JANUS REACTOR D&D PROJECT

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ABSTRACT

Argonne National Laboratory (ANL-E) has recently completed the decontamination and decommissioning (D&D) of the JANUS Reactor Facility located in Building 202. The 200 KW reactor operated from August 1963 to March 1992. The facility was used to study the effects of both high and low doses of fission neutrons in animals. There were two exposure rooms on opposite sides of the reactor and the reactor was therefore named after the two-faced Roman god. The High Dose Room was capable of specimen exposure at a dose rate of 3,600 rads per hour.

During calendar year 1996 a detailed characterization of the facility was performed by ANL-E Health Physics personnel. ANL-E Analytical Services performed the required sample analysis. An Auditable Safety Analysis and an Environmental Assessment were completed. D&D plans, procedures and procurement documents were prepared and approved. A D&D subcontractor was selected and a firm, fixed price contract awarded for the field work and final survey effort.

The D&D subcontractor was mobilized to ANL-E in January 1997. Electrical isolation of all reactor equipment and control panels was accomplished and the equipment removed. A total of 207,230 pounds (94,082 Kg) of lead shielding was removed, surveyed and sampled, and free-released for recycle. All primary and secondary piping was removed, size reduced and packaged for disposal or recycled as appropriate. The reactor vessel was removed, sized reduced and packaged as radioactive waste in April. The activated graphite block reflector was removed next, followed by the bioshield concrete and steel. All of this material was packaged as low level waste. Total low level radioactive waste generation was 4002.1 cubic feet (113.3 cubic meters). Mixed waste generation was 538 cubic feet (15.2 cubic meters). The Final Release Survey was completed in September. The project field work was completed in 38 weeks without any lost-time accidents, personnel contaminations or unplanned exposures. The project was managed by the ANL-E Technology Development Division's D&D Program personnel. Total cost of the project was $2,095,000.00. Total project exposure was 0.482 person rem (4.82 mSv). Detailed information on D&D methods and lessons learned are presented.

I. Introduction

The D&D of the Janus Reactor at Argonne National Laboratory-East (ANL-E) was completed in October 1997. This paper will describe the history of the facility and the D&D project operations. Difficulties encountered and lessons learned are also provided.

II. Facility History

The Janus Reactor was built in 1963 as a biological research facility to study the effects of high and low fluence of neutron radiation on animals. Experiments performed at Janus were used to determine the whole lifetime "chronic" effects, as well as the "acute" high dose effects of neutron exposures. The 200 kilowatt reactor was a heterogeneous, light-water-moderated, tank-type reactor. There were two faces to the reactor (180 degrees apart) which allowed delivery of neutrons of different intensities to two separate rooms for low level and high level irradiations.

The Janus Reactor facility operated until March, 1992. The reactor was defueled in 1993, and the fuel was shipped off-site for storage at another DOE facility. All liquid support systems were drained, and the facility was placed into dry lay-up awaiting D&D operations. As a result of the facilities operating history, structures and components remained radioactively activated.

III. Facility Description

The Janus facility is located on the east side of building 202 in the J-Wing. The facility occupied two floors.

The main floor is comprised of the high bay, control room, fan room, and HEPA room (see Figure 1). The overhead crane, high-dose room shutter drives and removable floor plugs that provided access to the reactor, high-dose room ceiling and low-dose room were located in the high bay. The operating controls and instrumentation for reactor operation and monitoring were in the control room and air supply fans, environmental controls and several Janus electrical distribution panels were in the fan room. The HEPA filter room contained the three HEPA filters, exhaust fan and two air reservoirs and associated piping for the high-dose room shutter control system.

The service floor comprised the low-dose preparation room, low-dose room, high-dose preparation room, high-dose room and the reactor equipment room (see Figure 2). The low-dose preparation room contained control panels for the high-and low-dose rooms, the pneumatic tube assembly, various electrical distribution panels and the building sump system. The low-dose room provided a space for low flux experiments, although the area was never utilized for experimental purposes during the operating history of the facility. The high-dose preparation room contained electrical distribution panels, high-dose room door controls and space for experiment preparation. Space was provided in the high-dose room for high flux experiments, and was used extensively throughout the operating history of the facility. The reactor equipment room contained the pumps, valves, components and piping of the primary system, secondary system, helium systems, skimmer system and water purification system.

The following is a detailed description of the Janus facility rooms and systems.

A. The Reactor

Located between the high- and low-dose rooms was the reactor cavity. This area contained a steel shell which housed the graphite reflector and reactor tank. The vertical cylindrical core comprised 19 fuel assemblies, each 26 in (66 cm) long containing uranium-aluminum alloy fuel of highly enriched uranium. The core was installed in a 4 ft (1.22 m) by 7 ft (2.13 m) tall aluminum reactor tank and was positioned off center inside the tank to provide different neutron intensities in the two dose rooms. The facility was capable of producing neutron doses up to 60 rad (0.6 Gy) per minute in the high-dose room. Figure 3 illustrates a cross sectional view of the reactor and dose rooms.

B. The High-Dose Room

The high-dose irradiation room was 12 ft (3.66 m) long (from the face of the reactor), 16 ft (4.88 m) wide and 10 ft (3.05 m) high. Additional gamma (lead) and neutron (borated hardboard) shielding was installed in 1969 which resulted in the room being somewhat smaller than originally designed. A convex radiation face, bowing outward into the room, allowed neutrons to escape from the reactor. This opening (face) was 3 ft (0.91 m) high and 6.5 ft (1.98 m) wide. The distance from the center of the reactor's core to the opening was approximately 5 ft (1.52 m). The high-dose room could accommodate 300 mice for a single experiment.

C. The Low-Dose Room

On the opposite side of the reactor was the low-dose room which was 23 ft (6.04 m) long, 23 ft (6.04 m) wide and 11 ft (3.35 m) high. The convex radiation opening (face) on the low-dose side was 3 ft (0.91 m) high and 10.5 ft (3.20 m) wide. The distance from the center of the reactor's core to the opening was approximately 7 ft (2.13 m).

D. Converter Plates

The production of fast neutrons was achieved through the use of movable converter plates manufactured from highly enriched uranium alloyed with aluminum and encased inside an aluminum shell. The curved converter plates were mounted in vertically movable stainless steel frames located outside the steel shell at the high-and low-dose openings (faces). This location did not affect the operational characteristics of the core. The thermal neutrons that escaped from the reactor interacted with the highly enriched uranium of the converter plates to produce fast neutrons.

E. Neutron and Gamma Shields

When personnel were present in the high- and/or low-dose rooms during reactor operations, vertically movable neutron shutters (three section neutron absorbers) were positioned over each face. The shutters were located between the converter plates and the interior of the high-and low-dose rooms. The high-dose shutters were constructed of lead and borated polyethylene encased inside a steel jacket while low-dose shutters were constructed of ferrophosphate concrete in a steel jacket. The shutters were moved up and down by pneumatic cylinders that were operated from the control room.

Since the purpose of the experimental work at the Janus Reactor facility was to determine the effect of neutron exposure on animals, it was necessary to install lead gamma shielding at the faces of the high-and low-dose rooms. In 1969, an additional 4 in (10.16 cm) of lead shielding was installed in the high-dose room to provide shielding from the gamma rays emitted from the concrete activation products in the walls, floor and ceiling. In addition, 4 in (10.16) cm of borated wall board was also installed to prevent further activation of these concrete structures.

Vertically movable neutron attenuators constructed of boral were provided for the high-and low-dose openings (faces) of the reactor. These attenuators were positioned in front of the converter plates and were moved into position to absorb neutrons whenever personnel were present in the high-or low-dose room's during reactor operations.

F. Pneumatic Tube

A pneumatic tube penetrated the graphite reflector and the reactor vessel from the north. This shielded tube allowed special in-core irradiations of samples as well as providing for the insertion of the Beryllium/Antimony start-up source. Samples were pneumatically transferred into the reactor core from a sample loading and unloading station located in the low-dose preparation room.

G. Liquid Systems

Reactor-produced heat was transferred to the primary water and circulated from the reactor to the twin main heat exchangers by two reactor coolant pumps. The heat exchangers were constructed from stainless steel and normally operated in parallel. A 750 gallon (2,839 l) aluminum primary coolant storage tank was located in the reactor equipment room which could store all or any part of the primary coolant. The secondary cooling system removed heat from the heat exchangers of the primary cooling system. Heat removed from the primary coolant was transferred to the cooling tower and dissipated to the surrounding air. The primary coolant purification system purified the primary coolant by removing soluble ions and insoluble corrosion products in a mixed-bed ion-exchange resin column and protective filters. The skimmer and level-control system was installed to remove the surface film or scum (aluminum oxide) that typically forms on the surface of the coolant in reactors of this design.

H. Helium Systems

The Janus Reactor had two helium systems, a reactor helium system and a graphite helium system. The reactor helium system provided an inert atmosphere over the primary coolant in the reactor tank and reactor coolant storage tank. Helium was continuously circulated across free surfaces to remove any dissociation products of gas produced by the radiation coming from the reactor. This prevented the build-up of an explosive atmosphere. The graphite helium system supplied an inert atmosphere to the graphite region of the reactor.

I. Graphite System

The principle graphite system was contained between the reactor tank and steel shell with the graphite being used as a neutron reflector and thermalizer. The base of the reactor tank also sat upon a layer of graphite. The graphite was installed in offset interlocking blocks that completely surrounded the reactor on all sides and the bottom.

IV D&D PROJECT ORGANIZATION, PLANNING AND ENGINEERING

The Janus D&D project had a specific management structure in which the administrative, programmatic and technical responsibilities, including management controls and reporting systems for the performance of the project, were well defined.

The Decontamination and Decommissioning Program of the Technology Development Division (TD) at ANL-E was assigned the lead for the D&D of the Janus Reactor facility, which included direction, management and control of all phases of work. A project manager was assigned and given full line authority and responsibility for the hands-on management of the project.

The ANL-E Health Physics Group performed a detailed characterization of the facility. The information from this characterization was used to develop an Auditable Safety Analysis and Environmental Assessment and a detailed bid specification for performance of the field work.

A contract to perform D&D field work was awarded to Afftrex, Ltd. To accomplish their assigned scope of work, they provided the D&D technicians, DOE certified health physics technicians, health and safety oversight personnel and management personnel. To fulfill contract requirements, they provided a project specific Health and Safety Plan (HASP), monthly reports which detailed the work accomplished, cost of work performed and issues or concerns regarding the project.

Project oversight was provided by personnel from various ANL-E organizations, e.g. Environment, Safety and Health (ESH), Plant Facilities and Services (PFS) and Technology Development (TD). A contract was awarded to MOTA Corporation (Cayce, SC) for an experienced field engineer to oversee the project's day-to-day activities. The field engineers's responsibilities included review and approval of plans and procedures, monitoring work site activities to identify and evaluate conditions which could affect the health and safety of workers, laboratory personnel, the general public or the environment.

V. D&D OPERATIONS

A. Subcontractor Mobilization

In November 1996 a contract for the D&D of the Janus Reactor facility was awarded to Afftrex, Ltd. of Pittsburgh, PA.. Prior to the start of on site work, contract documents were finalized, performance bonds were submitted, and plans and procedures were provided for review and approval by ANL-E. After approval was granted, a preconstruction safety meeting was held at ANL-E on December 13, 1996. Afftrex Ltd. personnel and the MOTA Corporation Field Engineer arrived at ANL-E on January 6, 1997 for a two-week on-site training and orientation session. Afftrex set-up project offices, crew facilities and equipment storage in H-wing of building 202. H-wing is located in close proximity to J-wing, where the D&D activities were conducted.

B. Decommissioning Activities

On-site D&D activities commenced on January 22, 1997. Much of the work was performed in parallel. The following descriptions discuss the activities associated with the D&D.

Electrical System Isolation

Electrical system isolation consisted of performing lockout/tagout (LO/TO) of circuits feeding power to equipment, components and panels scheduled for removal. All LO/TO operations were performed in accordance with the ANL-E ES&H Manual. Electrical isolation was started on January 28, 1997 and continued throughout the entire project.

Asbestos Abatement

The JANUS Reactor Facility characterization identified twenty locations having asbestos levels greater than 1% by weight. Afftrex subcontracted with SECO (Brookfield, IL), an Illinois-licensed asbestos abatement company, to remove the asbestos containing materials (ACM). All ACM was surveyed prior to the start asbestos abatement activities; none was suspected of being contaminated as a result of previous facility operations. Asbestos abatement began May 19, 1997 and was completed on June 3, 1997. A total of 513 ft^3 (14.36 m^3) of asbestos waste was generated. All waste was transferred to ANL-E Waste Management for disposal at a licensed disposal site.

Exhaust Stack Removal

The 75 ft (22.86 m) tall exhaust stack was located on the west side of the JANUS facility and was used to direct the discharge air from the installed HEPA system to the atmosphere. The installed HEPA system was required to be operational during all phases of D&D; it was not removed until all D&D work was completed. Afftrex subcontracted Imperial Crane (Bridgeview, IL) to remove the stack from Building 202. The removal was completed using a boom lift and crane on September 23, 1997.

Cooling Tower Removal

The cooling tower, used to dissipate the heat removed by the secondary circulating water system to the atmosphere, was located on the north side of the reactor building. The tower, including all support structures and systems, was mechanically dismantled and scrapped as clean trash. Work was started on April 28, 1997 and completed on April 29, 1997.

Lead Based Paint Removal

During the facility characterization, several areas were identified that had been painted with lead based paint. The building structures and floor plugs which were not identified for demolition were stripped of their lead based paint and repainted with lead free paint. To strip the paint, Peel Away™ paint remover was applied to the items. The paint residue was collected on paper and rags and packaged as mixed waste. This work was started on April 2, 1997 and completed on July 31, 1997.

High Dose Room Demolition

The high-dose room was located on the west side of the reactor. It was used for studying acute biological effects (10^5 to 10^6 rads/week) of fission neutrons.

Floor lead removal consisted of removing two 0.125 in (0.318 cm) lead sheets located above two layers of 2 in x 2 in x 4 in (5 cm x 5 cm x 10.16 cm) lead brick that covered the floor. The lead sheet was rolled up and removed to expose the two layers of lead brick which were then manually removed.

Wall lead removal consisted of removing the 4 in x 4 in x 2 ft (10.16 cm x 10.16 cm x 60.96 cm) chevron shaped lead blocks that completely lined the walls of the high-dose room. Originally it was thought that the blocks were fused together at the surface. It was determined, however, that during construction a gap of about 1 in (2.54 cm) was left between each adjoining block. As each tier of block was installed, the gap was filled with molten lead which fused adjoining blocks together as well as to a 1 in (2.54 cm) thick lead backing plate bolted to the concrete wall behind each butt joint. This construction method formed a continuous 4 in (10.16 cm) thick lead wall with no joints or seams. Various lead cutting techniques were tested to identify a safe, cost effective method of removing the wall lead. Electric chisels merely pushed the lead around and were easily wedged. A router produced good results to a depth of 0.5 in (1.27 cm), but melting of the lead at greater depths caused binding. A circular saw fitted with a non-ferrous metal cutting blade produced good results, but the depth of cut was limited to about 3.5 in (8.9 cm) The circular saw cut the lead wall in progressive cuts of 0.5 in (1.27 cm) depth per pass at a rate of one brick every two minutes. An electric chain saw proved to work most efficiently. The cutting rate was approximately one brick every 90 seconds at the full 4 in (10.16 cm) depth. In addition, the electric chain saw worked well in corners and other areas not accessible to the circular saw. Although the chain saw's nylon drive sprocket required several replacements during wall removal operations, the chain never needed sharpening. A combination of the circular saw and electric chain saw were used to remove the 320 lead wall bricks.

After the lead was removed from the walls and floor, the four layers of 1 in (2.54 cm) thick borated hardboard were removed. The hardboard, which was bolted to the concrete walls, was removed by unfastening the bolts and manually removing each section.

In front of the high level reactor face were nine layers of lead plate, each measuring 1 in x 6 in x 48 in (2.54 cm x 15.24 cm x 121.92 cm). These plates formed a gamma shield between the reactor face and the high-dose room which allowed personnel to enter during reactor operation. Two of the nine layers of lead had already been removed and stacked on the floor in the high-dose room to facilitate the removal of the fuel bearing converter plate. The remaining seven layers of lead plates were manually removed.

Attached to the false borobauxite concrete ceiling in the high-dose room were 4 in (10.16 cm) thick interlocking lead ceiling, soffit and face tiles. These tiles were attached to aluminum grating supported by I-beams. To support the lead tiles, four aluminum rods were cast into each lead block; the free end of the rods were then inserted through the grating, and a washer and nut were attached to the end of the rods. After the lead ceiling was installed, the 1 ft (30.58 cm) thick borobauxite concrete false ceiling was poured onto the grating. The concrete covered the nuts and washers, preventing access for removal. Because the ceiling tiles were interlocking and installation had begun in the northeast corner of the ceiling and finished in the southwest corner, tile removal had to be performed precisely opposite of installation. Removal started in the southwest corner, with each block being supported by a battery operated lift cart. Support rods were then cut and the tile lowered to the floor.

Approximately 122,000 lbs. (55,339 Kg) of lead from the high-dose room was surveyed for free release and transferred to the ANL-E lead bank for reuse.

After removal of the lead from the high-dose room ceiling, floor and walls, the equipment located above the false ceiling (attenuator and converter drives, air tanks and associated piping and wiring) was removed. First the floor plugs were removed from above the high-dose room and a containment tent was constructed. The area was classified as a permit-required confined space; air monitoring, retrieval capability and full time attendant during entry were required during equipment removal. The equipment was mechanically disassembled and removed through the floor opening. Upon completion of equipment removal the false ceiling was removed using electric jack hammers and the supporting I-beams and grating was removed using electric cut-off saws. The equipment, concrete rubble and ceiling support structure were packaged as low level waste. The high dose room demolition work began on February 3, 1997 and was completed on April 15, 1997.

Reactor Area Demolition

Reactor area demolition encompassed removing equipment and components in the vicinity of the reactor (the area between the high and low dose rooms) including the control rod drive system, piping and wiring, the reactor tank and internals, the graphite reflector, and the steel shell.

Above the reactor are fifteen shielded floor plugs that were removed to provide access to the top of the reactor and steel shell. The overhead crane was used to remove the plugs. They then were staged outside Janus facility, where they were stripped of lead based paint and repainted.

A containment tent was constructed over the opening to the reactor area allowing dismantlement of potentially contaminated equipment and piping to be done inside. The containment was ventilated with a portable HEPA ventilation system to control potential airborne emissions. This task was completed between February 27, 1997 to March 3, 1997.

After constructing the containment tent, the piping, equipment and wiring above the reactor was disassembled using hand tools and electric saws. All material was removed and packaged as low level radioactive waste. This task was accomplished between March 26, 1997 to April 23. 1997.

After removal of all piping and equipment that might interfere with the removal of the reactor shield plug, the hold down bolts were removed and the shield plug was rigged to the overhead crane. The plug was then raised to allow health physics personnel to perform radiological surveys for loose contamination and to determine dose rates around the top of the open reactor tank. Upon completion of the surveys the shield plug was packaged as low level waste into a special oversized waste bin as low level radioactive waste. This task was completed on April 24, 1997.

Prior to removal of the reactor tank, it was necessary to disconnect the pneumatic tube assembly from the reactor tank and remove it. The tube was mechanically disassembled and removed from it's access tube in the biological shield. Portions of the tube assembly which were located close to the reactor were packaged as low level radioactive waste. The shield plug and outside sections of the tube were surveyed and disposed of as clean scrap. The tube assembly was removed between April 9, 1997 and April 10, 1997.

Reactor tank removal involved lifting the aluminum reactor tank out of the steel shell and surrounding graphite reflector, and transferring it to a contamination-control area for size reduction and packaging. In order to lift the off-set load caused by the lead and graphite stepped system attached to one side of the reactor tank, a special lifting rig was purchased. The reactor tank was rigged to the overhead crane and transferred to the lay-down area on April 25, 1997. Size reduction and packaging of the reactor internals and reactor tank was completed on April 29, 1997.

Graphite Removal

After removal of the reactor tank, the graphite reflector blocks were exposed. The void area left by the reactor tank removal was classified as a permit required confined space requiring air monitoring and personnel retrieval during entry. Removal of graphite began at the top of the void left by the reactor tank and progressed down. The graphite was placed into 55 gal (208 l) drums and lifted out with the overhead crane. Waste was packaged for disposal into steel bins. After the height of graphite had been reduced to below the top edge of the low dose window, the window cover was removed allowing graphite removal to be continued from the low dose room. After the opening was enlarged, the area was reclassified as a non-permit-required confined space. This work started on May 8, 1997 and was completed on June 3, 1997.

Steel Shell Removal

The steel shell surrounded the graphite region of the reactor and, when the reactor was in place, it had provided a gas tight enclosure. The steel shell was made of 0.5 in (1.27 cm) thick steel; to reduce neutron activation of the steel and surrounding concrete, a .125 in (0.318 cm) thick layer of boral had been riveted to entire interior surface. During removal, the boral was stripped from the inside surface using pry bars, folded up and placed in low level radioactive waste bins for disposal. The steel shell was then cut into pieces with a plasma arc torch and abrasive cut off saw, and packaged as low level radioactive waste. This activity was started on May 19,1997 and completed on September 9, 1997.

High- and Low-Dose Shutter System Removal

The high- and low -dose shutter systems were used during operation to protect personnel from neutron and gamma radiation during entry into the dose rooms. The low-dose shutters, constructed of 10 in (25.4 cm) thick interlocking steel encased ferrophosphate concrete blocks, were operated (raised or lowered) from the reactor control room by pneumatic cylinders. When the shutters were in the down position, they rested upon shutter pedestals of the same construction. The high-dose shutters were 28 in (71.12 cm) thick interlocking steel encased lead and polyethylene blocks that sat upon pedestals of similar construction. The high-dose shutters were also operated from the control room by pneumatic cylinders. The following sections describes the removal of the shutter systems components.

The high-dose shutter drive consisted of three large pneumatic cylinders mounted on a support stand in the high bay, two air receiver tanks and associated piping in the HEPA filter room and associated electrical controls. To remove the shutter drive, the electrical and air systems were LO/TO, and the associated piping and electrical controls were removed. The cylinders were attached to the high dose shutters by a steel shaft that penetrated the shielded floor plugs. Once the cylinder shafts were disconnected from the shutters, the cylinders were removed from the stand, surveyed and released as clean scrap. The air receivers were isolated and disconnected from the building air system and also released as clean scrap. This task was performed between January 22 and January 28, 1997.

The low-dose shutter drive consisted of three pneumatic cylinders mounted in special shielded floor plugs below the high bay. The air receiver and electrical controls for these cylinders was located in the reactor equipment room. LO/TO was performed on the electrical and air systems prior to their removal. The cylinder shafts were disconnected from the shutters, and the cylinders were rigged to the overhead crane, removed, disassembled and packaged for disposal as low level radioactive waste. This work was performed between January 22, 1997 and March 24, 1997.

The high-dose shutters were left in place until the graphite was removed to provide gamma shielding for personnel working in the high-dose room. The shutters and pedestals were rigged to the overhead crane and transferred to a containment, where activated lead and polyethylene from inside the steel casing were removed. The steel casing and polyethylene were disposed of as low-level radioactive waste, and the lead was packaged as mixed waste. The grouting of voids behind the shutter guides and pedestals prevented direct removal of the high-dose shutter pedestals with the crane. Before they could be lifted free, the shutter guides had to be dismantled in place and the grout removed from around the pedestals. This work started on June 6, 1997 and finished on September 9, 1997.

As with the high-dose shutters, the low dose shutters were also left in place until removal of the graphite was started to provide gamma shielding for personnel working in the low-dose room. The shutters and pedestals were rigged to the overhead crane and transferred to a lay-down area for survey and release. The low dose shutters were disposed of as clean scrap. This work started on May 29, 1997 and completed on June 2, 1997.

Activated Structure Removal

Activated materials present near the reactor consisted of activated bioshield concrete, the converter plate frame, the gamma attenuator pedestal and the reactor pedestal. The following sections describe the removal of these items.

The activated bioshield consisted of the concrete "bridges" located on top of the steel shell above the high and low dose windows, the concrete "wings" located directly north and south of the steel shell and the reactor pedestal which supported the steel shell. These concrete structures were removed utilizing electric and pneumatic jack hammers, Bristar™ expanding grout and the Brokk 150 semi remote, portable hydraulic jack hammer. Concrete removal was performed inside of a HEPA-ventilated containment enclosure to control the spread of activated concrete dust. The concrete was packaged into steel drums and steel waste bins for disposal as low-level radioactive waste. This work was started on May 14, 1997 and completed on September 10, 1997.

Control Room Facilities Removal

Removal of the control facilities required dismantlement of the reactor control panels, low dose control panels and the high dose control panels. The following sections describe the removal of these items.

The low-dose room control panels were located in the low-dose preparation room on the service floor of the Janus Reactor Facility and housed various controls and power supplies for performing experimental work. Prior to removal, power to the control console was LO/TO. After electrical isolation, the panels were manually disassembled, surveyed for free release and disposed of as clean scrap. This work was started on February 4, 1997 and completed on February 28, 1997.

The high-dose room control panel was located in the high-dose preparation room and housed controls and power supplies for performing experimental work. Power was disconnected and LO/TO, and the panel was dismantled, surveyed and free released as clean scrap. This work was started on February 4, 1997 and completed on February 28, 1997.

The reactor control consoles were located in the reactor control room on the main floor; they provided control power for reactor operation as well as instrumentation readouts for monitoring reactor operation. Power was isolated to the control panels and LO/TO, and dismantling began. On January 30, 1997, two energized emergency power circuits were cut during dismantlement work. These circuits were added after completion of the reactor facility and did not appear on any available drawings. All work was stopped and an investigation was ordered by the ANL Project Manager. As a result of the investigation, the dismantlement procedure was revised and additional electrical monitoring equipment was purchased prior to restarting dismantlement operations. The consoles were dismantled, surveyed for free release and disposed of as clean scrap. This work was started on January 29, 1997 and completed on January 31, 1997.

Systems Removal

Systems removal consisted of dismantlement of the secondary cooling system, primary water system, reactor and graphite helium system and the level control and skimmer system. These systems were primarily located in the reactor equipment room on the service floor of the Janus Reactor Facility. After removal, the piping and equipment was size reduced with portable electric saws and surveyed for free release as clean scrap or packaged as low level radioactive waste. This work began on March 4, 1997 and was completed on May 7, 1997.

C. Close-Out Operations

At the completion of all D&D activities and prior to starting the final status survey, the facility was wiped down with damp rags. This work was performed from June 9, 1997 to September 19, 1997. A final status radiological survey was performed on the Janus Reactor Facility at the completion of the D&D phase of work. The survey was performed in accordance with NUREG/CR-5849 "Manual for Conducting Radiological Surveys in Support of License Termination" and an approved final survey plan. The final status survey started on May 8, 1997 and was completed on September 30, 1997. In conjunction with the final status survey, paint and concrete samples were collected and analyzed for residual activity. Sample collection and analysis was performed between August 28, 1997 and September 5, 1997. Upon completion of the final survey the contractor demobilized from the site. Demobilization consisted of archiving all records and data, packaging and shipping equipment and supplies and disbanding the project staff. Demobilization was performed on September 30, 1997.

The final project activity consisted of preparation of the final report. The report utilized the information and data from several documents i.e. the Janus Characterization Report (March, 1996), and the Final Project Report and Final Survey Report prepared by Afftrex, Ltd. The final report was submitted on October 28, 1997. The JANUS D&D Project schedule depicting the actual work durations is shown in Figure 4.

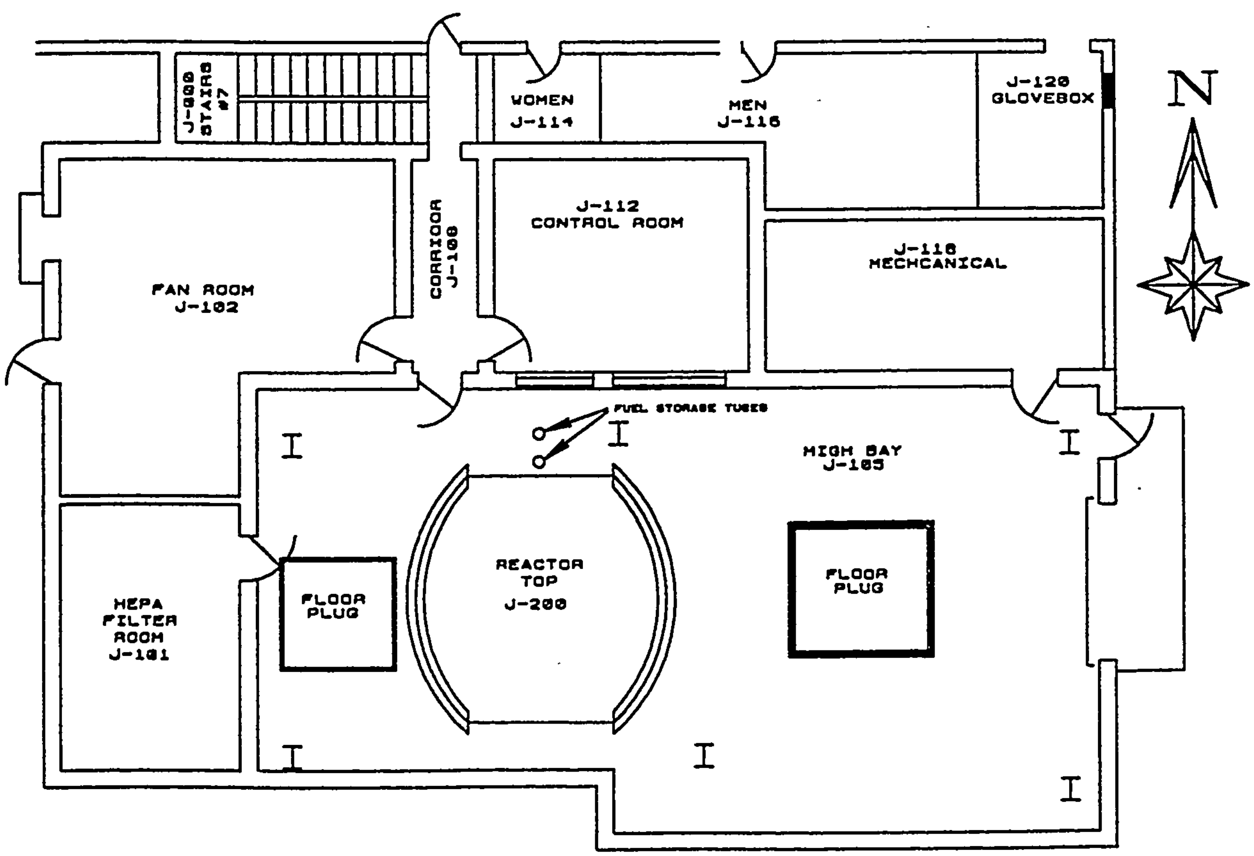


Figure 1. JANUS Reactor Facility Main Floor Layout

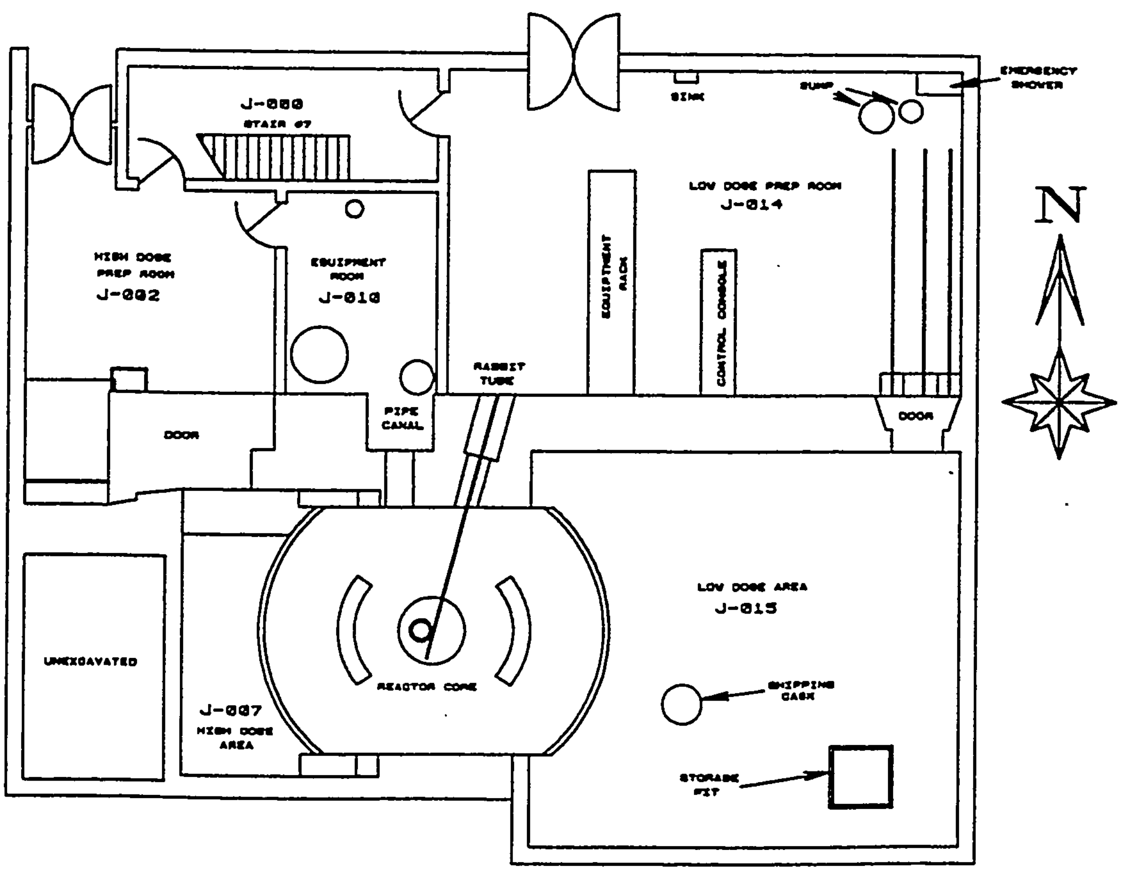
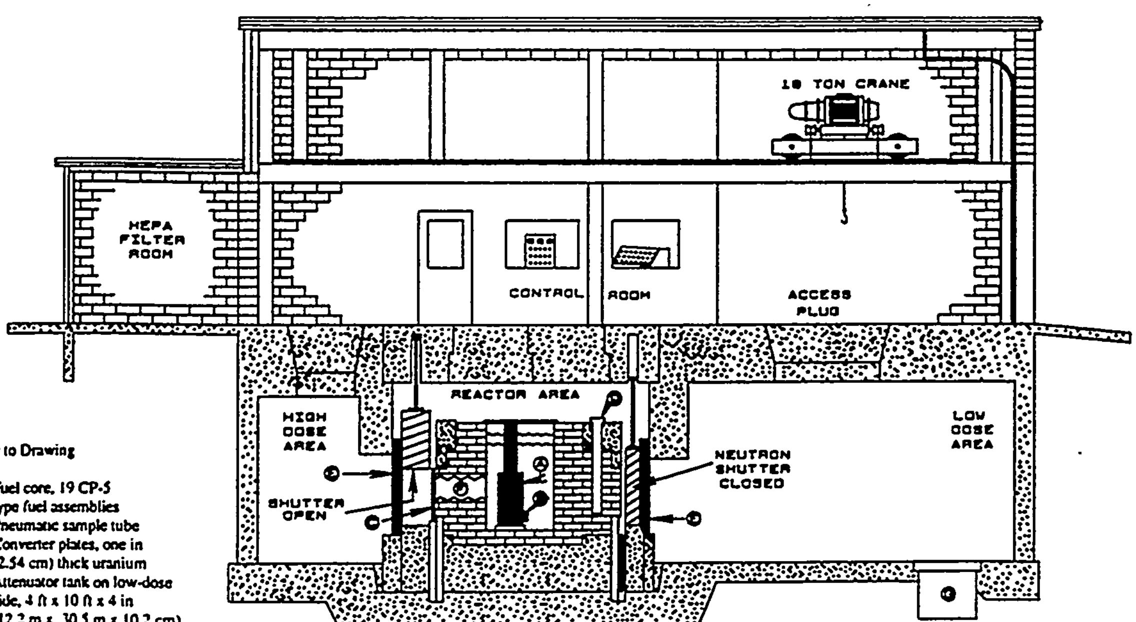


Figure 2. JANUS Reactor Facility Service Floor Layout



Key to Drawing

A Fuel core, 19 CP-5 type fuel assemblies
B Pneumatic sample tube
C Converter plates, one in (2.54 cm) thick uranium
D Attenuator tank on low-dose side, 4 ft x 10 ft x 4 in (12.2 m x 30.5 m x 10.2 cm)
E Lead gamma shields, 6 in (15.2 cm) thick on high-dose side, 4 in (10.2 cm) thick on low-dose side
F 16 in (40.5 cm) square hole in thermal column on high-dose side, normally packed with graphite
G Storage pit, 3 ft (91.4 cm) deep, location for gamma source, if needed

Figure 3. Elevation Cross Section of the JANUS Reactor Facility

JANUS D&D PROJECT
Argonne National Laboratory

ID	Task Name	Start	Finish
1	JANUS D&D PROJECT	10/2/95	12/22/97
2	Project Management and Staff	10/2/95	10/3/97
3	Engineering and Procedure Support	10/2/95	9/30/97
4	Equipment and Materials	10/2/95	9/30/97
5	Characterization	12/21/95	5/30/96
6	Procurement Activities	6/3/96	11/12/97
7	Contractor Mobilization	11/11/96	1/21/97
8	Surveillance and Maintenance	1/6/97	9/30/97
9	Decommission Facilities	1/22/97	9/23/97
10	High- and Low-Dose Shutter System Removal	1/22/97	9/9/97
11	Miscellaneous Components	1/28/97	9/23/97
12	Control Room Facilities Removal	1/29/97	3/4/97
13	High-Dose Room Demolition	2/3/97	4/15/97
14	Reactor Area Demolition	2/27/97	9/9/97
15	Systems Removal	3/4/97	5/7/97
16	Storage Facilities and Excess Material	3/5/97	7/23/97
17	Activated Structure Removal	3/19/97	9/10/97
18	Close-Out Operations	5/8/97	12/22/97

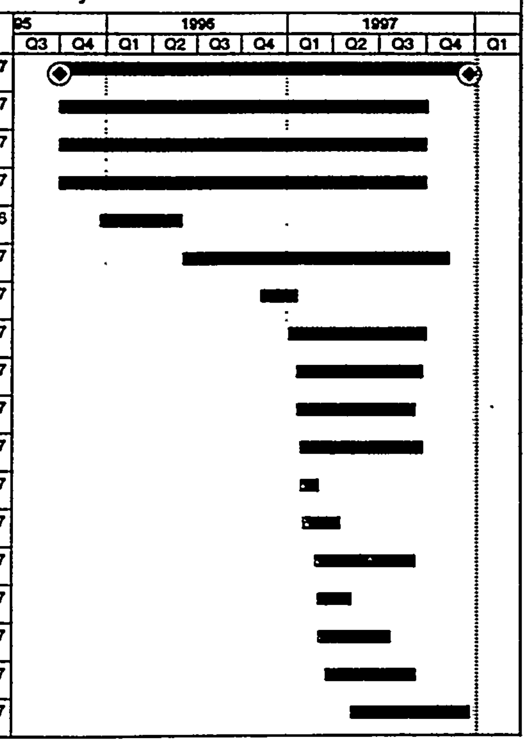


Figure 4. JANUS D&D Project Schedule