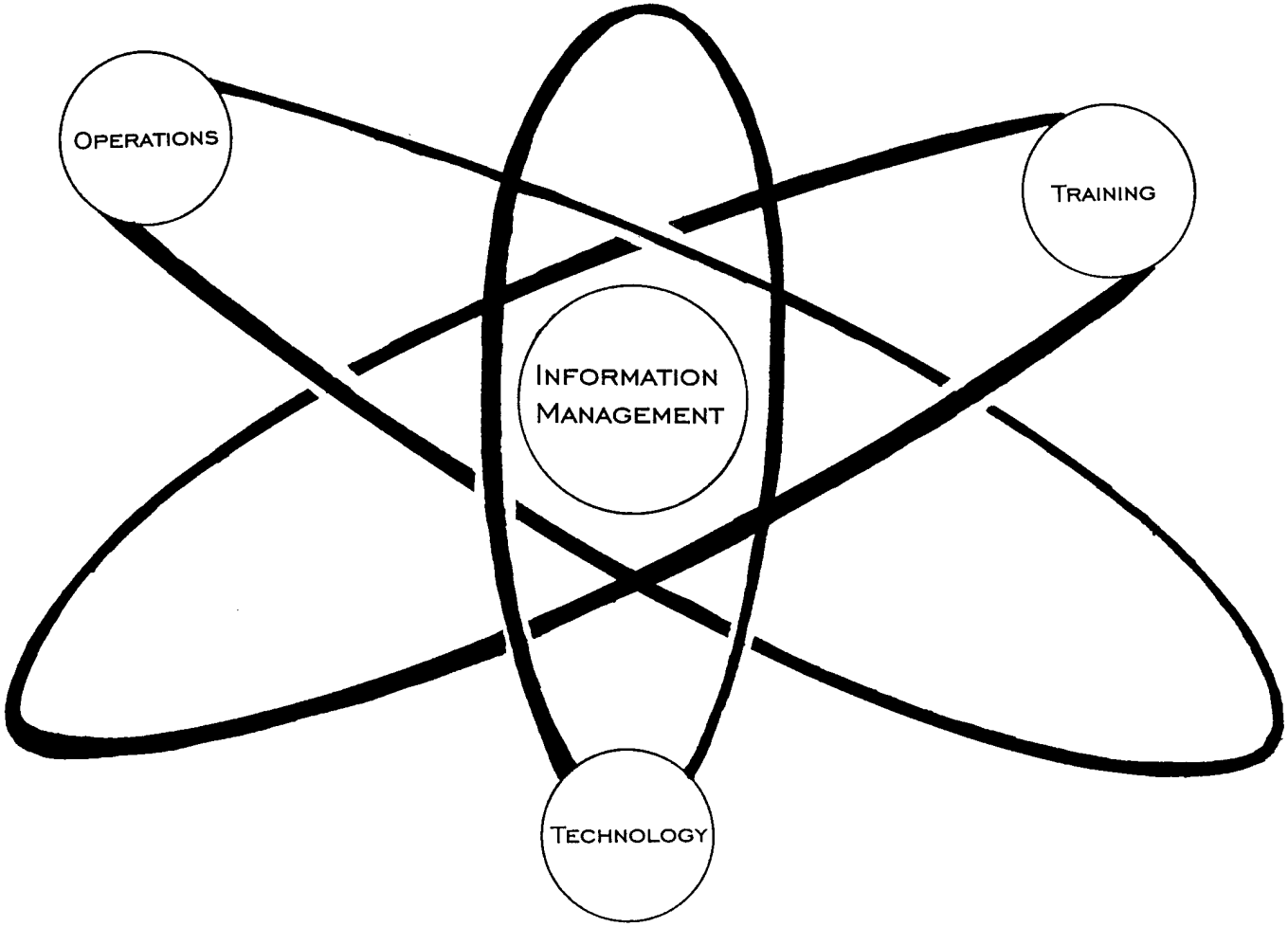

Argonne National Laboratory - East
Technology Development Division
Decontamination & Decommissioning Program

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ANL/D&D/98-1

FISCAL YEAR 1997
DECONTAMINATION AND DECOMMISSIONING
ACTIVITIES PHOTOBRIEFING BOOK

FOR THE

ARGONNE NATIONAL LABORATORY-EAST
TECHNOLOGY DEVELOPMENT DIVISION
DECONTAMINATION AND DECOMMISSIONING PROGRAM

Work supported by the Office of Environmental Management, U.S. Department of Energy, under Contract W-31-109-Eng-38.

Argonne National Laboratory

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Disclaimer

Report Cover

The report cover was designed by Anja M. Wagner, D&D Program, Technology Development Division, Argonne National Laboratory. Information management is the nucleus of the ANL-E D&D Program, with each activity (Operations, Technology, and Education and Training) playing an integral role. Successful planning, execution and closeout of D&D projects produces lessons learned. Identification of D&D technology needs leads to innovative solutions through development, demonstration and deployment. Project experiences and technology recommendations are shared with the national and international D&D community through training courses and information exchanges. The ANL-E D&D Program is uniquely positioned to manage D&D information and to serve as a conduit through which this information can flow.

Report Availability

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge TN 37831; prices available from (423) 576-8401. Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield VA 22161.

FOREWORD

The Decontamination and Decommissioning (D&D) Program at Argonne National Laboratory-East (ANL-E) is dedicated to the safe and cost-effective D&D of surplus nuclear facilities. This mission includes all phases of D&D, from initial issue identification to conceptual design, detailed planning and budgeting, project execution, and project closeout and facility release. To complete the cycle, technological improvements and lessons learned are fed back to benefit future projects.

There is currently a backlog of more than 7000 contaminated U.S. Department of Energy facilities nationwide. Added to this are 110 licensed commercial nuclear power reactors operated by utilities learning to cope with deregulation and an aging infrastructure that supports the commercial nuclear power industry, as well as medical and other uses of radioactive materials. With this volume, it becomes easy to understand the importance of addressing, in a more integrated manner, the unique issues and objectives associated with the D&D of surplus nuclear facilities.

Argonne National Laboratory, a pioneer in the development of nuclear energy applications, is uniquely qualified to become a leader in charting the course for final disposition of the country's surplus nuclear facilities. By integrating the major aspects of the D&D problem into one seamless organization, the Laboratory is well positioned to provide the necessary leadership to a growing, and as yet relatively unfocused, D&D marketplace.

Robert W. Rose
Manager, D&D Operations and
Argonne Lead for the CP-5
Large Scale Demonstration Project

Introduction

INTRODUCTION

This photobriefing book summarizes the Decontamination and Decommissioning (D&D) projects and activities either completed or continuing at the Argonne National Laboratory-East (ANL-E) site during Fiscal Year (FY) 1997.

The ANL-E D&D Program

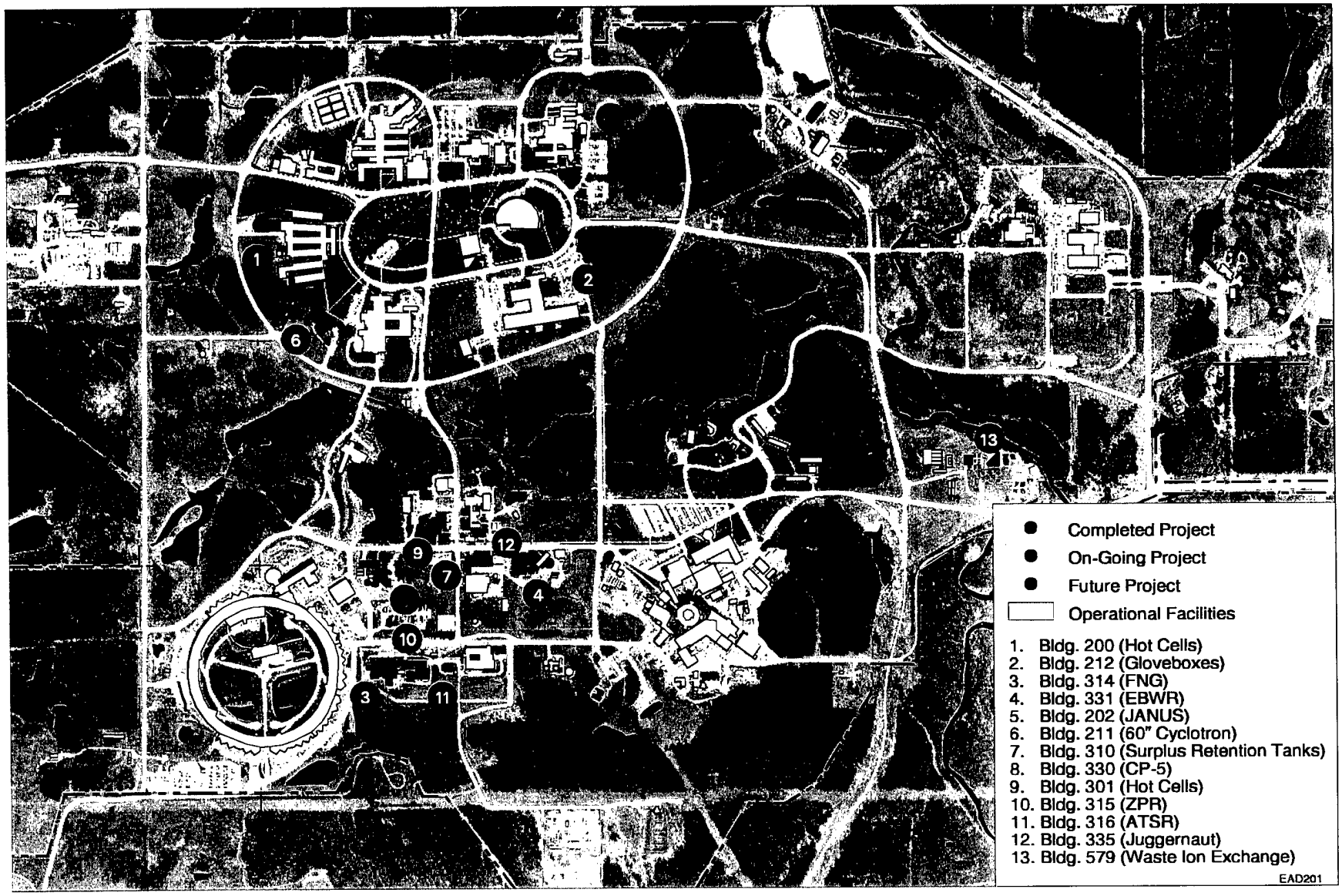
Three major components comprise the ANL-E D&D Program: operations, technology, and information exchanges. Funded by the U.S. Department of Energy (DOE) Office of Environmental Management (EM), the ANL-E D&D Program supports the missions of both DOE and ANL-E. As a highly visible component of the Technology Development Division, the ANL-E D&D Program shares in a rich history. Argonne National Laboratory has been associated with the development of every nuclear reactor type since the beginning of the nuclear age. Reactor D&D represents the final stage in reactor development and utilization.

The goals of the ANL-E D&D Program are to:

- conduct D&D operations safely, efficiently and economically, leading to a reuse of facilities where possible
- test and validate methods and technologies for the D&D of nuclear facilities
- incorporate lessons learned into D&D operations being conducted at the ANL-E site and within the DOE complex
- transfer knowledge gained on technologies and lessons learned to the commercial and international D&D communities
- provide technical expertise in national and international D&D activities through training and technical information exchanges

These goals are achieved through development of a broad knowledge base that contributes to the unique capabilities of the staff in the ANL-E D&D Program and through contacts and alliances with universities, integrating contractors, corporations, utilities, and international organizations.

D&D Operations



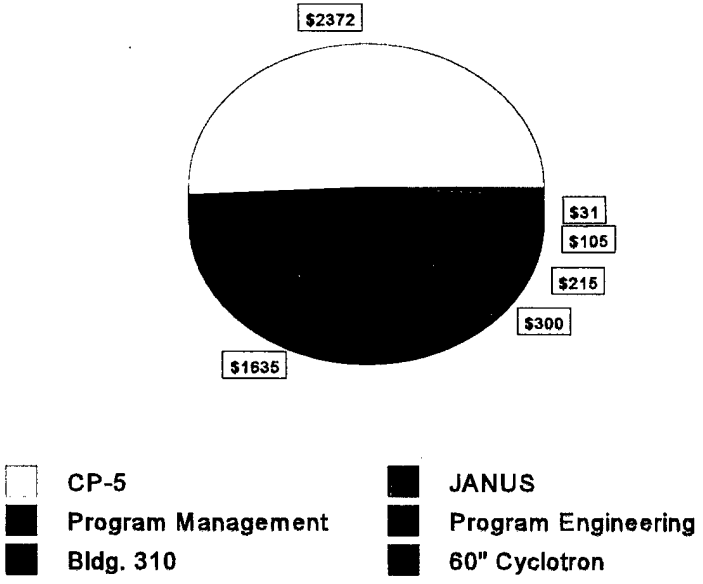
Status of D&D Projects at the Argonne National Laboratory-East Site (as of September 30, 1997)

FY 1997 Project Highlights

FY 1997 Project Status

- FY 1997 project funding totaled $4658K
- Physical D&D work at the JANUS Reactor facility was completed
- Physical D&D work at the CP-5 Research Reactor facility continued
- D&D planning and documentation for the Bldg. 310 Retention Tank D&D Project was completed
- Characterization Plan was prepared for the 60" Cyclotron facility
- Program Engineering/Oversight and Program Management activities were conducted

FY 1997 Project Funding
(in $K)



FY 1993 - 1997 Project Status and Funding

D&D Projects Completed

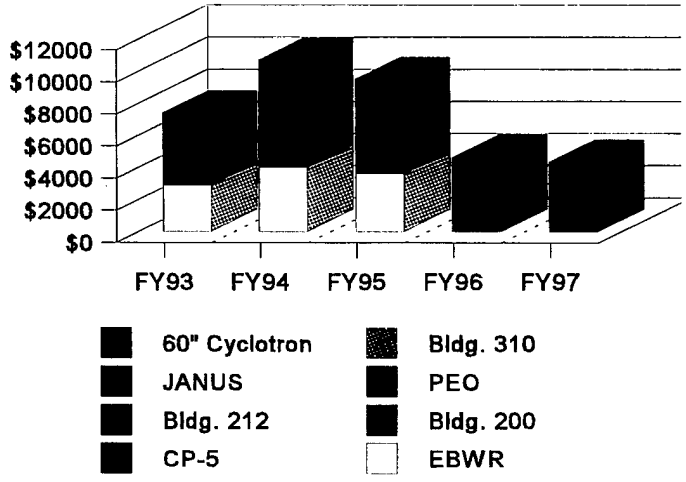
1996:

- Experimental Boiling Water Reactor (Bldg. 331)
- M-Wing Hot Cell Facilities (Bldg. 200)
- Plutonium Gloveboxes (61 gloveboxes in Bldg. 212)
- Fast Neutron Generator (Bldg. 314)

1997:

- JANUS Reactor (Bldg. 202)

Funding by Fiscal Year
(in $K)



Future D&D Projects at the ANL-E Site

Several ANL-E facilities, surplus to the mission of the Laboratory, will require future D&D. Planning and documentation for the Bldg. 310 Surplus Retention Tanks was completed in FY 1997. Planning and documentation for the remaining projects will be completed in future years. If funding is received at the levels proposed in Department of Energy Office of Environmental Management document *Accelerating Cleanup Paths to Closure** (formerly *Draft 2006 Plan*), the ANL-E D&D Program would be completed at the end of FY 2002.

- 60" Cyclotron (Bldg. 211) - Used for basic research, this facility met widely diversified operational requirements, producing beams of deuterons, helium ions, singly charged hydrogen molecules and neutrons of a broad energy spectrum.

- Hot Cells (Bldg. 301) - The hot cell area, the first cells constructed at ANL-E, contains eight caves that were used to perform a variety of radiological research activities.

- Surplus Retention Tanks (Bldg. 310) - These tanks were placed into service more than 30 years ago and used for interim storage of radioactive liquids when the processing and holding tanks at an adjacent facility were full.

- Zero Power Reactors 6&9 (Bldg. 315) and the Argonne Thermal Source Reactor (Bldg. 316) - These facilities were used for reactor physics research and instrumentation studies.

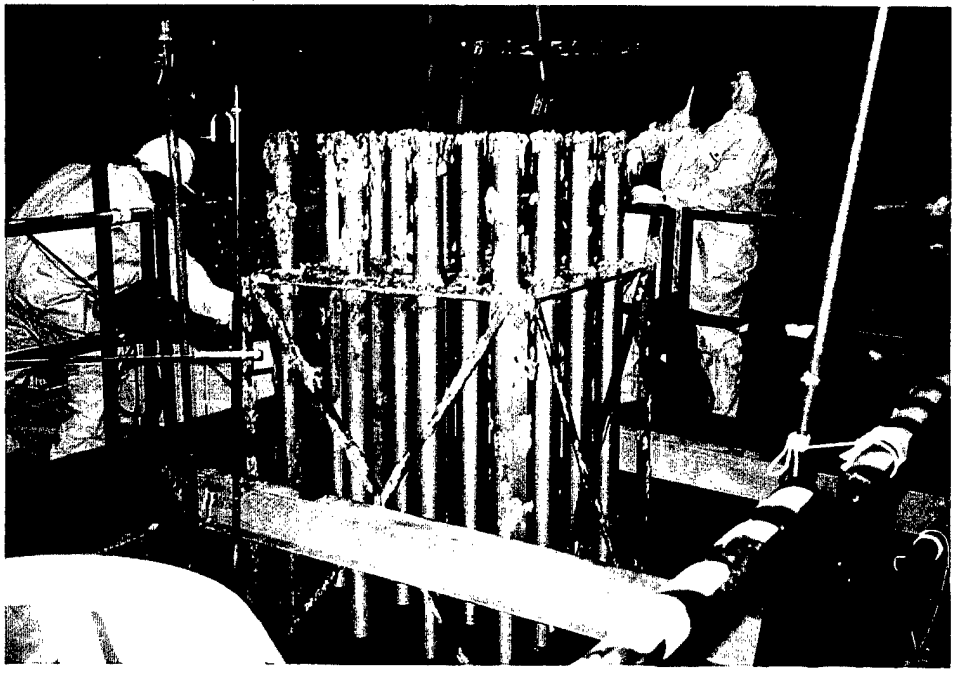
- Juggernaut Reactor (Bldg. 335) - A light-water moderated and cooled, graphite-reflected research reactor designed to conduct basic research.

- Waste Ion-Exchange Facility (Bldg. 579) - This facility was utilized to process waste from Laboratory tanks.

*Full document can be found at **http://www.em.doe.gov/closure**.

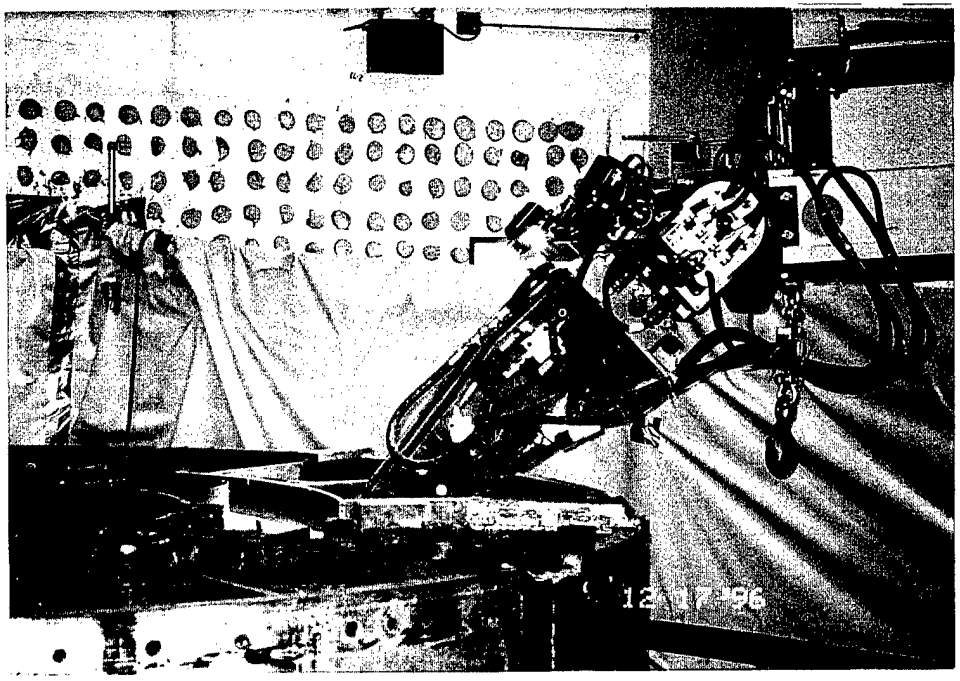
CP-5 Research Reactor D&D Project

CP-5 Research Reactor D&D - December 1996



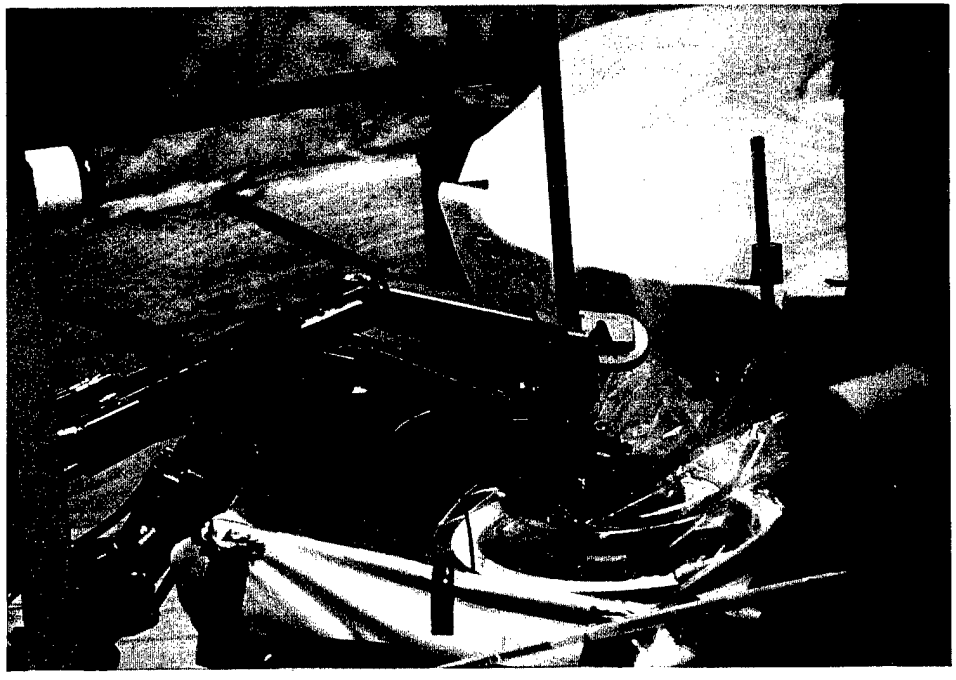
Sitting on the bottom of the CP-5 spent fuel pool were two "anti-criticality" racks that had been used to support the spent fuel after it was removed from the reactor core. The racks and tubes were made of aluminum, and each tube had a cadmium strip inside. The cadmium acted as a neutron absorber, preventing an accidental criticality of the fuel assemblies while they were in the pool. Using the facility's overhead crane, the racks were removed and transferred to a High Efficiency Particulate Air (HEPA) filtered containment tent. The cadmium strips were segregated from the aluminum tubes, and each material was packaged in separate waste containers by personnel from ANL-E Waste Management Operations and Health Physics.

CP-5 Research Reactor D&D - December 1996



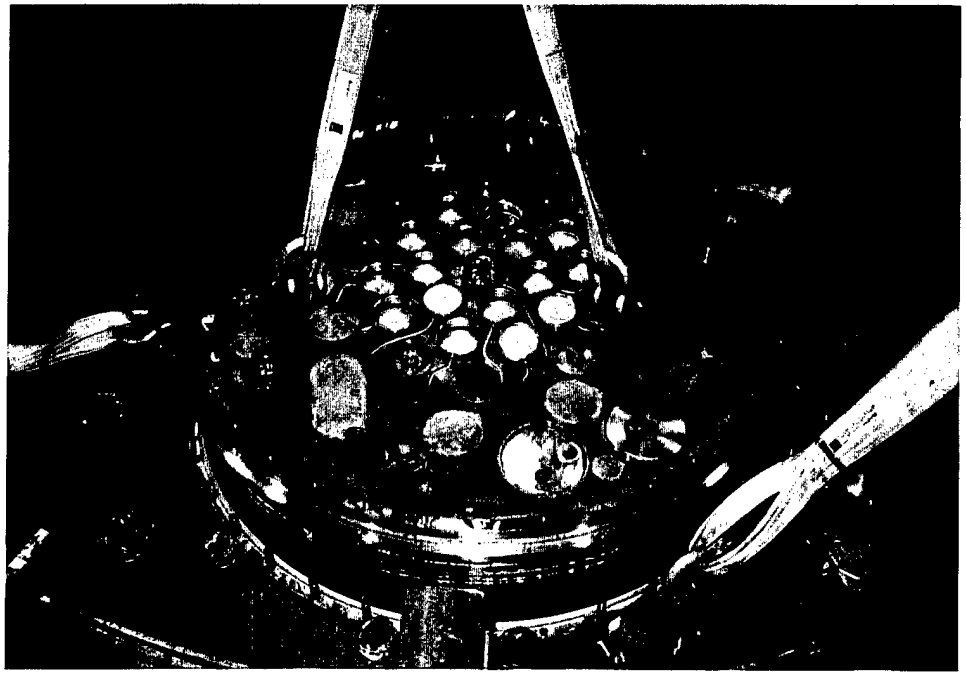
Rosie, from RedZone Robotics, Inc., was brought to CP-5 as part of the DOE EM-50 Large Scale Demonstration Project. Its teleoperated, remotely controlled long reach lifting and positioning capabilities make it useful for many tasks. Rosie has a mounting plate at the end of its boom assembly that allows a variety of components and tools to be attached. Multiple utility ports adjacent to the mounting plate include 120V AC power, 3000 psi hydraulics and audio/video ports. Using a large, modified demolition jackhammer, Rosie removed concrete from a radioactive shield that had been taken from the top of the reactor. The plug, which weighed 43,000 pounds, had to be cut in half before it could be removed from the reactor room and disposed.

CP-5 Research Reactor D&D - March 1997



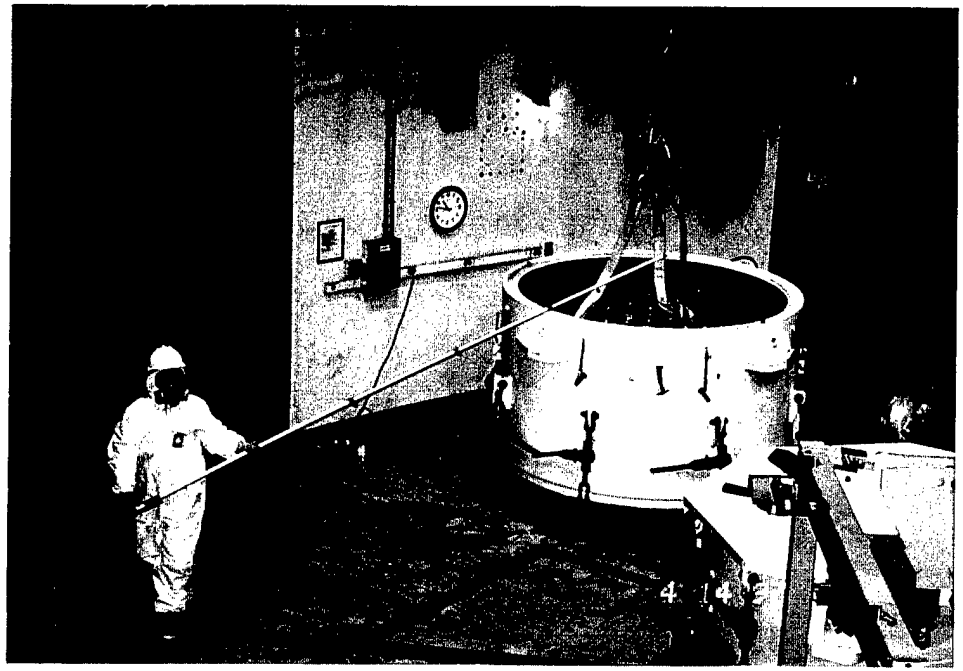
As part of the CP-5 reactor disassembly, 28 vertical thimbles used to hold samples and experimental packages irradiated in the reactor were removed. One vertical thimble (VT-21) was used to hold a control rod for the reactor and was the most radioactive thimble removed. The Dual Arm Work Platform (DAWP) was used for size reduction of VT-21 and packaging it into a drum. The DAWP is a counter-weighted steel platform equipped with two Schilling manipulator arms operated remotely from a control room. The arms are capable of holding and lifting items weighing up to 240 pounds. In order to size reduce VT-21, one arm was used to stabilize the upper part of the thimble assembly over a shielded drum and the other arm was used to cut the thimble into pieces using a portable bandsaw.

CP-5 Research Reactor D&D - March 1997



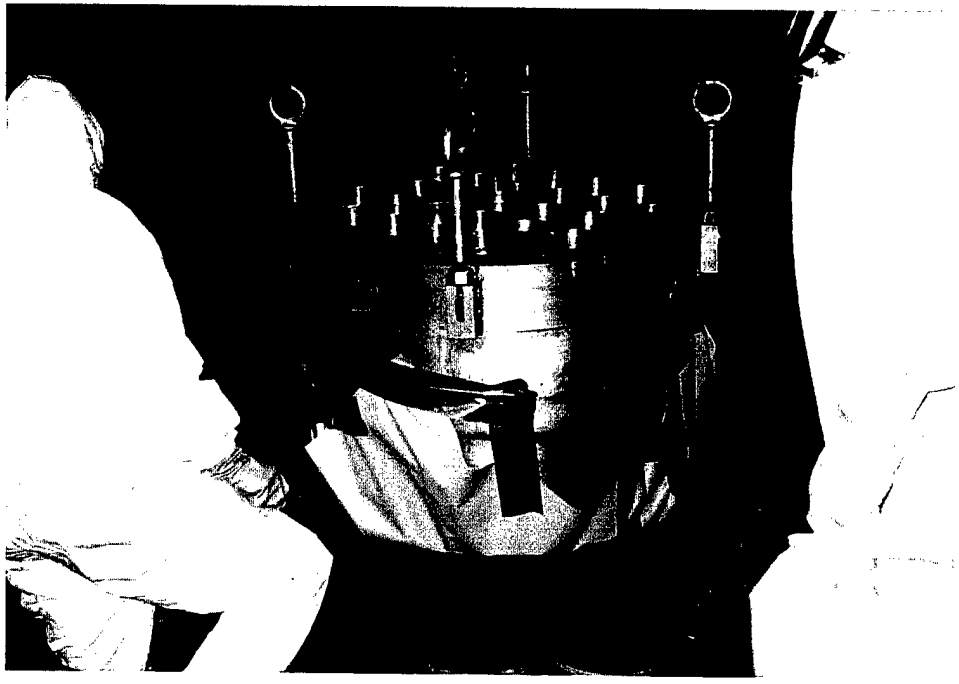
The CP-5 reactor had seven large, heavy shielding subassemblies installed as part of its upper structure. One of these subassemblies, the lower center shield plug, was constructed of stainless steel, high-density concrete and lead. The penetrations for the vertical thimbles provided access to the reactor internals. A remotely controlled, 20-ton polar crane was used to raise the 18,000 pound radioactive plug from the reactor and transfer it into a NuPac 7-100 cask for temporary storage. This was one of three "critical" lifts performed in 1997.

CP-5 Research Reactor D&D - March 1997



A radiation survey of the lower center shield plug was performed by an ANL-E Health Physics technician immediately after it was transferred into a NuPac 7-100 cask. This is one of four NuPac 7-100 casks at the CP-5 facility. Two are certified Type A containers and will be used to transport low-level radioactive waste (LLRW) to the Hanford Disposal Site. The other two casks are "strong-tight" containers used for temporary, on-site storage of LLRW removed from the CP-5 reactor and bioshield.

CP-5 Research Reactor D&D - March 1997

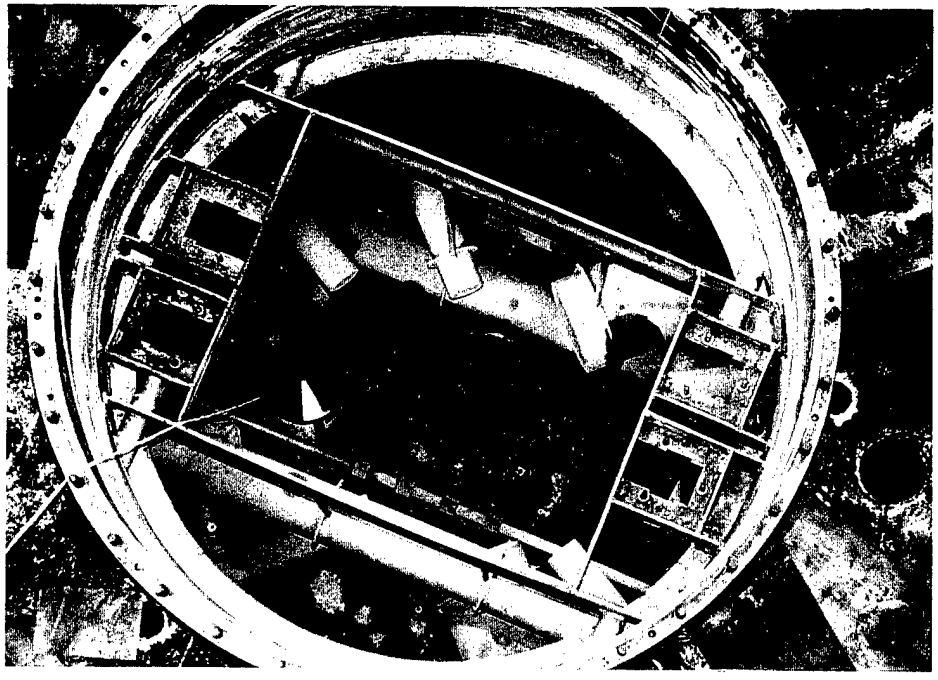


The upper center shield plug was the third of seven shield plugs removed from the CP-5 reactor structure. This plug, made of carbon steel, weighed approximately 6000 pounds. Before removing this assembly, obstructions such as other shielding assemblies, tubing and miscellaneous protuberances were manually cut or unbolted from the surrounding components. An ANL-E Waste Management Operations D&D crew member and the CP-5 Field Engineer were on hand as the center shield plug was removed from the inside of the upper outer shield plug assembly.

CP-5 Research Reactor D&D - March 1997

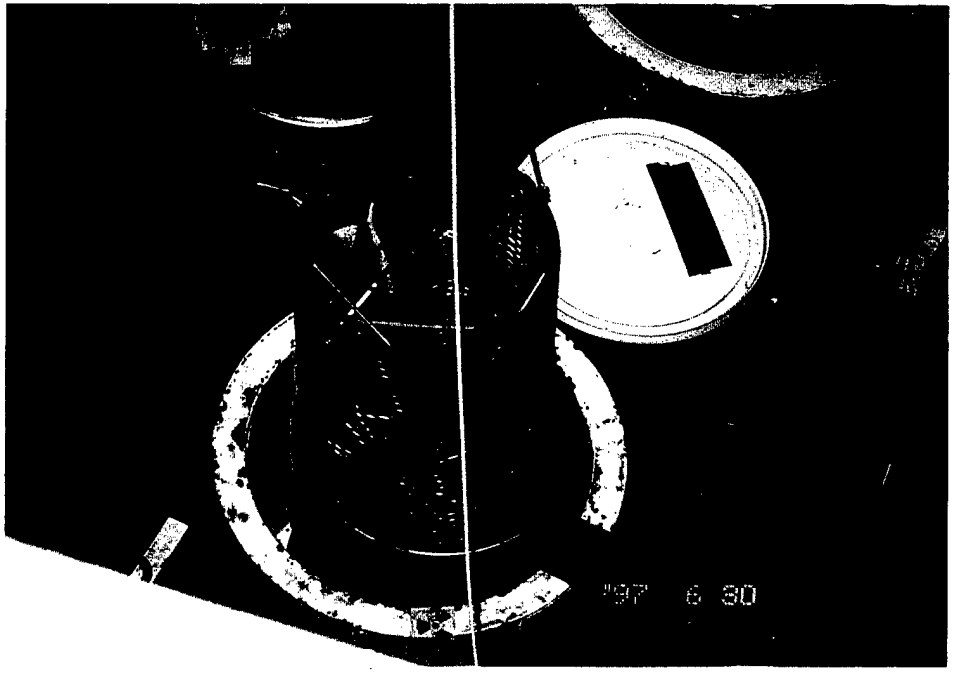
The remotely controlled polar crane and the two robots, Rosie and the DAWP, were set up to allow for operations at a safe distance from the radiation and industrial hazards associated with the dismantlement of the CP-5 reactor assembly. The old reactor control room was partially redesigned to provide a low exposure, remote location for the operators of these sophisticated pieces of equipment. The control room houses the control panels, computers, electronic systems, video displays and power supplies for the robotics systems, and the controller and gauges for the modified shell-ventilation system. Robotics operators received extensive training to become qualified on Rosie and the DAWP. The DAWP operator relies on ten available cameras to provide the views necessary to remotely size reduce radioactive material.

CP-5 Research Reactor D&D - June 1997



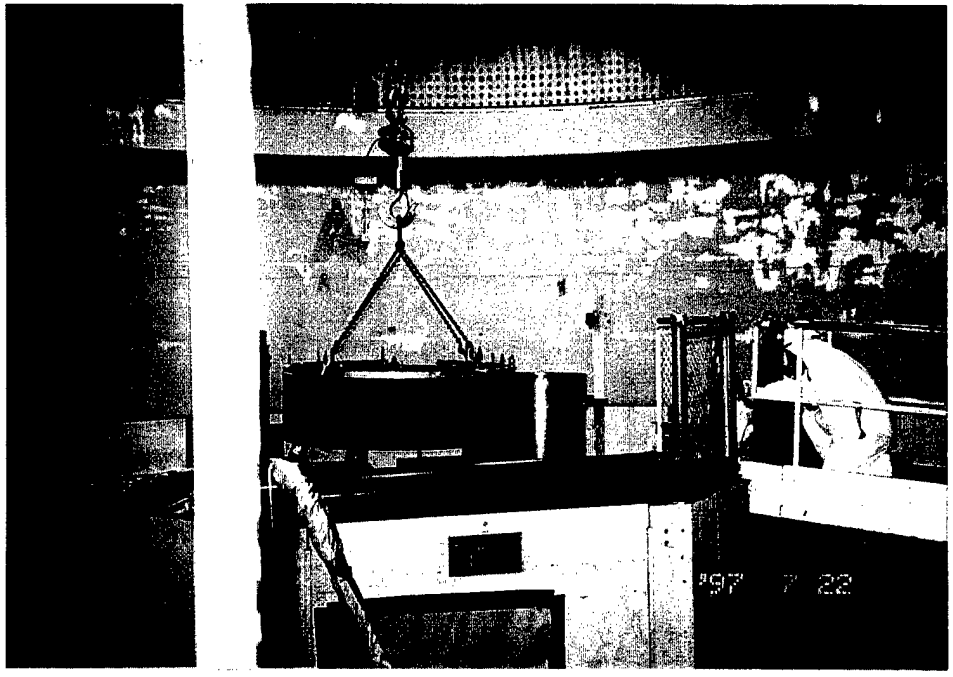
After the seven shield plugs were removed from the top of the CP-5 reactor, the inside of the vessel and top of the graphite area could be seen. The vessel - centered inside of the graphite tank - is comprised of several components, including the grid plate assembly that held the control rods, the horizontal beam tubes and the fuel-rod cooling-water plenum at the bottom of the vessel. This photo of the outer part of the graphite tank shows the vertical irradiation openings and seal plate above the graphite.

CP-5 Research Reactor D&D - June 1997



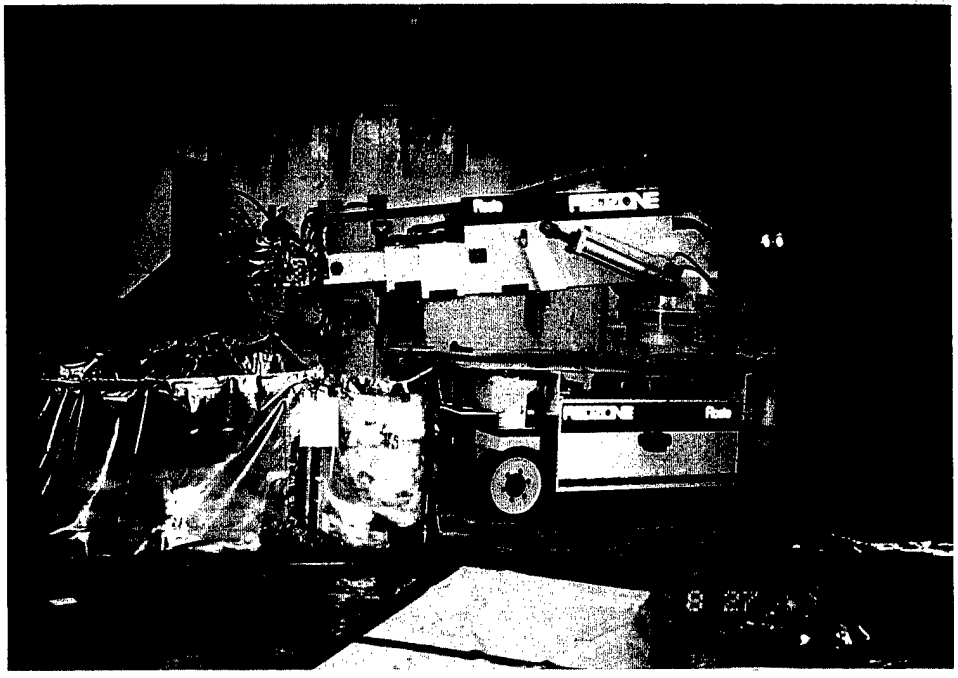
During the removal of the weight plugs from the bottom of the E-wing spent fuel pool, many unexpected items were discovered. Among these were radioactive, experimental packages made of different metals, wire cables, cutoff remnants of old experiments, nuts, bolts, a very fine layer of silt approximately 5 inches thick and other pieces of radioactive debris. The silt was removed using a filtration system. The materials were size reduced and collected in a wire mesh basket using a pneumatically operated cutter and a retrieval tool and long-reach poles. The disposable mesh baskets containing the materials were loaded into shielded 55-gallon drums.

CP-5 Research Reactor D&D - July 1997



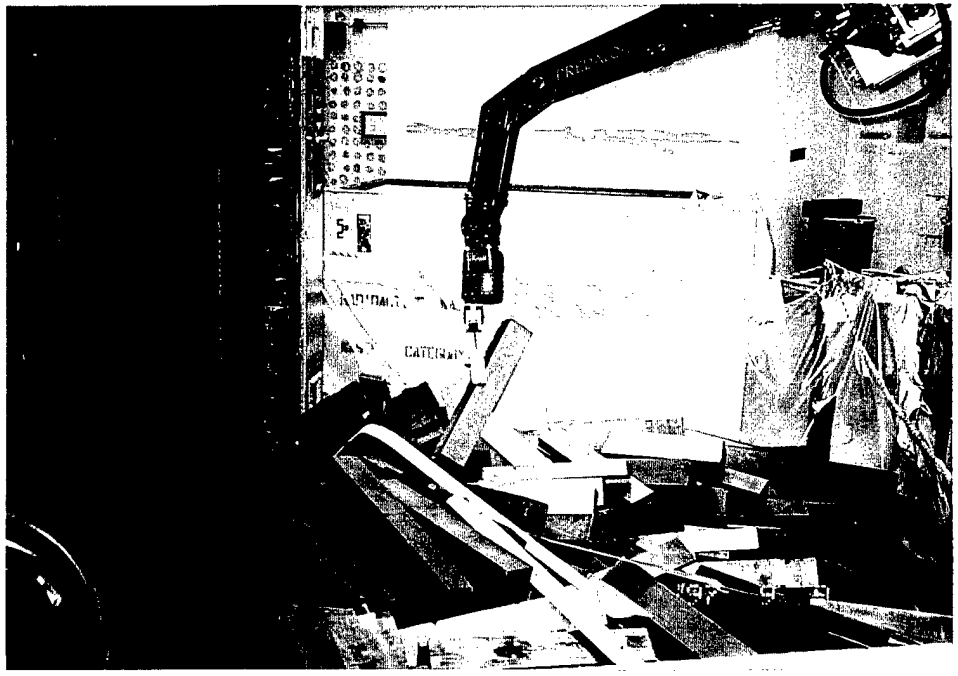
D&D activities present unique and sometimes difficult challenges. Original facility and design drawings used to identify assemblies, materials and obstructions that may be encountered during D&D activities do not always portray an accurate picture. What was shown on the drawings to be a cast-iron ring made from eighteen lap-jointed segments bolted with four bolts per segment, was actually a ring constructed of twelve 1/4-inch-thick, overlapping carbon-steel, 120° segments spot welded together to form a single ring assembly. The ring lifted from the reactor assembly was 2 inches thick, 6 feet in diameter and weighed 2000 pounds.

CP-5 Research Reactor D&D - September 1997



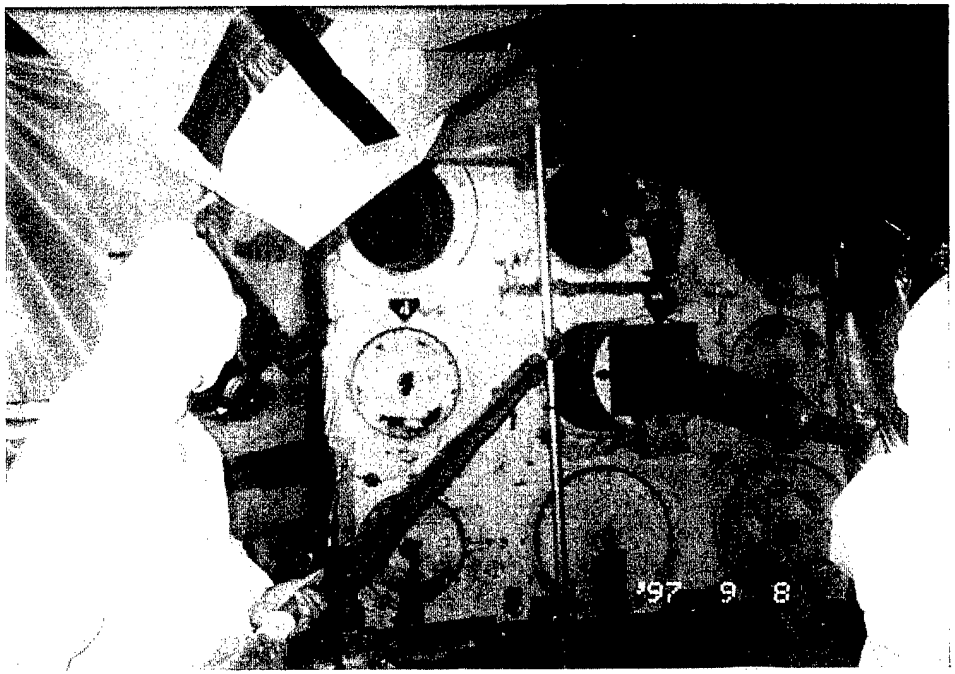
Rosie, fitted with a Kraft TeleRobotics, Inc. Predator manipulator arm, was able to remotely lift and position radioactive materials and tooling to perform tasks in highly radioactive environments. Rosie and the Predator arm were used to remove graphite blocks weighing between 20 and 80 pounds from the west thermal column of the CP-5 reactor bioshield assembly. The dose rate to personnel working in the area would have been up to 2 Rem per hour.

CP-5 Research Reactor D&D - September 1997



The Predator arm was used to remove graphite from the CP-5 west thermal column. Approximately eighty 4 inch x 4 inch graphite blocks of varying lengths were removed and packaged into a radioactive waste bin (the yellow bin seen in the background).

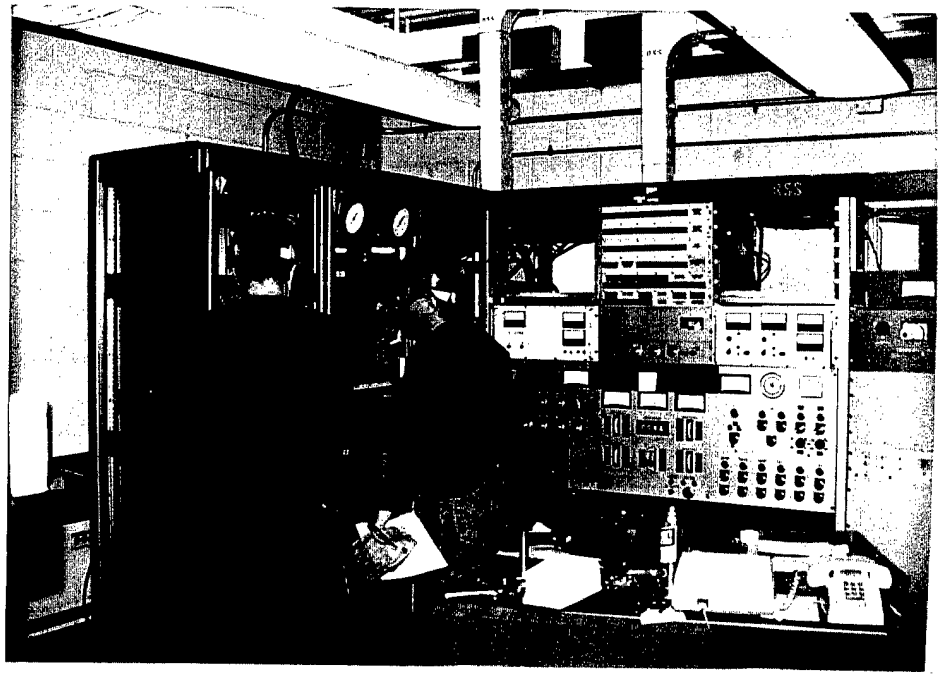
CP-5 Research Reactor D&D - September 1997



Two sets of horizontal storage holes are located in the E-wing adjacent to the spent fuel pool. The storage holes were used to store various radioactive materials including control rod blades and experimental packages. The storage holes are internally contaminated. Working within a containment tent, the CP-5 crew removed the remaining materials stored inside the holes, segregated the materials according to their radiation levels and waste type, and packaged the materials in appropriate containers.

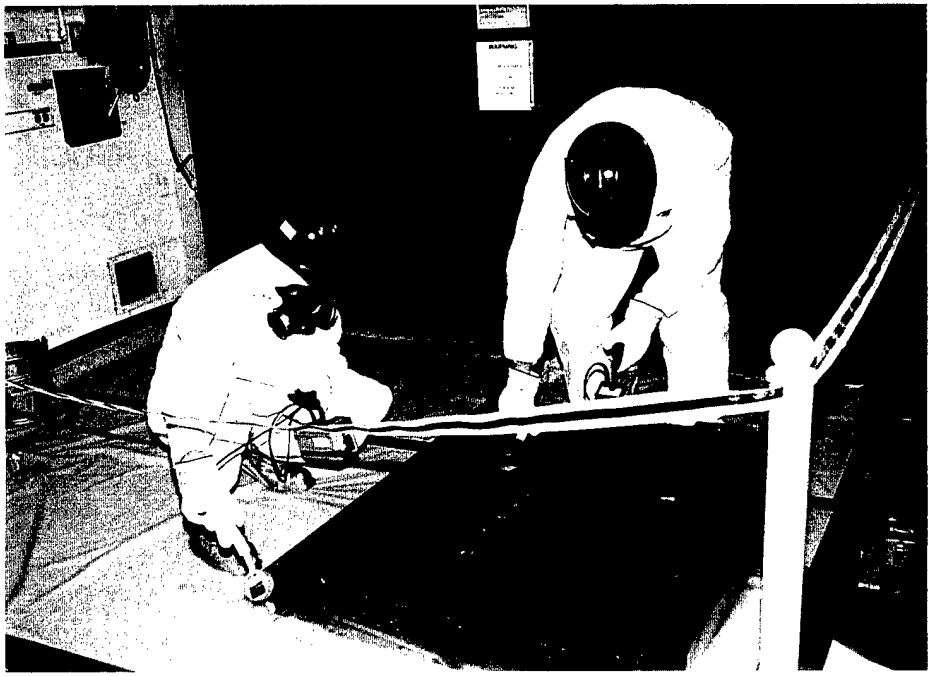
JANUS Reactor D&D Project

JANUS Reactor D&D - January 1997



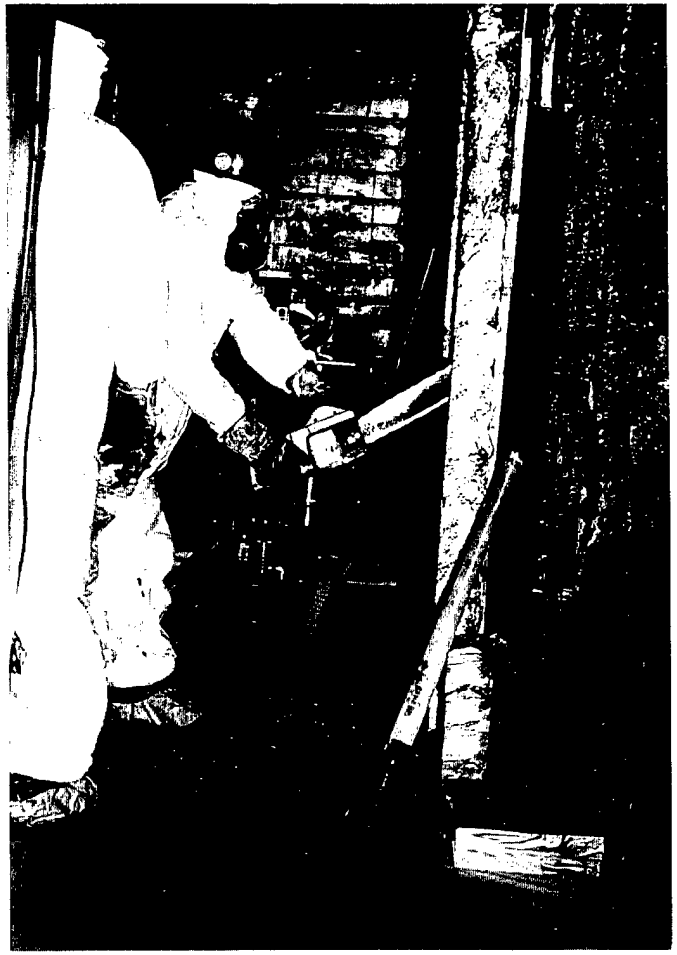
D&D of the JANUS Biological Irradiation Facility required removal of all surplus equipment. The reactor control panels were among the first items to be removed. This required locating all electrical power sources and isolating them to protect workers. All wire terminals were verified de-energized, the wires cut and the panel sections removed from the control room. Even with these precautions, two energized wires were cut during the process. No injuries occurred. The investigation into the incident revealed that the wires had been improperly routed through the cabinets instead of being routed separately in electrical conduit. Additional electrical test equipment (proximity testers) were utilized during the rest of the work.

JANUS Reactor D&D - February 1997



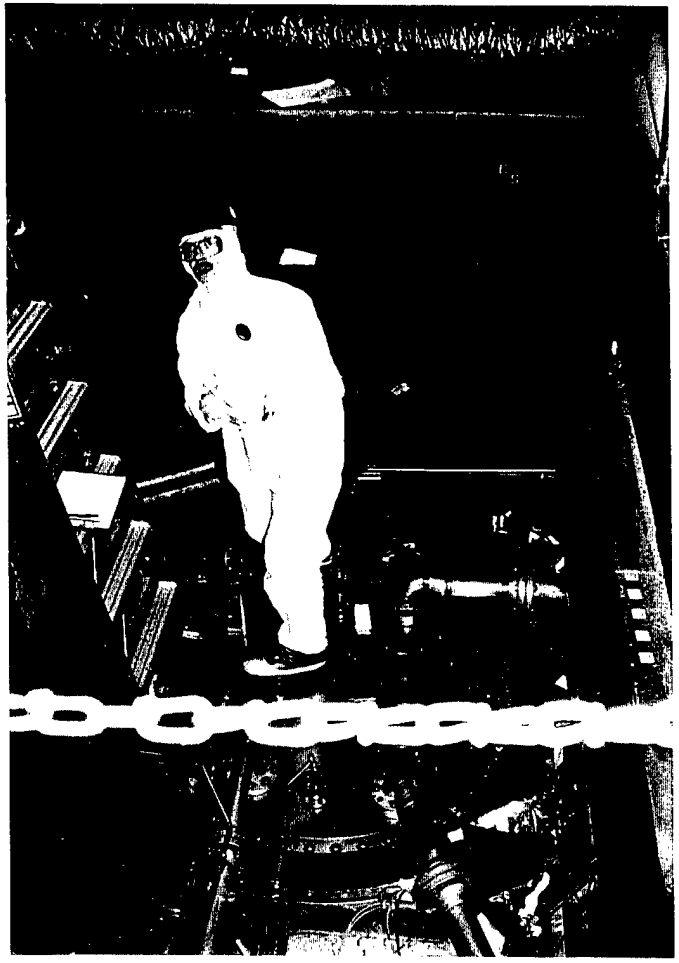
The walls, floor and ceiling of the High Dose Room were covered with lead bricks or plates to a depth of four inches. Lead sheets also covered the face of the reactor to a depth of seven inches. Health Physics technicians surveyed every piece of lead removed. They were able to free release for recycle over 200,000 pounds of lead.

JANUS Reactor D&D - February 1997



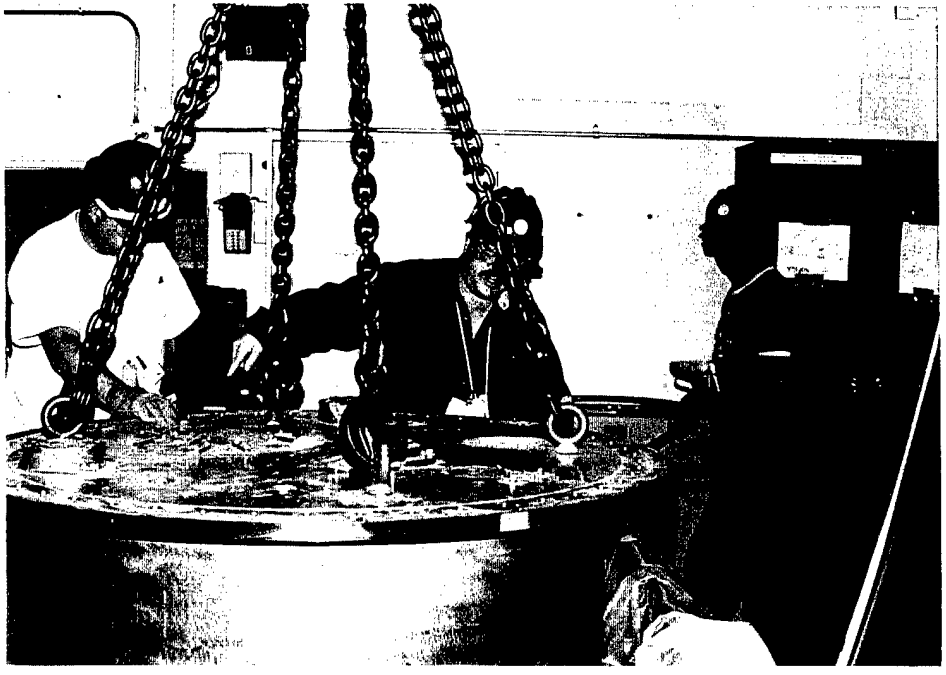
The High Dose Room lead consisted of 4 inch x 4 inch x 24 inch chevron-shaped lead bricks that had been fused together by pouring the joints full of molten lead. Various cutting techniques were tested to determine the best method for segmenting the wall. An electric chain saw provided the best solution. Other methods tested included electric-powered chisels, circular saws and routers.

JANUS Reactor D&D - March 1997



Before the reactor vessel could be removed, it was necessary to disconnect and remove all primary system piping from the top of the vessel shield lid. This piping was internally contaminated with radioactive material. After removal, it was packaged for disposal as low-level radioactive waste.

JANUS Reactor D&D - April 1997



The reactor vessel shield lid was constructed of a stainless steel shell filled with concrete. A special disposal box was constructed to allow packaging of the lid in one piece, saving worker time and exposure.

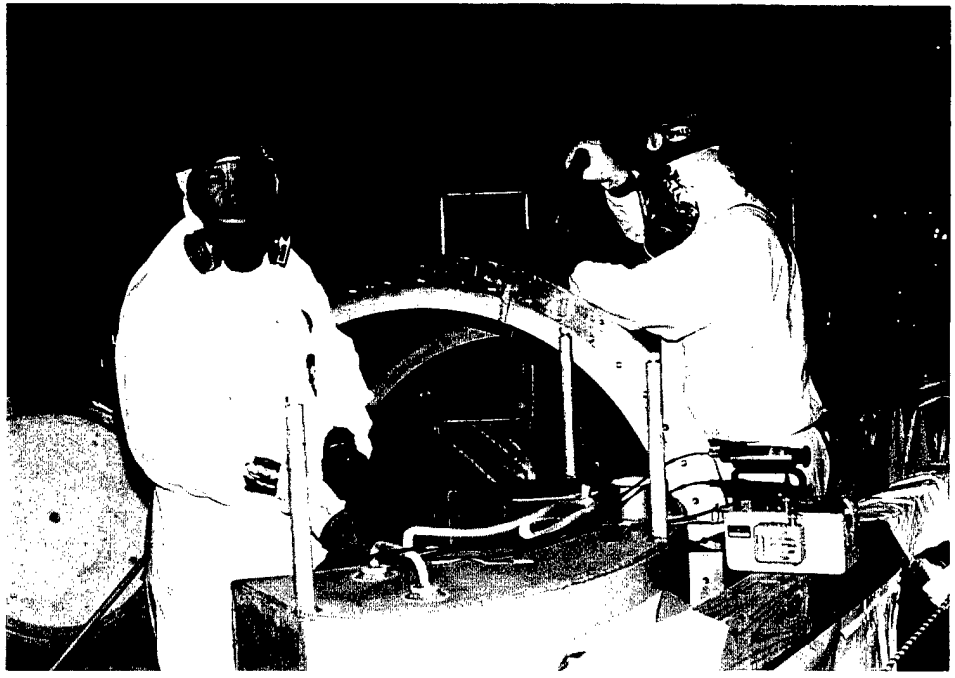
JANUS Reactor D&D - April 1997

The reactor vessel was removed from the reactor cavity containment tent and transferred to the size-reduction area using the installed 10-ton crane. The vessel and internals, weighing a total of 8000 pounds, were constructed of aluminium. Some of the internal structures were activated to a level of 400 mR per hour on contact.

JANUS Reactor D&D - April 1997

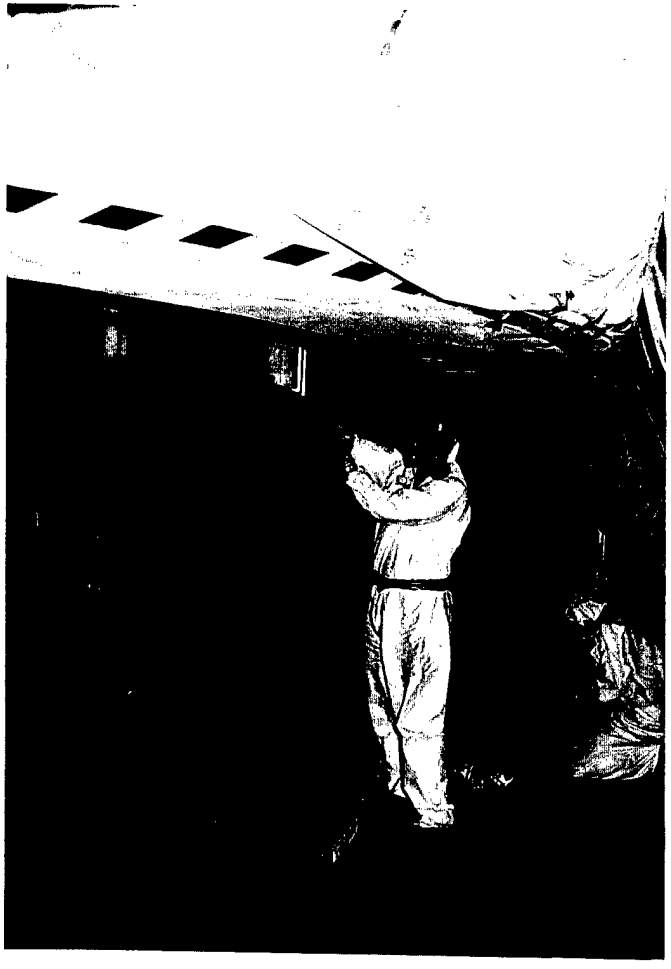
Decontamination technicians removed the lead and graphite blocks from the side of the reactor vessel. Each lead block weighed approximately 30 pounds, while each graphite block weighed approximately 6 pounds. The lead provided shielding for gamma radiation. The graphite reflected neutrons back into the reactor, as well as serving as a thermal column.

JANUS Reactor D&D - April 1997



The reactor vessel was placed on its side for size reduction using electric saws. Workers wore HEPA-filtered respirators to prevent inhalation of any radioactive material. Note the use of heavy leather gloves over the rubber gloves when working near the cut surfaces.

JANUS Reactor D&D - May 1997



The reactor face in the Low Dose Room was shielded with four-inch-thick lead bricks. These were removed by hand, surveyed for free-release for recycle, and sent to the ANL-E Lead Bank. Workers wore respirators to prevent inhalation of lead dust.

JANUS Reactor D&D - May 1997

As the D&D work in each room was completed, the walls and floor were marked with grid lines to allow for identification of areas for the final release survey. A laser was utilized to project a beam of light onto the walls and floor to provide accurate grid placement.

JANUS Reactor D&D - July 1997

In areas where access was limited, activated concrete around the reactor was removed by jack hammers. The concrete was high-density and proved very difficult to remove with hand-held equipment. The workers wore fall-restraint harnesses and safety lanyards to prevent injury from falls through open areas on each side.

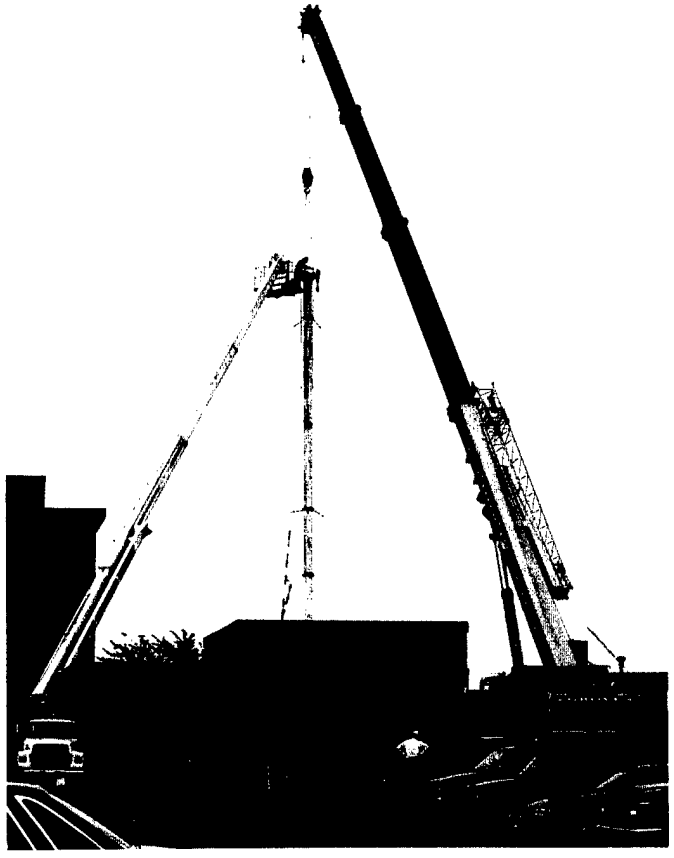
JANUS Reactor D&D - July 1997

Throughout the project, waste containers were inspected and transferred to ANL-E Waste Management for ultimate shipment and disposal at the Hanford, Washington DOE Disposal Site. A document package accompanies each container from the time an empty container is placed into use until it is buried.

JANUS Reactor D&D - August 1997

To expedite activated concrete removal, a remotely controlled, electro-hydraulic machine was utilized to break the concrete. Replacing the hammer with a scoop bucket, the machine was used to pick up and load the pieces of concrete into the disposal boxes.

JANUS Reactor D&D - September 1997

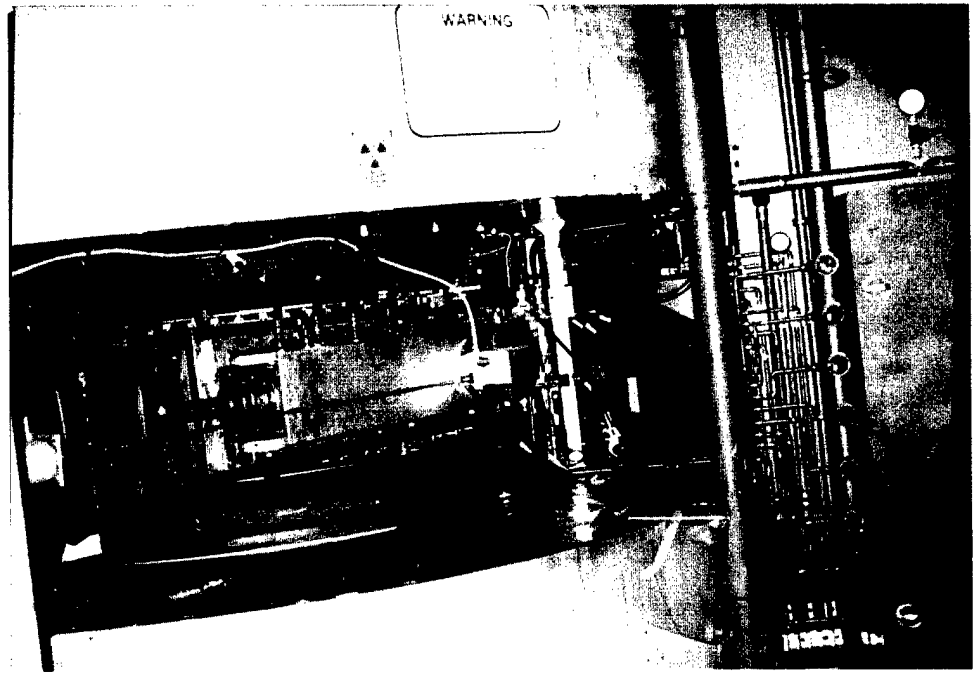


When all D&D work activities were completed, the HEPA-filtered ventilation system was no longer required. The 75-foot tall exhaust stack was removed, surveyed and free-released as scrap metal. A large crane and a boom lift with a work platform was used to remove the stack.

Future D&D Projects

60" Cyclotron D&D Project

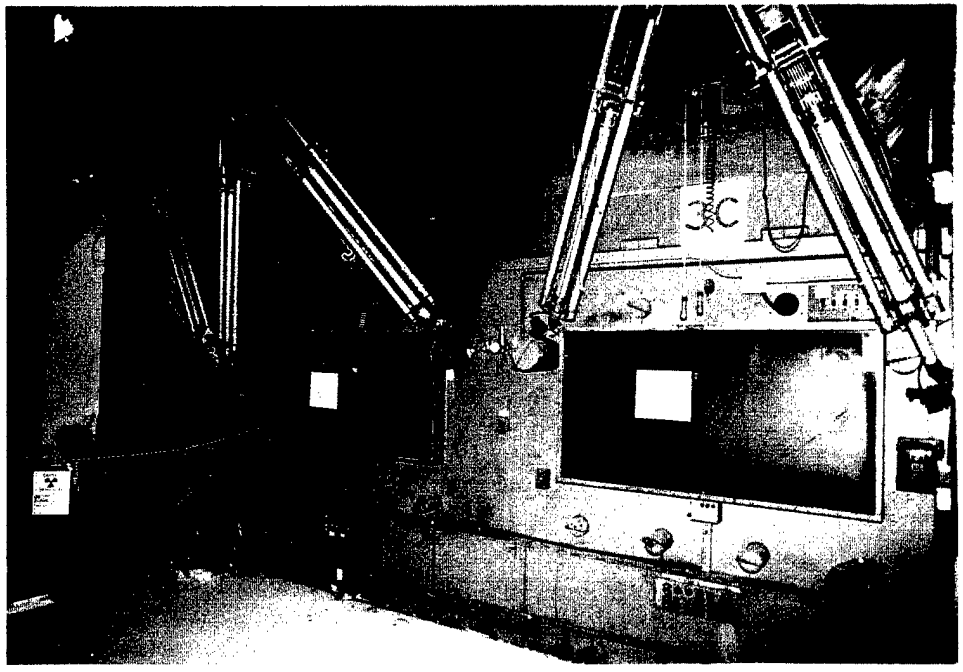
Argonne's 60" Cyclotron in Building 211 was a fixed frequency machine built in 1952 to conduct basic research. It has had a rich history, meeting widely diversified operational requirements, and producing deflected beams of deuterons, helium ions, singly charged hydrogen molecules and neutrons of a broad energy spectrum. Early work encompassed fields of heavy element chemistry, nuclear activation studies, nuclear scattering, solid state physics, radiation chemistry, isotope production and biological studies. Argonne's Nuclear Medicine Group was a significant later user of the facility; other users were the Argonne Physics Division and Oak Ridge National Laboratory. Operations ended in 1992.



The purpose of this project is to decommission the 60" Cyclotron and permit the release of the facility for unrestricted use. To accomplish this, the cyclotron will be disassembled, size-reduced and segregated. All radioactive materials associated with the facility will be disposed of at an approved facility.

Building 301 Hot Cells D&D Project

The hot-cell facility in Building 301 was placed into use in the early 1950s to perform a variety of radiological research experiments for the U.S. Department of Energy. Limited documentation is available which describes the work conducted in the facility. It is known that research and development of nuclear reactor fuel components and materials was conducted. The eight caves contained within the hot cell facility were phased out in 1971 because they were obsolete and deteriorating. The interior of the caves received a preliminary cleanup, but significant levels of fixed contamination within the painted floor, walls, cells and equipment remains spread throughout the facility. From 1971 until it was taken out of active use in 1992, the hot-cell facility was used for non-radiological experimentation.

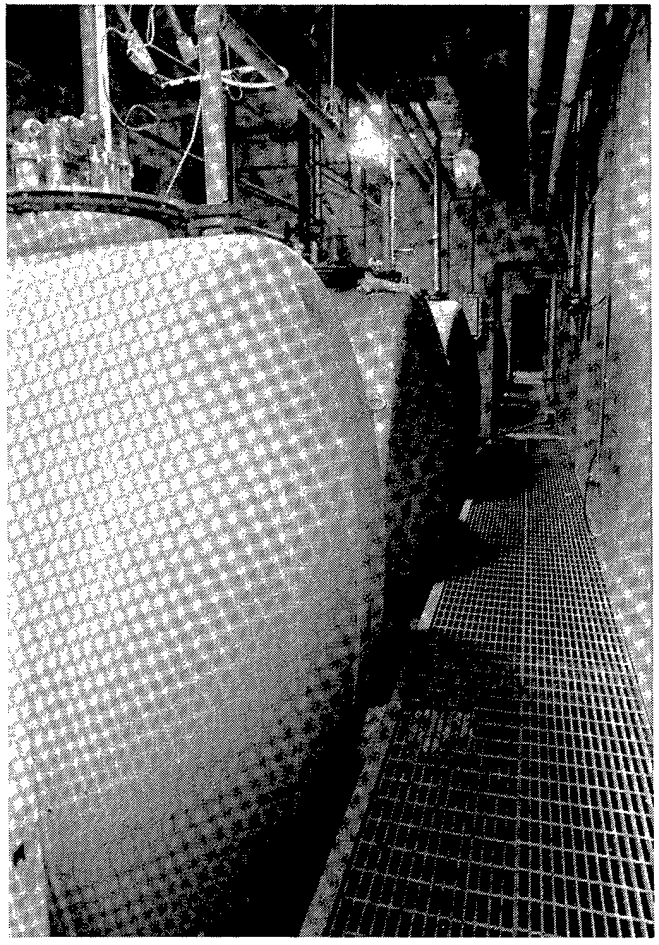


The scope of this project includes cleaning or dismantling radioactively contaminated equipment and disposing of it. The hot-cell area and other contaminated areas will be decontaminated and removed to permit the area to be released for unrestricted use, and the cave structures, retention tanks, and ventilation systems will be demolished.

Building 310 Retention Tanks D&D Project

The ANL-E Building 310 service floor retention tank facility was originally installed more than 30 years ago. Even though the Building 310 tanks were installed for excess storage capacity for the adjacent Building 306 tanks, they were infrequently used for this purpose. The facility consists of three rooms containing three tanks each, and a larger room containing one tank, for a total of ten tanks. The tanks have not been used since 1975, when it was decided that the excess capacity was no longer required.

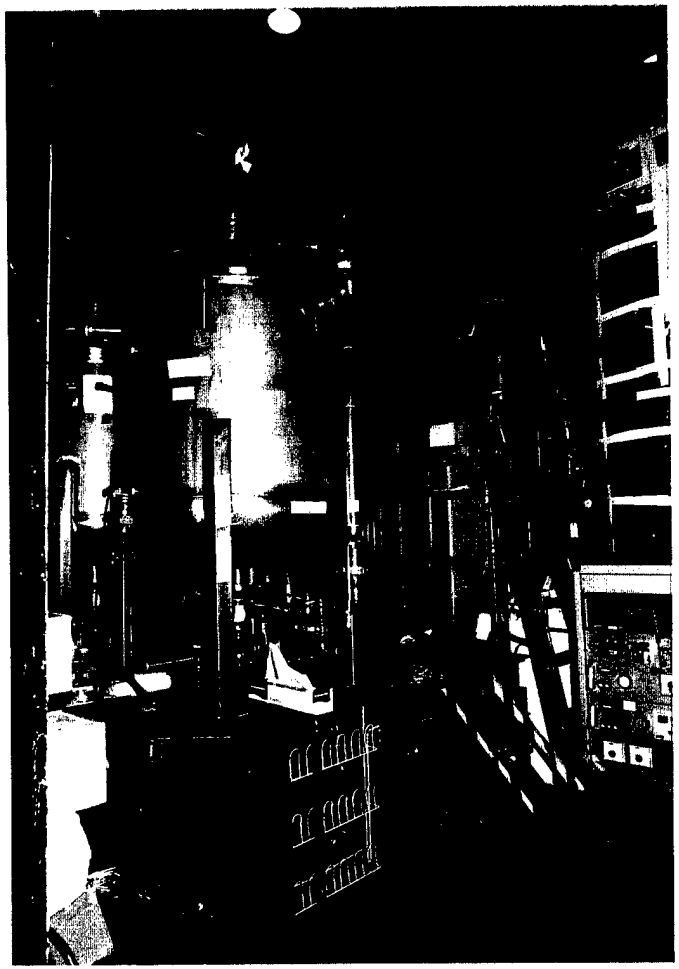
During project planning, which was completed in FY 1997, the option of recycling the tanks was chosen over size reducing, segregating, packaging and shipping them to a disposal site. D&D field activities will consist of decontaminating and removing the piping associated with the retention tanks. After excavating the access and pipe tunnels, and an area to enable removal, the tanks will be pulled out of the building and shipped to a decontamination/recycle center.



ZPR D&D Project

The Zero Power Reactors (ZPR) 6 and 9 in Building 315 were low-power, experimental reactors utilized for reactor physics studies from the early 1960s until 1982. Uranium and plutonium fuels were used to study the neutronic properties of reactor assemblies. Each reactor is in an individual, blast-resistant, concrete cell. Shield walls separate the cells from their control rooms; between the cells is a separate work room used to load fuel drawers. The facility is no longer in use; it is contaminated with low-level radioactivity.

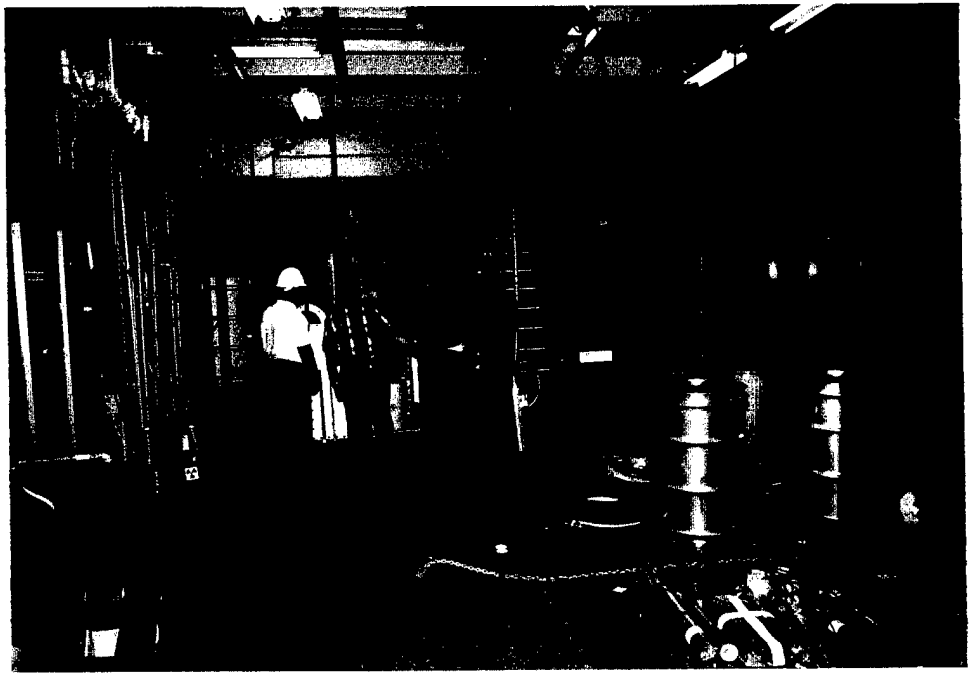
The purpose of this project is to decommission ZPR-6 and ZPR-9 and permit the area's release for unrestricted use. To accomplish this, the reactors, process systems and associated equipment will be cleaned or dismantled and disposed of properly.



ATSR D&D Project

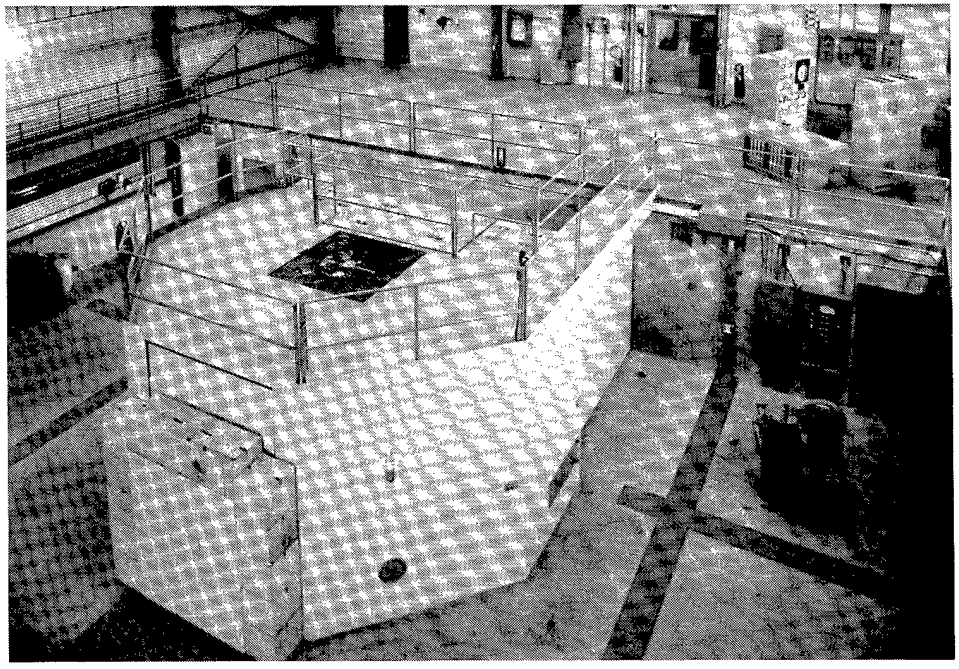
The Argonne Thermal Source Reactor (ATSR) in Building 316 operated from 1953 to 1988. ATSR is a highly enriched, light-water moderated thermal reactor dating back to Argonne's first zero-power reactor (ZPR-1). It was used as the source of a broad range of neutron energies and intensities for irradiating materials and testing nuclear instrumentation. The facility was defueled in 1992 and remains contaminated with low-level radioactivity.

The purpose of this project is to decommission the ATSR facility and permit its release for unrestricted use. To accomplish this, the reactor, process systems and associated equipment will be cleaned or dismantled and disposed of properly.



Juggernaut Reactor D&D Project

The Juggernaut Reactor in Building 335 was a light-water moderated and cooled, graphite-reflected research reactor with a rated thermal power of 250 kW. It operated from 1962 through 1970. The purpose of the facility was to provide neutron flux levels of medium intensity for research and development experiments for the fast reactor development program. At the time of reactor shutdown, the reactor fuel was removed and all systems were drained.

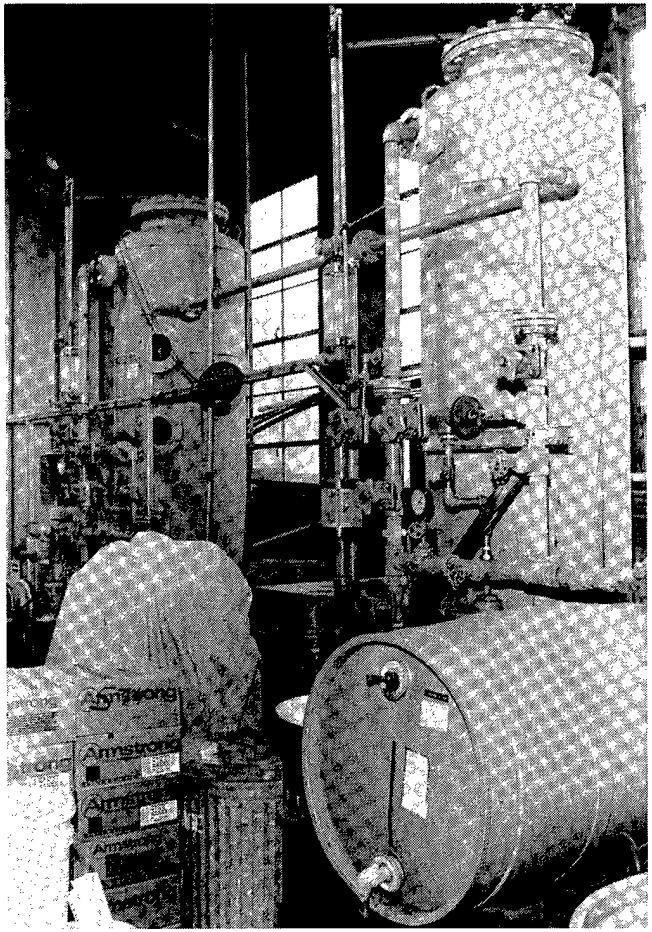


Only the high bay area of Building 335 housing the Juggernaut Reactor, the pump room, and the pit are covered by this project. The scope of this project includes the disassembly, size-reduction, segregation, packaging and disposal of all radioactive materials associated with the facility. After the removal of all radioactive materials, the facility will be decontaminated to levels that allow its release for unrestricted use.

Building 579 Waste Ion-Exchange Facility D&D Project

The Waste Ion-Exchange Facility was used to process slightly contaminated waste fluids from a collecting lagoon. Constructed in the 1950s, it is no longer in use today, but remains contaminated with low-level radioactive material. The unit consists of a cation exchange column, mixed bed column, and associated regeneration and operating equipment. The ion-exchange equipment was connected to the collecting lagoon, equalization tanks and Building 575 distribution pit by underground piping.

The scope of this project includes the decommissioning of the equipment and drainage systems in the Waste Ion-Exchange Facility to permit the demolition of the building.



D&D TECHNOLOGY

D&D TECHNOLOGY

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 and the Idaho National Environmental and Engineering Laboratory.

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.

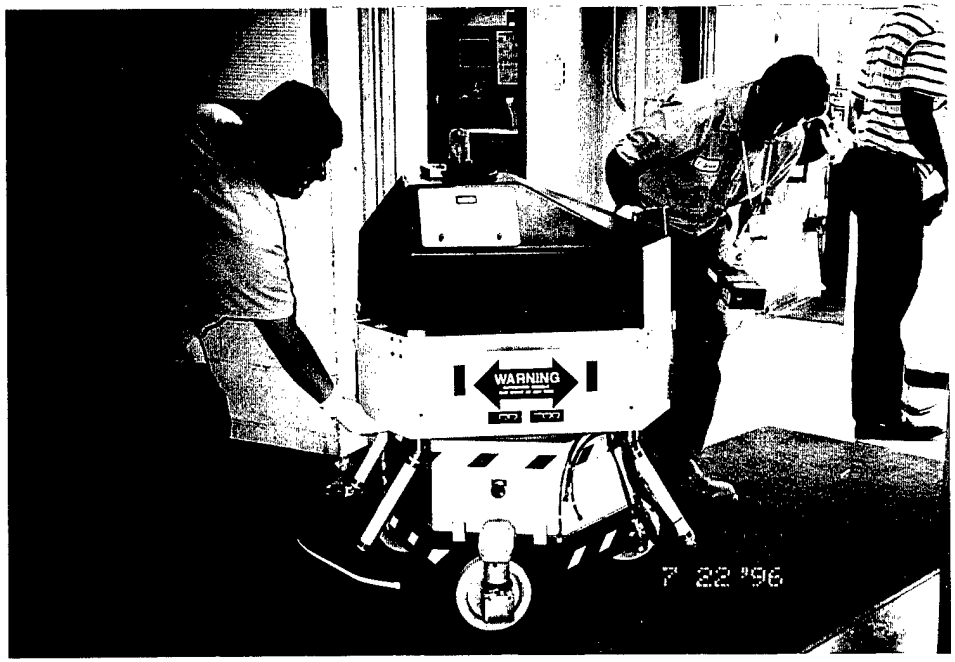
Swing-Reduced Control and Remote Crane Operation Upgrades, supplied by Convolve, Inc. Installation and upgrades were funded by DOE's Robotics Technology Development Program.

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 Characterization System (MACS)

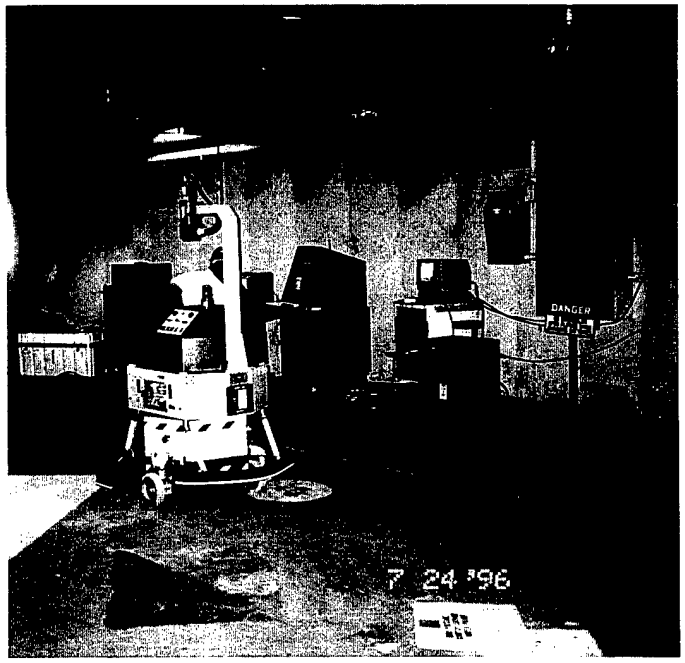


The Mobile Automated Characterization System (MACS) was developed by Oak Ridge National Laboratory and the Savannah River Technology Center for the U.S. Department of Energy's Robotics Technology Program. It is a commercially available, battery-powered, autonomous robot base supplemented by a laser positioning 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.

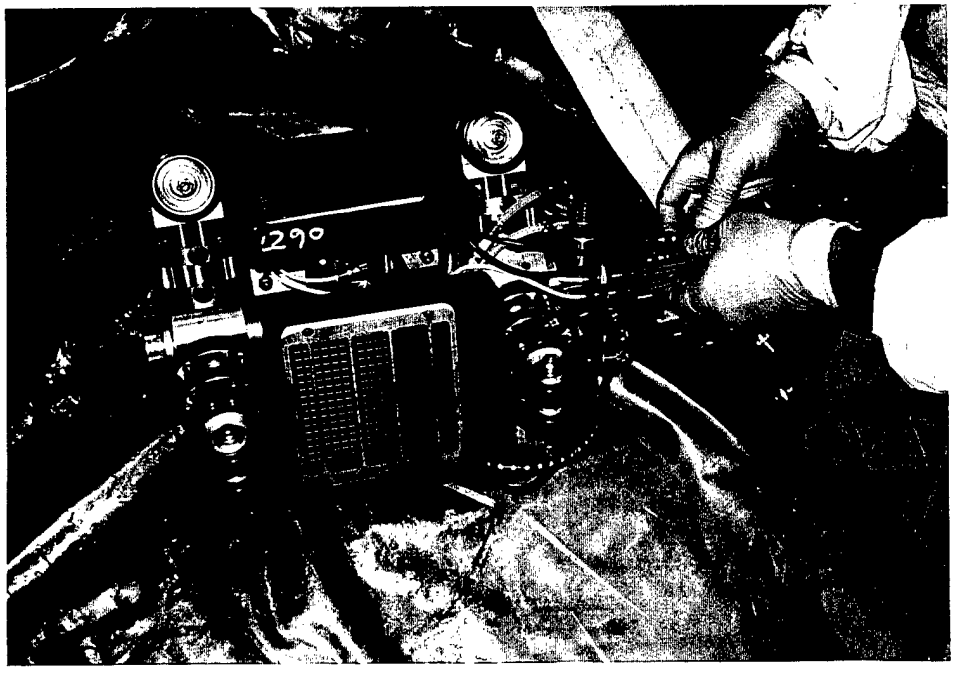
Characterization - Mobile Automated Characterization System (MACS)

Vendors and test engineer overseeing
MACS perform a floor survey



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

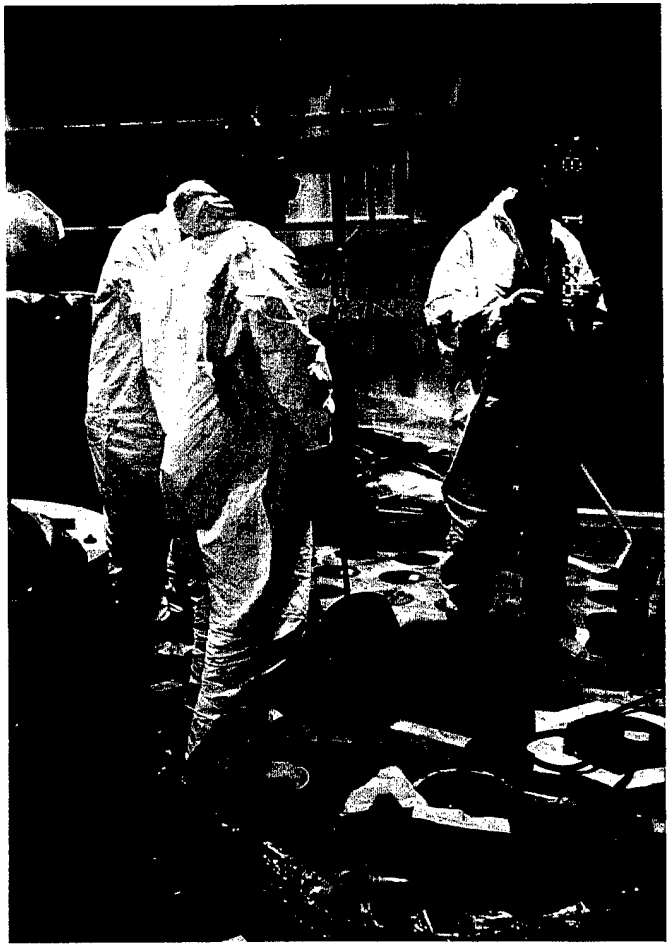
Characterization - Pipe Crawler Radiological Surveying System



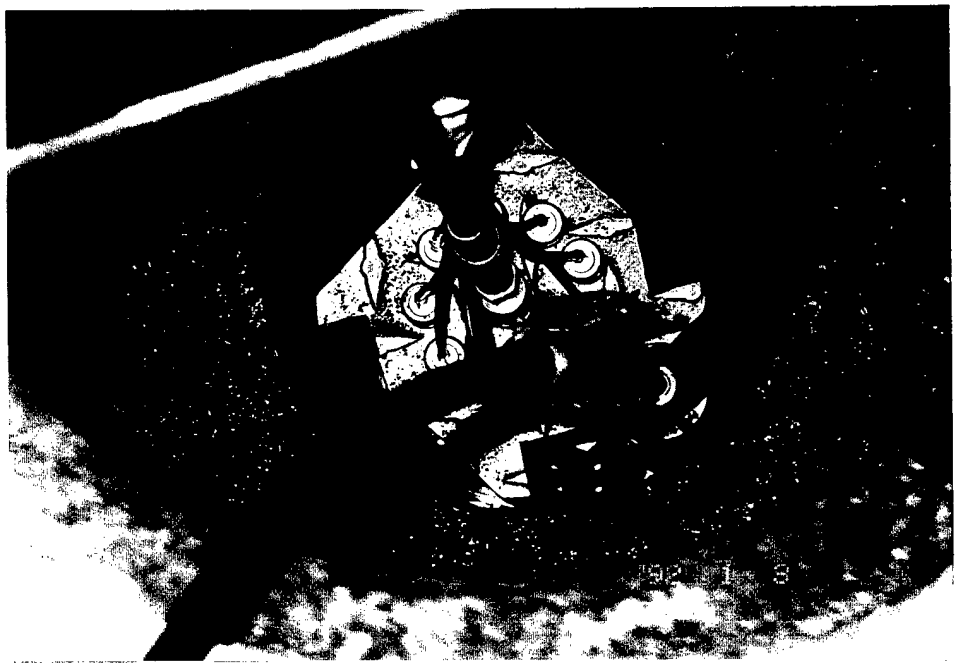
The Pipe Crawler was developed by Radiological Services, Inc., for use as part of a turn-key pipe inspection, decontamination and survey service. The technology consists of a wheeled robot, or mule, on which is mounted an array of thin Geiger-Müller detectors. The crawler is manually transported through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

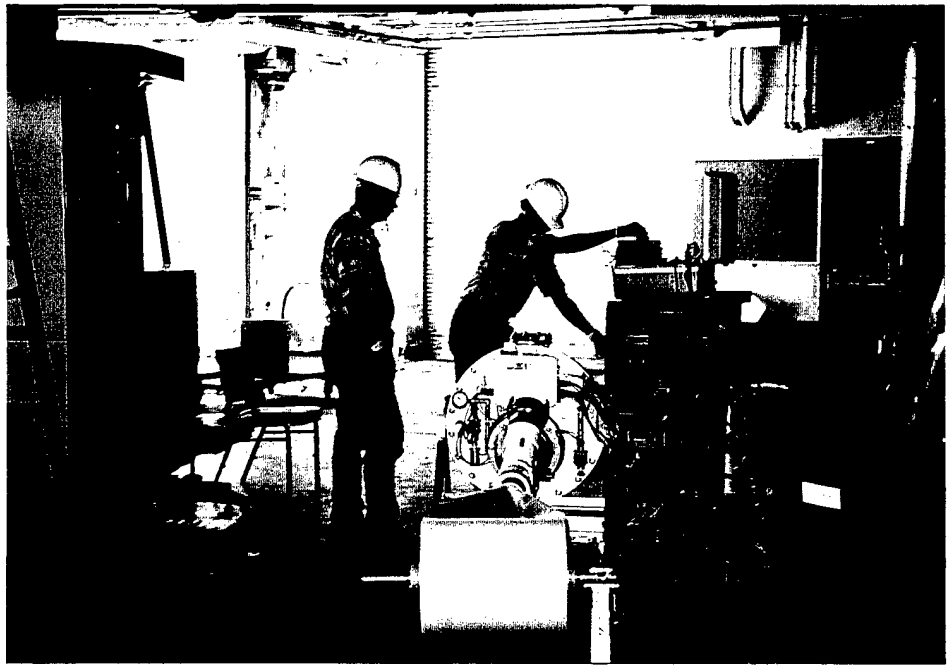


Vendors and test engineer
inserting Pipe Crawler for demonstration



Pipe Crawler inserted into rod storage hole

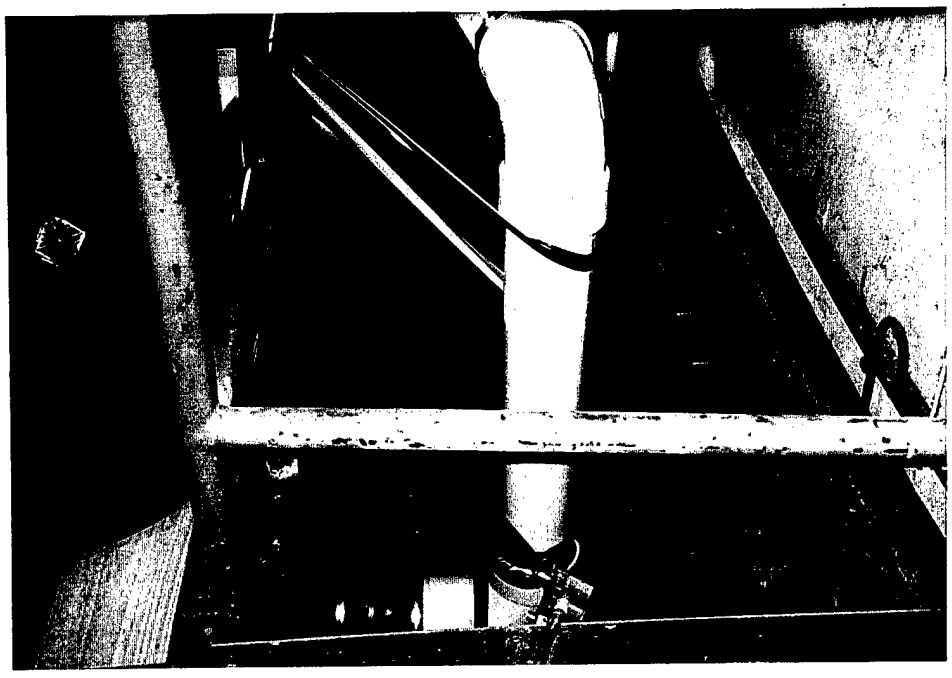
Characterization - Pipe Explorer System™



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™)

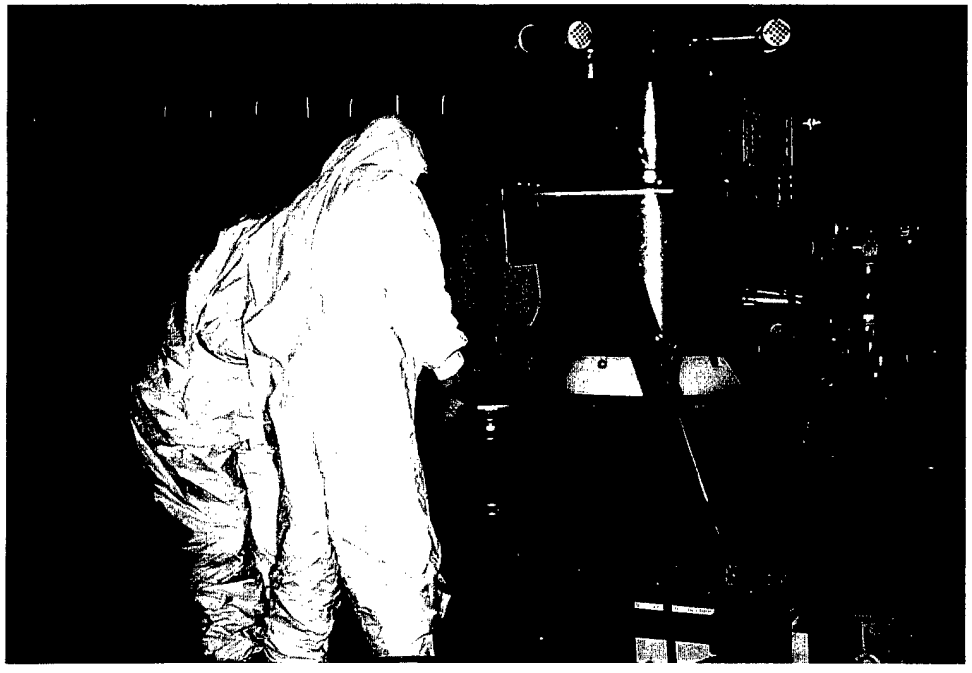
The Advanced Recyclable Media System (ARMS™), provided by Surface Technology Systems, Inc., is an open blast technology which uses a soft recyclable medium consisting of a urethane foam matrix. ARMS™ is divided into three units: the media feed unit, the sifter unit, and the media remake unit. The media 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™)

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.

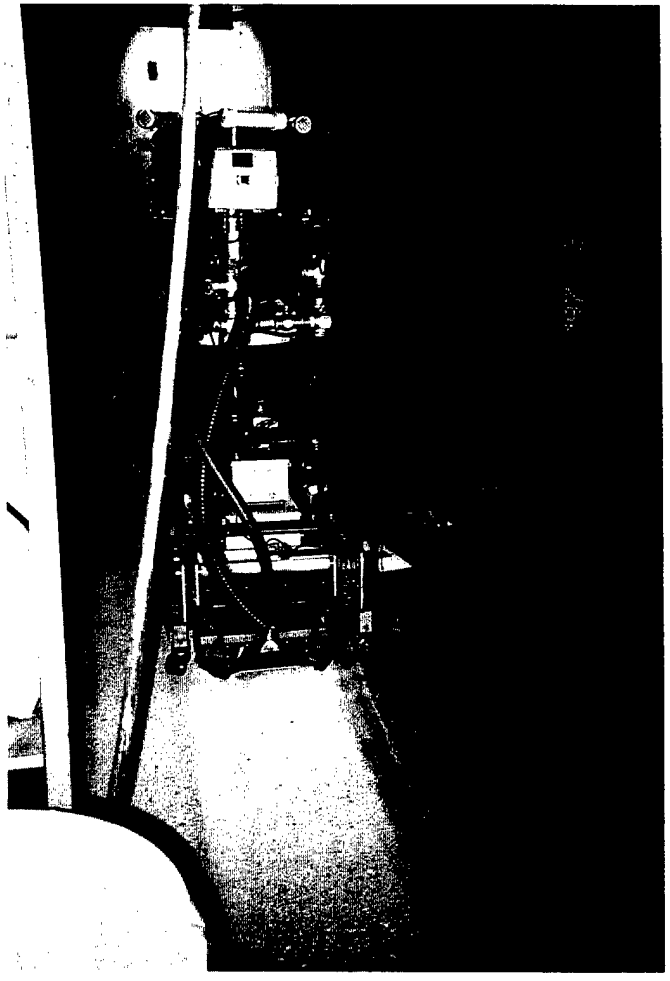
Decontamination - MOOSE®



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.

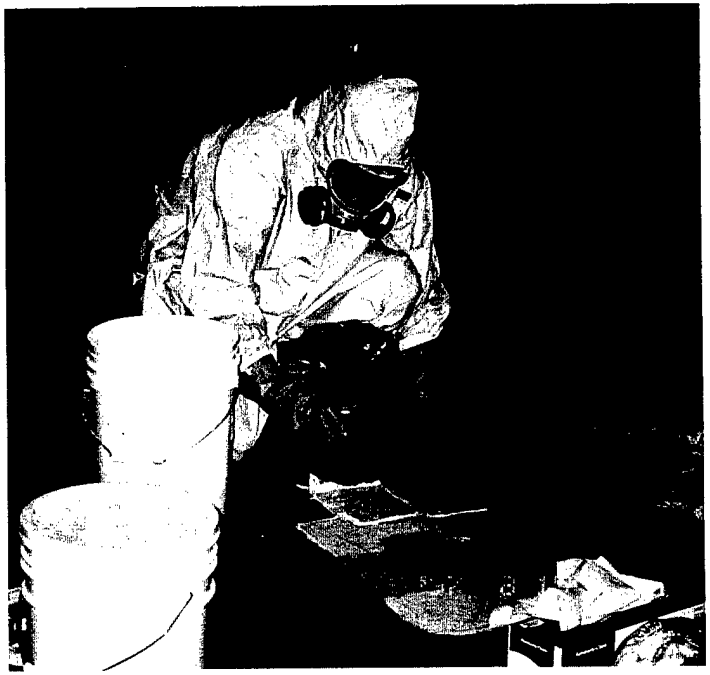
MOOSE® is very maneuverable and easy to operate. It is capable of scabbling within 6 inches from walls. Independent skid steering allows the MOOSE® to pirouette 360 degrees about its geometric center.

Decontamination - Pegasus Coating Removal System

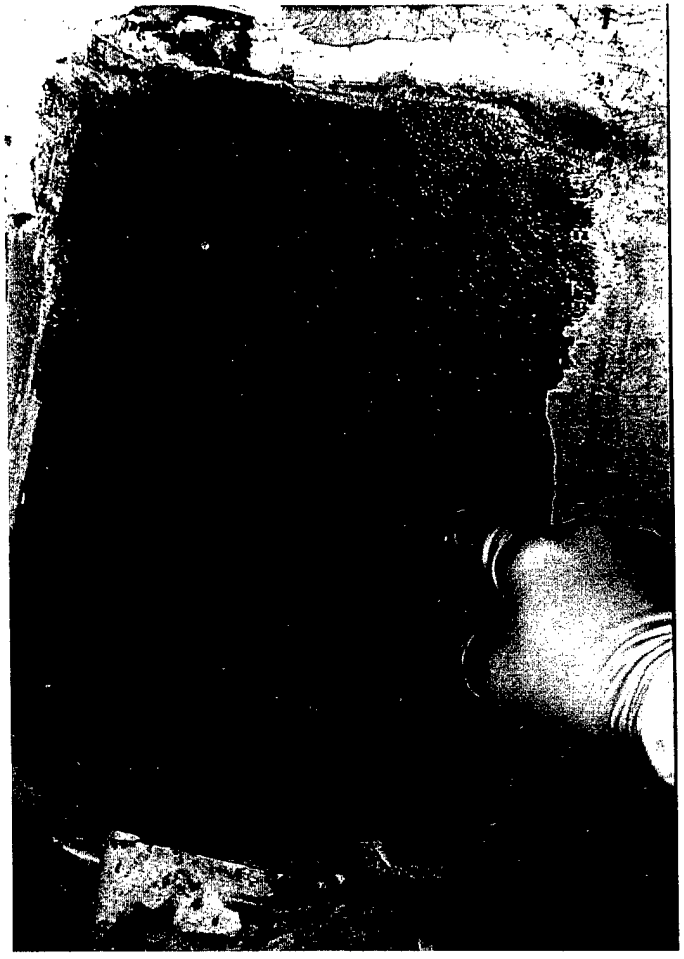
The Pegasus Coating Removal System (PCRS) is a chemical-based coating removal system developed by Pegasus International, Inc. The PCRS is applied using either long- or short-handled spreaders, trowels, rollers or a spray applicator. The material is left on the surface for a predetermined period of time 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

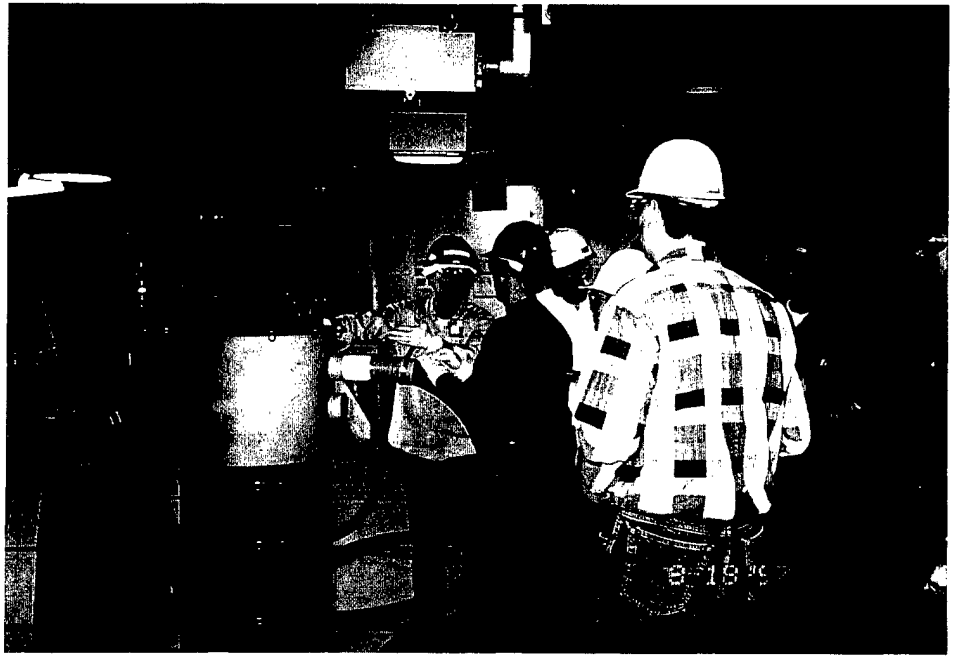


A worker applying Pegasus coating



Condition of floor after removal of chemicals

Decontamination - Roto Peen

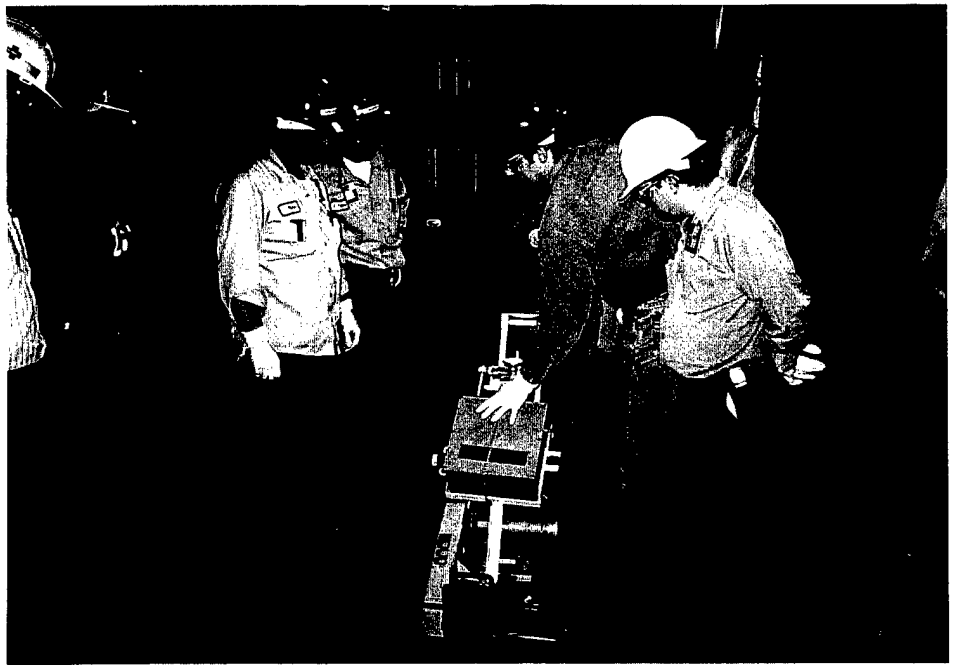


Roto Peen technology, provided by 3M Company, uses heavy-duty Roto Peen flaps to remove concrete and coatings from concrete floors. The flaps are mounted on an EDCO model CPM-4 floor unit and outfitted with a Pb Sentry from West Environmental which will shut off electrical power to the concrete planer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

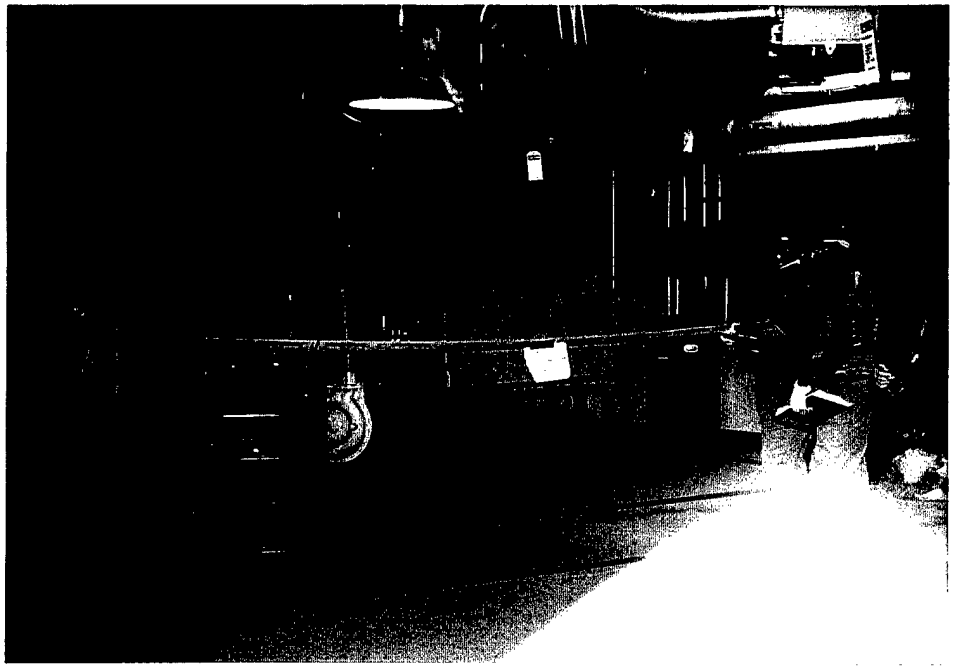
Decontamination - Roto Peen



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.

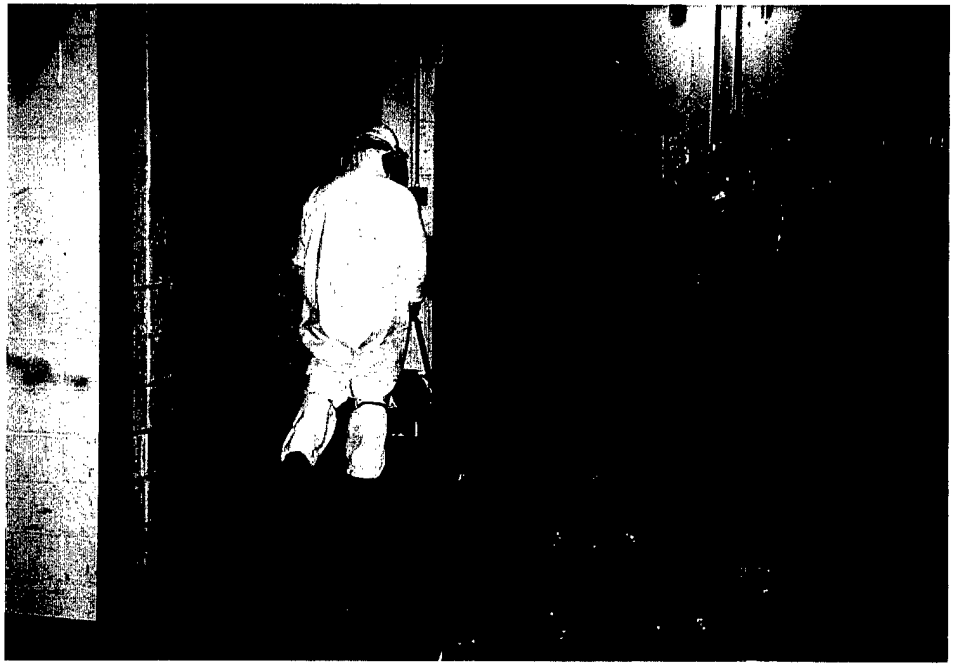
Decontamination - Starboldt™ Flashlamp



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.

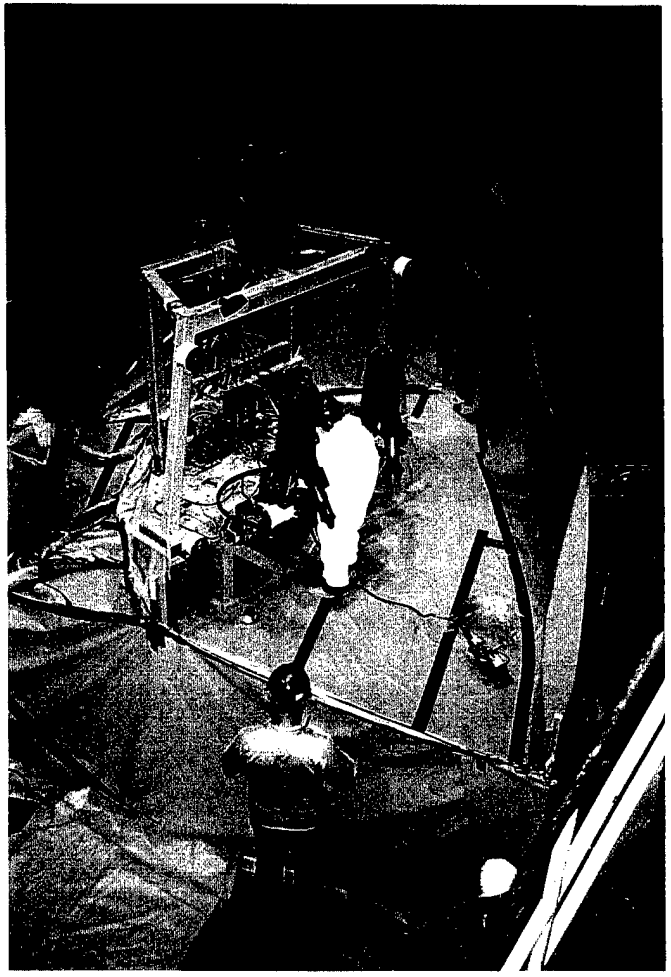
Decontamination - Starboldt™ Flashlamp



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)

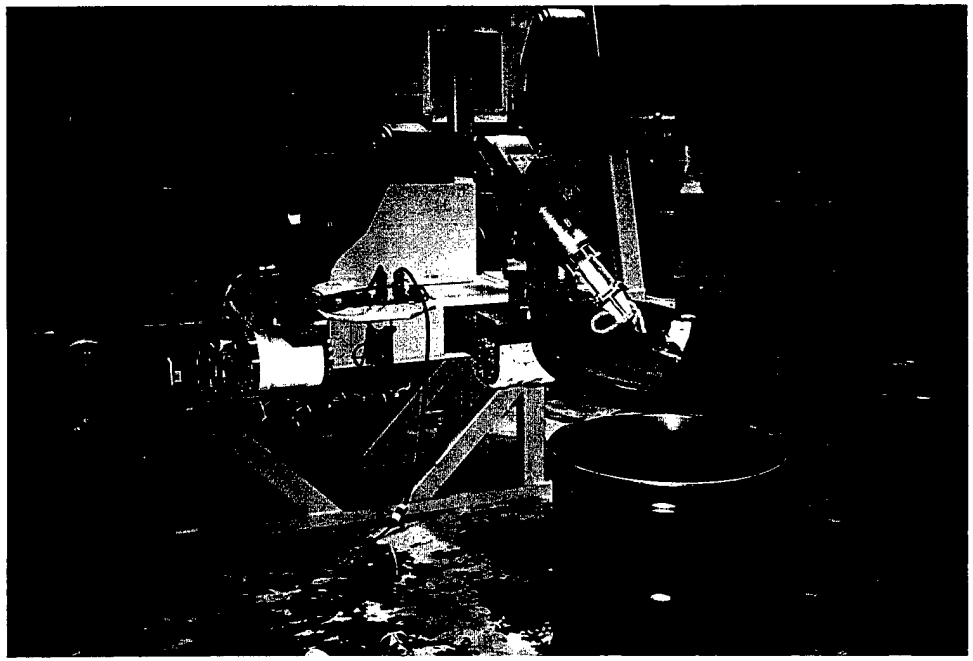


The DAWP was tested at the CP-5 Research Reactor from June through September 1997. Its ability to remotely cut and dismantle the aluminum reactor tank; disassemble the boral, steel and aluminum subassemblies; and transfer these materials to a staging area was demonstrated.

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.

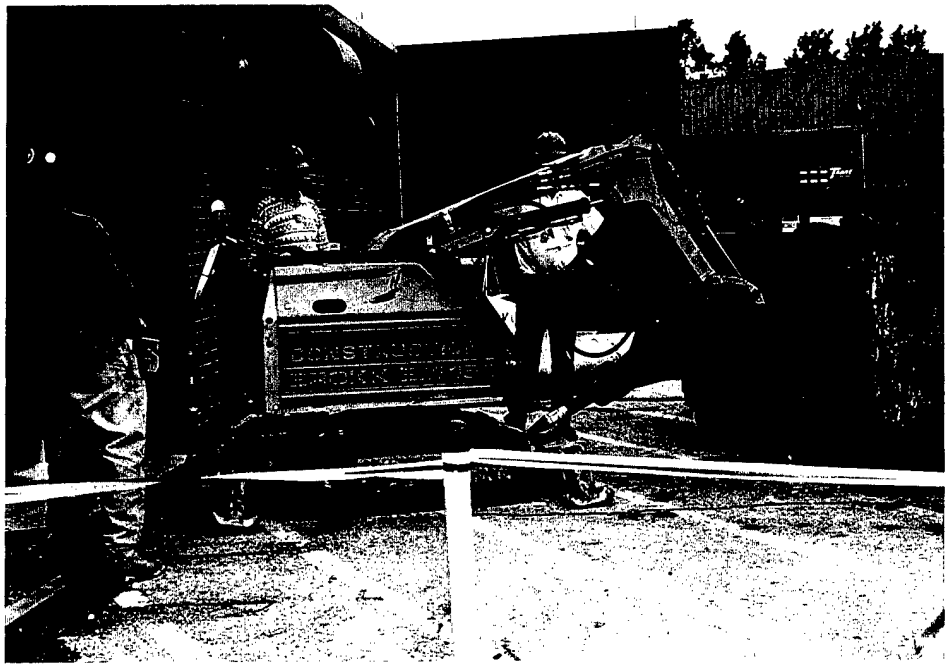
Robotics/Dismantlement - Dual Arm Work Platform (DAWP)



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.

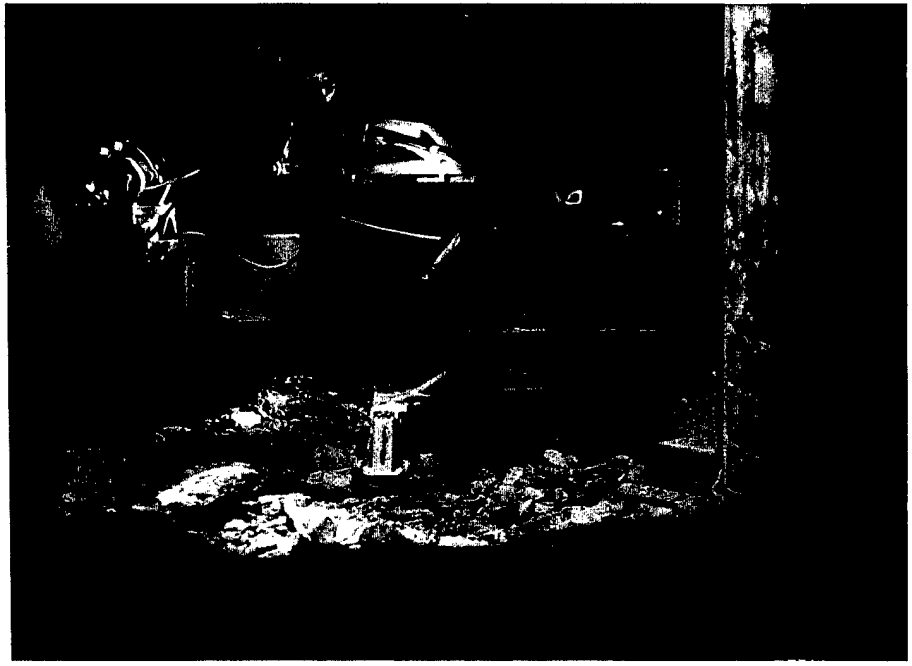
Robotics/Dismantlement - Remote Controlled Concrete Demolition System



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.

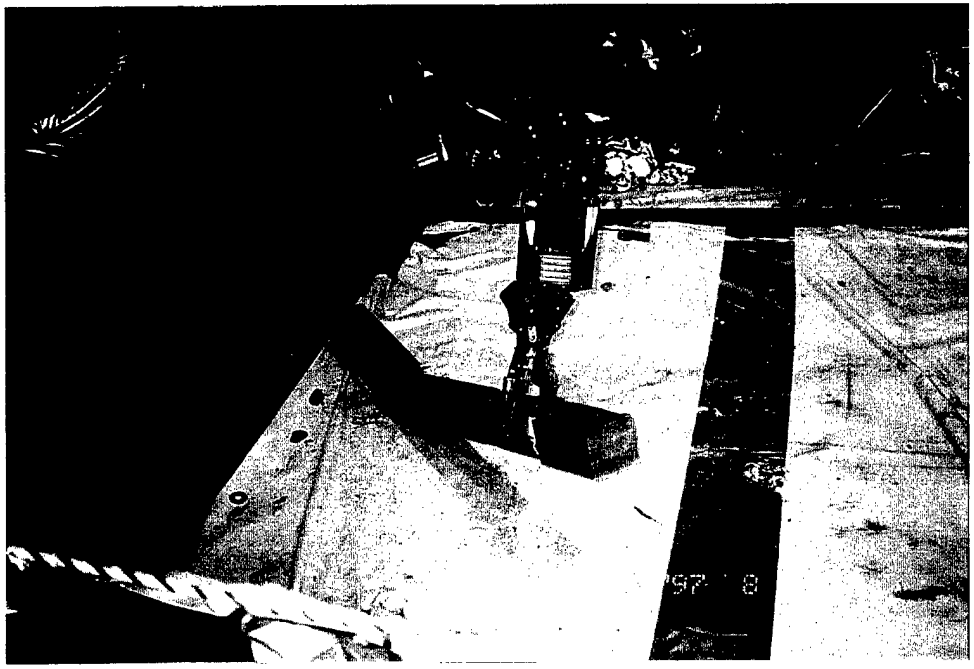
Robotics/Dismantlement - Remote Controlled Concrete Demolition System



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)

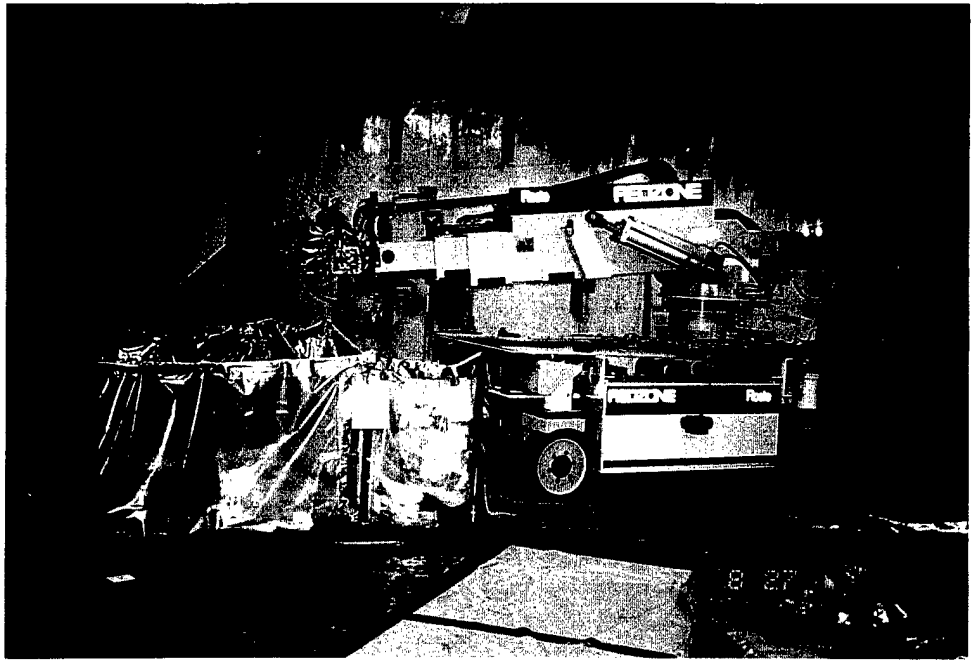


Rosie was tested at the CP-5 Research Reactor from June through September 1997. Its ability to remotely remove graphite with the Predator arm, move radioactive materials from the reactor assembly to a staging area using a specially designed steel transfer can, and position video cameras in strategic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

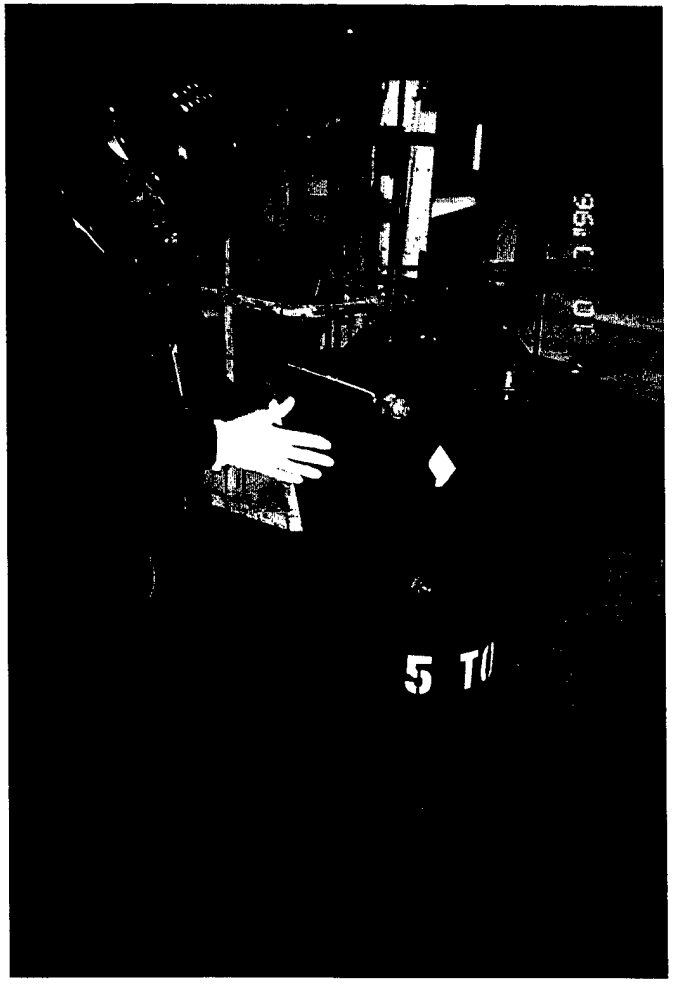
Rosie was outfitted with a Predator manipulator arm built by Kraft TeleRobotics, Inc., as shown in this picture The arm, attached to a mounting plate bolted onto the end of the heavy manipulator, is capable of lifting 200 pounds.

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).

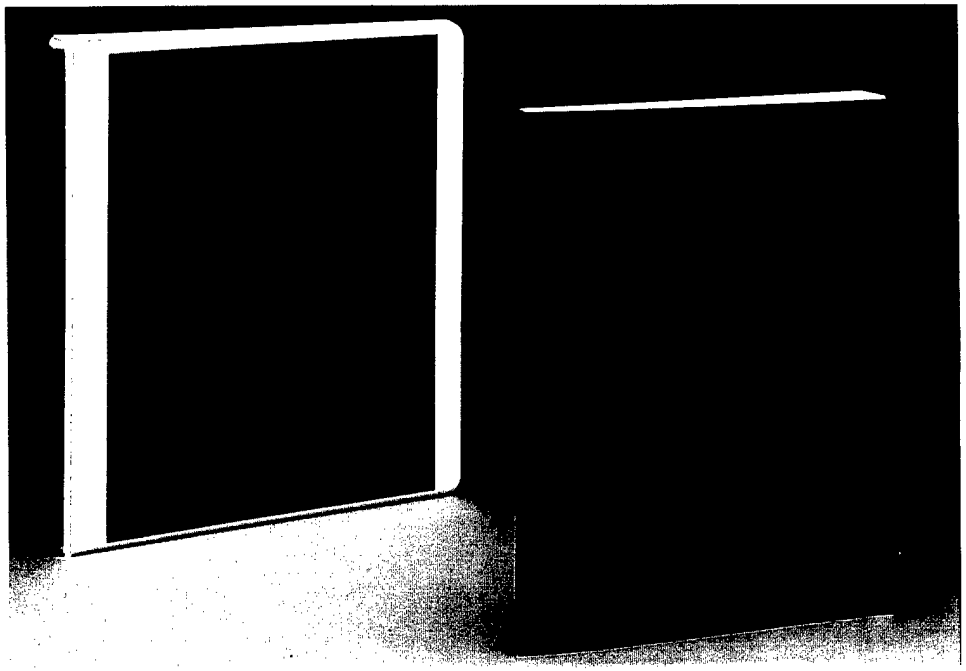
As shown here, a vendor is inspecting the rotating hook attachment.

Special Projects/Information Exchanges

D&D Special Projects Group

A 12-person delegation from RF Gosatomnadzor attended a two-week training course at ANL-E on *Decommissioning of Research Reactors and Other Fuel Cycle Facilities*. Organized and coordinated by the ANL-E D&D Special Projects Group, this activity was funded by the U.S. Department of Energy Office of the Assistant Secretary for Nuclear Energy (DOE-NE) through the Pacific Northwest National Laboratory (PNNL) International Nuclear Safety Program. After attending one week of classroom-type lectures on the entire decommissioning process, the delegation visited ongoing decommissioning projects at ANL-E and at PNNL in Hanford WA.

D&D Special Projects Group



The D&D Special Projects group is investigating various opportunities in pollution prevention/waste minimization in the specific area of decommissioning. Studies and information exchanges have resulted in two documents, the *Waste Minimization Handbook* completed in late 1996 and the recently completed *Sixty-Inch Cyclotron - Evaluation of Alternative Disposal Options for Activated Carbon-Steel Materials*. The *Waste Minimization Handbook* has been well received by the technical community as a compilation of waste minimization techniques and technologies, and their state of utilization. The specific study on the ANL-E 60-inch Cyclotron's 265-ton carbon steel magnet yoke validated the feasibility of recycling the carbon steel versus shipping it to a DOE burial site.

GAN of the Russian Federation

Special Projects staff members supported a "Quality Assurance (QA)" workshop held at GAN Headquarters in Moscow. This course, organized by the U.S. Department of Energy Office of the Assistant Secretary for Nuclear Energy (DOE-NE) through the ANL-E Division of Educational Programs, offered lectures on quality assurance in the decommissioning process.

International Atomic Energy Agency (IAEA)

During the June IAEA Regional Training Course for European member countries (emphasizing Eastern Europe), the Special Projects group provided a lecturer who presented a set of three lectures on characterization of facilities prior to, during and after decommissioning. Attended by over 30 IAEA trainees, this set was one of only three given by non-Europeans.

Technical support by staff in the Special Projects Group was provided to the IAEA Decommissioning Unit for several ongoing activities. The first activity involved planning assistance for the decommissioning of the Salaspils research reactor in Latvia. In addition, technical assistance in the decommissioning of several Russian naval reactor prototype facilities was provided to Estonia.

A D&D Special Projects staff member assisted the IAEA Decommissioning Unit as it updates its *Decommissioning Technologies* technical document. This document will serve as a primer (together with a separate similar report on characterization) for countries facing first-time decommissioning projects.

Strategic Alliance for Environmental Restoration Technology Open House

Technologies being demonstrated at the CP-5 Research Reactor facility as part of the EM-50 Large Scale Demonstration Project were highlighted during the one-day open house. One hundred guests from the U.S. Department of Energy, industry, academe and other national laboratories saw 30 innovative technologies on display at the ANL-E Guest House and the CP-5 facility. Vendors and test engineers were available to discuss their technologies and test results.

Rita A. Bajura (Dir., DOE-FETC) and Cherri J. Langenfeld (Mgr., DOE-CH) receive briefing on Field Transportable Beta Counting System

DOE-HQ officials Gerald G. Boyd (EM-50) and James J. Fiore (EM-40) receive briefing on Wall Walker technology

Secretary Peña visits ANL-E

As part of his first visit to the ANL-E site, U.S. Energy Secretary Federico Peña toured the CP-5 Reactor facility. As Manager of DOE Chicago Operations Cherri Langenfeld looked on, Secretary Peña received a briefing on the Dual Arm Work Platform (DAWP) from Mark Noakes of Oak Ridge National Laboratory. The DAWP was designed through a partnership involving Oak Ridge National Laboratory, Oak Ridge TN; Schilling Robotic Systems, Inc., Davis CA; and RedZone Robotics, Inc., Pittsburgh PA.

After receiving an overview of the CP-5 D&D Program from Technology Division Associate Director Samit Bhattacharyya, Secretary Peña moves to the CP-5 observation window to see the project first hand.

Information Exchanges - FY 1997

Community Leaders' Roundtable

Local government and community leaders meet periodically with ANL-E and U.S. Department of Energy representatives to discuss topics covering a wide range of issues, including the environment, education and the economy. In July, the Roundtable provided the ideal forum for providing a report to stakeholders on the ANL-E D&D Program.

Tours of the CP-5 Research Reactor Facility

Approximately 400 people toured the CP-5 Research Reactor facility in FY 1997 to see first-hand the innovative technologies being used as part of the ongoing decontamination and decommissioning work. These technologies included Rosie the robot and the Dual Arm Work Platform (DAWP). Most noteworthy were the following groups:

January: 100 participants attending the Strategic Alliance for Environmental Restoration Technology Open House

June: 60 participants attending Exchange Monitor Publication's Fourth Annual Decommissioning Decisionmaker's Forum being held at the Argonne Conference Center

July: 80 members of Commonwealth Edison Corporate Services

July: Personnel from the National Institute of Science and Technology (NIST) reactor project

August: OSHA auditors attending a training session at ANL-E

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