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Abstract

The former Rockwell International Hot Laboratory, located at Boeing Canoga Park's Santa Susana Field Laboratory in Ventura County, California, operated under Department of Energy funding from 1959 until 1987. It was used originally for the disassembly and examination of irradiated nuclear reactor fuel assemblies and test specimens, and later for the decladding of irradiated plutonium-bearing fuels from off-site reactors. Decontamination and decommissioning (D&D) of the facility was initiated in 1987, and facility dismantlement was completed in 1999. This report documents the Hot Laboratory facility decontamination and dismantlement activities. It includes a description of the facility, an overview of the D&D program, details and highlights of the program activities chronologically by fiscal year, waste management and cost summaries, and a synopsis of lessons learned from the program.

Responsible Person: R. D. Meyer

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1.0 INTRODUCTION

The Rockwell International Hot Laboratory (RIHL) is one of a number of former nuclear facilities that has been decontaminated and decommissioned at the Santa Susana Field Laboratory (SSFL). The former Hot Laboratory facility has been completely dismantled and all components and materials have been removed. The only remaining action is final release by the Department of Energy (DOE). This report documents the decontamination and dismantlement activities performed at the facility, which occurred over the time period 1988 through 1999.

1.1 FACILITY LOCATION

The Hot Laboratory was part of Rocketdyne's Santa Susana Field Laboratory in the Simi Hills of southeastern Ventura County, California, adjacent to the Los Angeles County line and approximately 29 miles northwest of downtown Los Angeles. Figure 1-1 shows the location of the SSFL relative to the surrounding communities. The Hot Laboratory was located in Area IV, which comprises the western portion of the SSFL in an area known as Burro Flats. This is indicated in Figure 1-2, a portion of the 1967 edition of the U.S. Geological Survey Calabasas Quadrangle topographic map. Figure 1-3 is an aerial photograph of Area IV, showing the Hot Laboratory and surrounding buildings. The facility itself is shown in more detail in Figures 1-4 and 1-5.

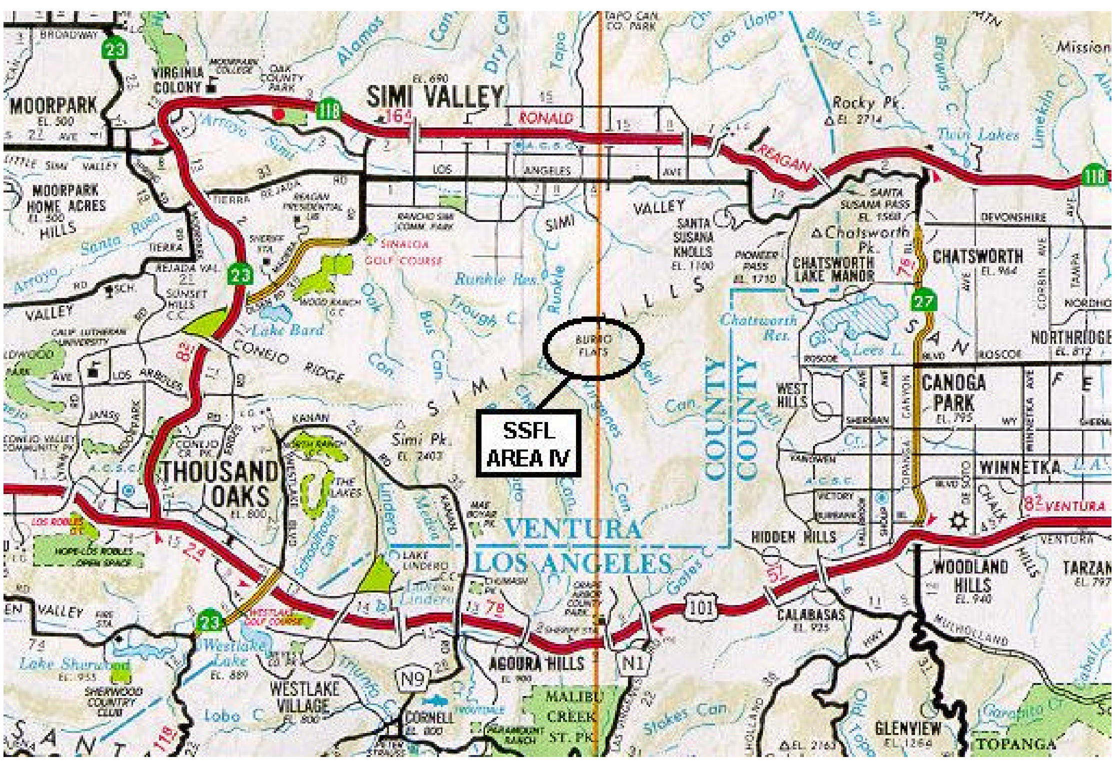


Figure 1-1. Map of Southeastern Ventura County, Showing the Location of the SSFL.

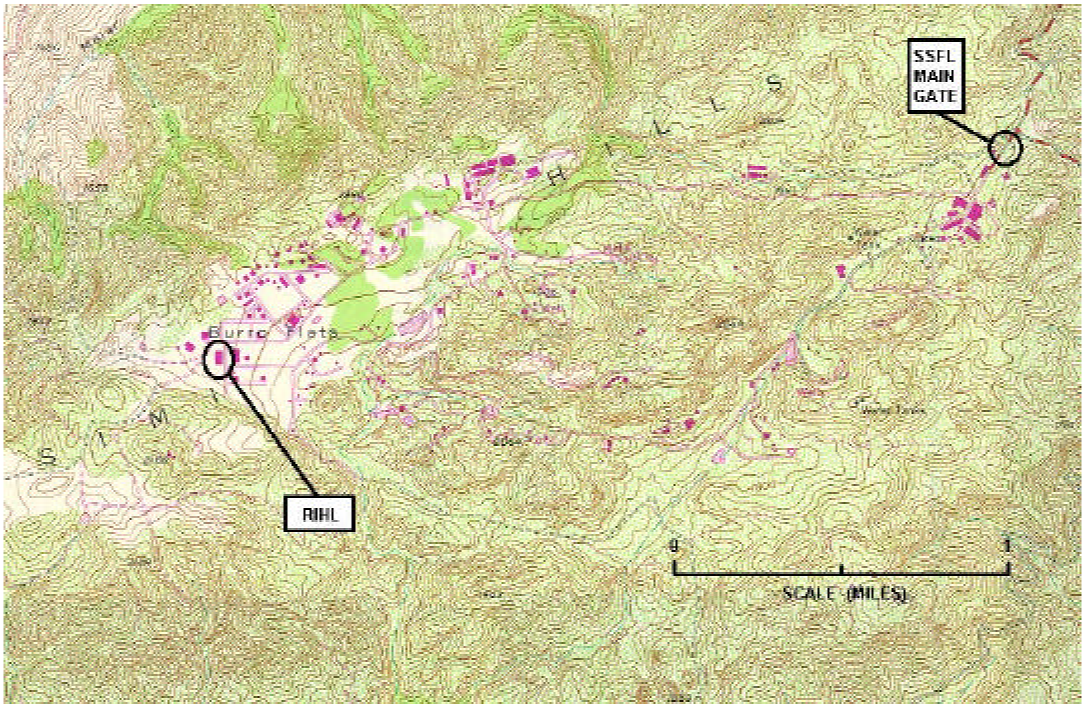


Figure 1-2. Topographic Map for the Area Encompassing the SSFL, Showing the Location of the Hot Laboratory.

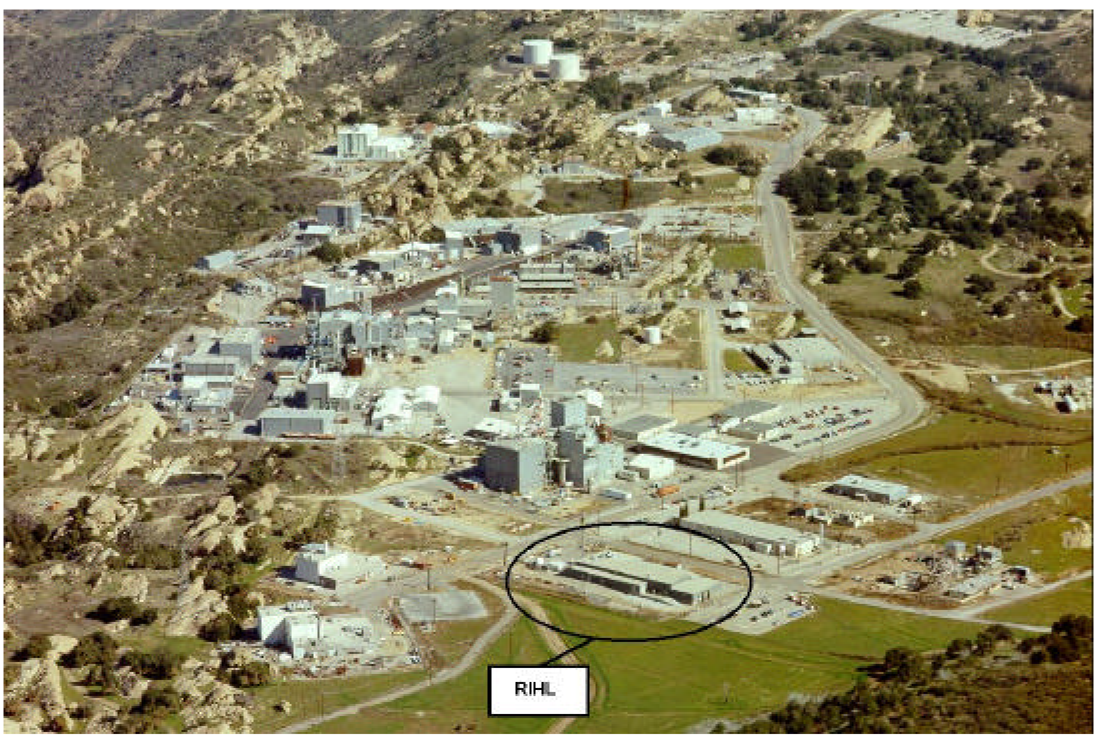


Figure 1-3. Aerial Photograph of SSFL Area IV. *[SS-812CN]*

Figure 1-4. Aerial Photograph of the Hot Laboratory Facility in 1987, Just Prior to Initiation of Decontamination and Decommissioning. *[6DH21-3/26/87-S1P]*

Figure 1-5. Photograph of the Hot Laboratory Facility Looking North.

1.2 OPERATIONAL HISTORY

The Rockwell International Hot Laboratory was originally built and owned by Rockwell International, with the operations funded under Department of Energy programs. It was constructed for the remote handling, disassembly, and examination of irradiated nuclear reactor fuel assemblies and test specimens. The facility construction was completed in 1959, and operations were conducted under Nuclear Regulatory Commission (NRC) Special Nuclear Materials License No. SNM-21.

The Hot Laboratory was used for the disassembly and examination of irradiated nuclear fuel assemblies from several facilities, including the Sodium Reactor Experiment (SRE), Organic Moderated Reactor Critical Facility (OMR), Sodium Graphite Reactor Critical Facility (SGR), and Piqua (Ohio) Reactor. Several Systems for Nuclear Auxiliary Power (SNAP) reactor cores were disassembled and examined in the Hot Lab, including the SNAP-2 Experimental Reactor (SER), SNAP-2 Developmental Reactor (S2DR), SNAP-8 Experimental Reactor (S8ER), SNAP-8 Developmental Reactor (S8DR), and SNAP-10 flight system ground test reactor (10FS-3). The facility was also used for other related remote-handling activities, including the analysis of irradiated test materials, the manufacture of sealed radioactive sources (primarily ^{147}Pm), the leak checking of radioactive sources, and the machining of radioactive ^{60}Co.

Following the termination of the SNAP program, the Hot Laboratory was used for the decladding of irradiated plutonium-bearing fuels from off-site reactors. The decladding operations included the disassembly of fuel assemblies, removal of the fuel from its cladding, size-reduction of the non-fuel components, and shipment off-site of the separated materials. Decladding operations were performed for fuels from the SRE, Hallam Reactor, Experimental Breeder Reactor I (EBR-I), Experimental Breeder Reactor II (EBR-II), Southwest Experimental Fast Oxide Reactor (SEFOR), and the Fermi Reactor. Those operations spanned a time period of about ten years, immediately prior to the facility shutdown.

The 30-year service history of the facility was generally uneventful in terms of unusual radiological occurrences. There was one fire in a decontamination cell in May 1971, which occurred during the process of disposing of about 100 gallons of NaK, a sodium-potassium eutectic that is liquid at room temperature. The NaK contained about 100 mCi of mixed fission products, and the release of about 25 gallons of the liquid into the cell from a hole in a tank fill line resulted in the burning of the material. The facility's high-efficiency, filtered ventilation system confined essentially all combustion products to the Hot Laboratory facility. Airborne and surface radiological contamination concentrations inside the building from the event ranged from 2% to 20% of the maximum permissible concentration for occupational use, and the average concentration of the release from the laboratory exhaust stack was about 5% of the permitted concentration in an unrestricted area.

1.3 DECONTAMINATION AND DISMANTLEMENT

The decision to decontaminate and decommission (D&D) the Hot Laboratory was made in 1987, following the completion of the Fermi fuel decladding program. The Fermi program was completed ahead of schedule, and the DOE directed Rocketdyne to utilize the balance of the year's funding to begin planning for facility D&D rather than for a follow-on decladding program. The D&D was thus initiated under the Fermi fuel decladding contract (DE-AC03-86SF16021). DOE assumed responsibility for the decontamination and decommissioning of the facility, because of its use on DOE programs, and decommissioning was conducted under NRC Special Nuclear Materials License No. SNM-21. Ownership was transferred to the DOE in October 1995 to facilitate the final dismantlement. Concurrent with this ownership transfer, Rocketdyne requested termination of the NRC license. Termination was granted on October 3, 1996, under the condition that Rocketdyne and the DOE complete decontamination and release of the facility in compliance with the NRC guidelines.

The original objective of the D&D work was to decontaminate the facility to levels that would allow its release for unrestricted use. Rocketdyne was redirected in 1992 to dismantle the facility. The effort was re-planned to first decontaminate the facility, and then demolish the structures and dispose of the rubble as clean waste. Additional funds were allocated to the program in 1996 by the DOE through a Small Sites Initiative, with direction to accelerate the dismantlement. This dictated a second change in planning, including the demolition and removal of the contaminated structures prior to the decontamination, restoration, and release of the cleared site.

This report documents the decontamination and dismantlement activities performed at the Hot Laboratory facility over the time period 1987 - 1999. Section 2 provides a description of the facility and its radiological status prior to the initiation of D&D, and Section 3 is an overview of the D&D program over the 1987 - 1999 time period. Section 4 discusses the regulations, procedures, and documentation associated with the work, while Section 5 outlines the policies enacted for personnel protection throughout the program. Section 6 provides details and highlights of the program activities in a chronological fashion by fiscal year. Sections 7 and 8 provide waste management and cost summaries, respectively, and Section 9 discusses the lessons learned from the program.

2.0 FACILITY DESCRIPTION PRIOR TO D&D

2.1 FACILITY DESCRIPTION

The Rockwell International Hot Laboratory facility is shown in plan view in Figure 2-1. The primary structure was a rectangular, structural steel building (Building 4020) with a floor space of about 16,000 ft^2. A separate support building (Building 4468) housed a 3,000-gallon radioactive holdup tank that received effluents from Building 4020 through a radioactive drain system. Three subsurface fission gas tanks, which were never put into service, were located at the north end of Building 4020. Temporary office and health physics office trailers (not shown) and a materials holdup yard were also located within the facility boundary at various times.

Building 4020, the hot laboratory building, housed four radioactive material handling ("hot") cells constructed of reinforced concrete, with adjacent concrete decontamination ("decon") rooms and an underlying concrete basement. The steel building structure provided an operating gallery on the front side of the cells, a service gallery in the rear, and rooms for maintenance, mockup testing, engineering support, and administrative activities. The building roof and outer walls were fabricated of structural steel columns, trusses, and beams with an attached sheet-metal skin. The building interior walls, with the exception of the hot cells and decontamination rooms, were fabricated of metal studs, wire mesh, plaster and gypsum board. All of the radiologically controlled areas within the building were connected to the drain system that terminated in the Building 4468 holdup tank.

The configuration of the hot cells and decontamination rooms are shown in plan view in Figure 2-1 and in elevation view in Figure 2-2. The hot cell walls were constructed of 42-inch-thick, high-density, steel-reinforced magnetite concrete, and the decontamination room walls of 24-inch-thick standard reinforced concrete. All of the hot cell surfaces, plus the floors and east walls of the decontamination rooms, were clad with ¼-inch-thick steel plate. The other decontamination room walls were covered with approximately 1-inch-thick plaster, and all surfaces were covered with several layers of epoxy paint. The hot-cell viewing windows were constructed of 42-inch-thick, oil-filled leaded glass. Each hot cell contained wells for materials storage and had a 3-ton bridge crane.

The hot cell walls incorporated a variety of through-wall penetrations for instrumentation, inter-cell transfers, and other functional requirements. Master/slave manipulators were mounted at each cell viewing window, and Cells 3 and 4 were also outfitted with electromechanical manipulators. In-cell equipment was operated remotely from the operating gallery using the manipulators plus controllers that were interfaced through the wall penetrations. This is depicted in Figure 2-3, an operating gallery photograph of remote operations for the disassembly and downsizing of irradiated nuclear reactor fuel assemblies. The oil-filled, leaded-glass viewing windows provided radiation shielding while allowing direct viewing of the remote machining, grinding, cutting, and packaging operations.

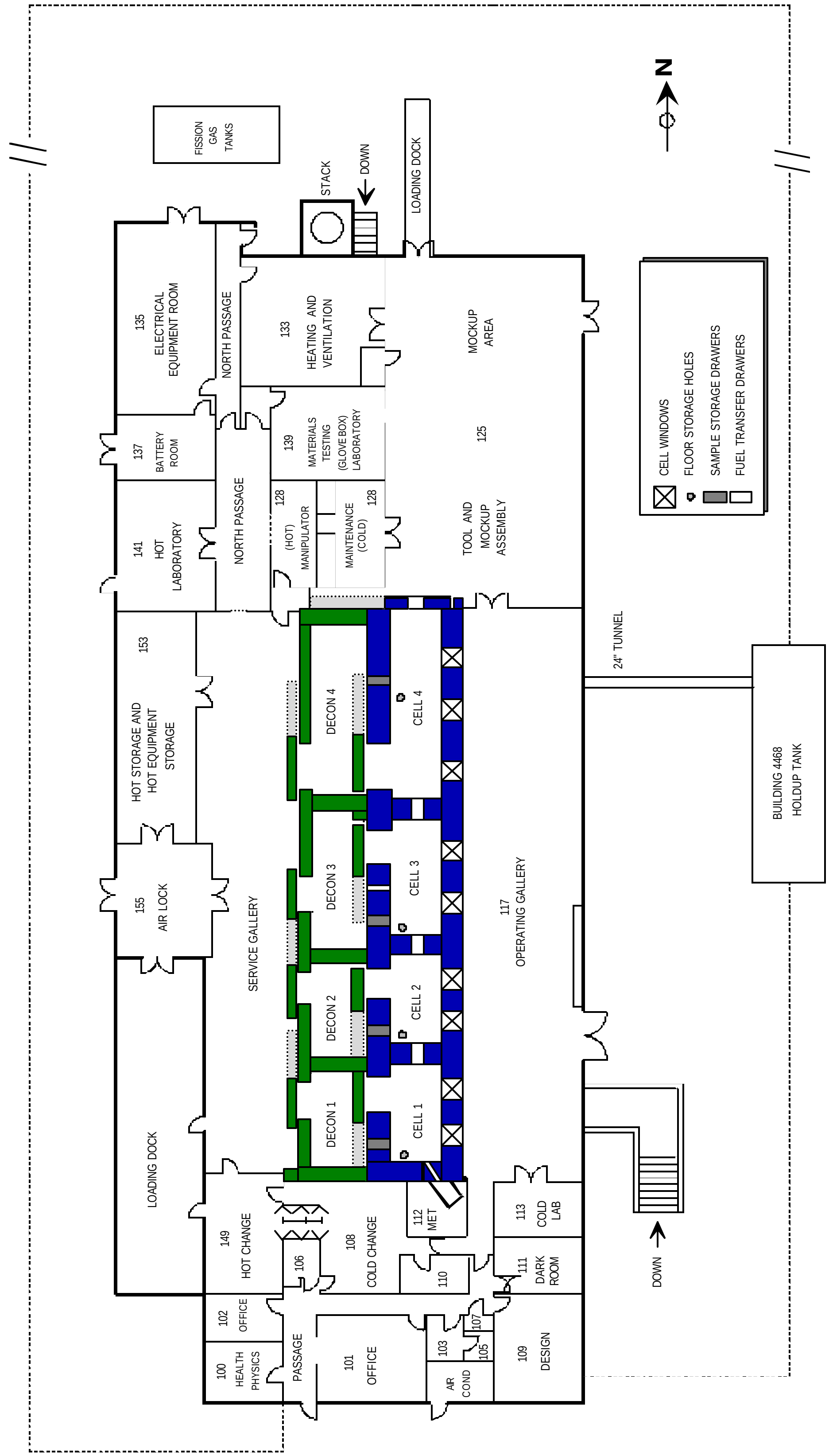


Figure 2-1. Plan View of the RIHL Facility.

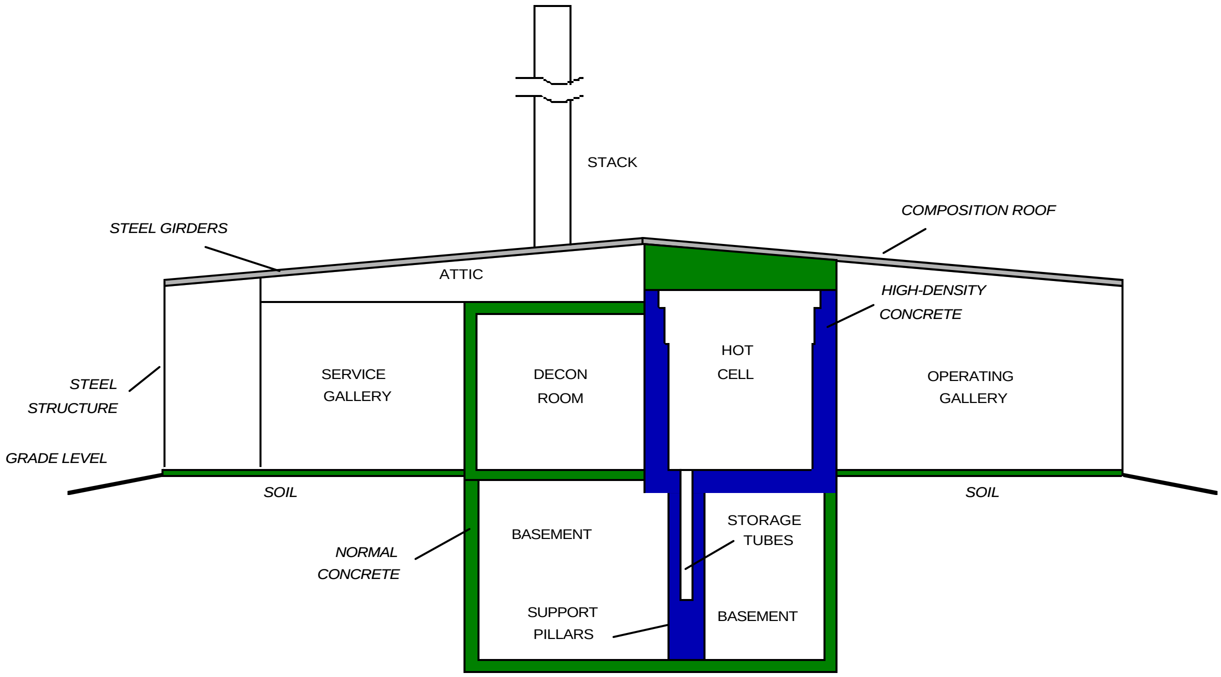


Figure 2-2. Elevation View of Building 4020, Showing the Geometry of the Hot Cells, Decon Rooms, and Basement.

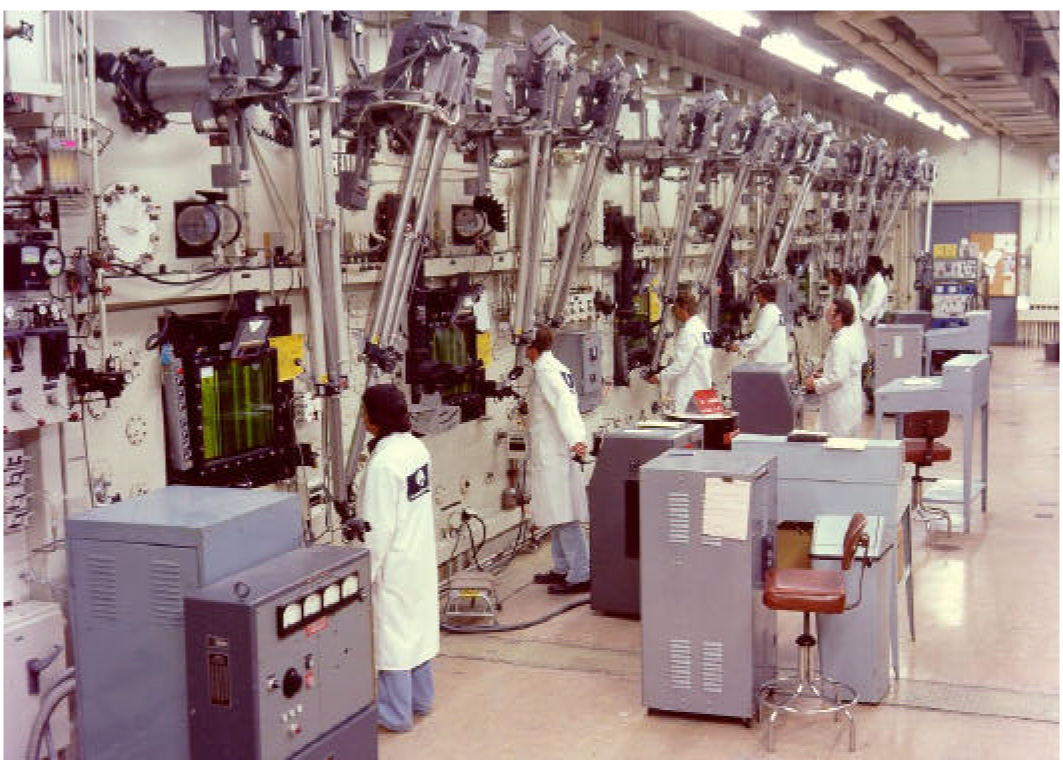


Figure 2-3. Photograph of Remote Fuel Declad Operations from the Operating Gallery. [9180-112CN]

The service gallery provided access into the hot cells through the decon rooms. It was used for the temporary storage and packaging of radioactive equipment and materials, and for the movement of equipment, materials, and wastes into and out of the hot cells. The decon rooms were also used for equipment decontamination and packaging, and served as contamination control areas between the cells and the service gallery. An alternative hot cell entry route was used for high-activity materials, such as spent nuclear fuels. They were transferred directly into and out of the cells in shielded casks through an access port on the north door of Cell 4.

The concrete structure of the hot cells and decon rooms also included an underlying basement with 24-inch-thick concrete walls. The basement is shown schematically in elevation view in Figure 2-2, and in plan view in Figure 2-4. As indicated in Figure 2-4, the basement structure included five large concrete support columns which provide part of the structural support for the hot cells. Columns 1, 2, 3, and 5 (starting at the left in Figure 2-4) were constructed of steel-reinforced dense concrete and had 6½-foot-square cross sections. A carbon-steel pipe storage tube was embedded in the center of each of these columns, extending vertically downward from the hot cell floor a distance of about 12 feet. Column 4, also constructed of steel-reinforced dense concrete, had a 5-ft. 6-in. by 5-ft. 7½-in. cross section and formed part of an internal concrete wall. Figure 2-5 shows these basement columns during building construction.

The Building 4020 support areas included the operating gallery, service gallery, and several additional special-purpose rooms. The hot storage room (Room 153) and air lock (Room 155) were connected to the service gallery and provided for the movement of materials and equipment to the loading dock. Rooms 141 (hot laboratory), 128 (manipulator maintenance), and 139 (glove box laboratory) were used for servicing equipment with low-level radioactive contamination. Room 139 had also seen service as a hot shop and a ^{147}Pr loading facility. Room 141 contained a stainless steel hood for handling radioactive chemicals, and Room 128 was divided into a "cold" side and a "hot" side, for servicing manipulator components from the clean operating gallery and contaminated hot cells, respectively. Personnel dressing areas for entry to controlled-access areas included both cold-change (108) and hot-change (149) rooms, and general support office areas included Rooms 100, 101, 102, 103, 105, 106, 107, 109, 110, 111, 112, and 113 on the south end of the building. Building support equipment was located in Rooms 133 (heating and ventilation), 135 (electrical equipment room), and 137 (battery room) at the north end of the building. The office area had a drop ceiling, while the laboratory and service areas had plastered ceilings; the remainder of the building had no false ceilings.

Air flow in the building was controlled by two High Efficiency Particulate Air (HEPA) filter systems. These systems were designed to ensure that the air flow was always from the areas of lowest potential radiological contamination to the areas of highest potential contamination. The air then flowed through roughing filters and HEPA filters, and out of the building through a 60-foot-high (above roof) exhaust stack. One filter system was dedicated to the hot cells and decontamination rooms, while the second system serviced the balance of the controlled areas (service gallery, support areas, and basement). The two systems had independent blowers and filter banks, and discharged to the same exhaust stack. Ventilation ducts were located in the basement directly below the hot cells and decontamination rooms. The purpose of the stack, located on the north end of the building, as shown in Figures 1-5 and 2-1, was to force natural convection of released air in the event of a total power loss within the facility.

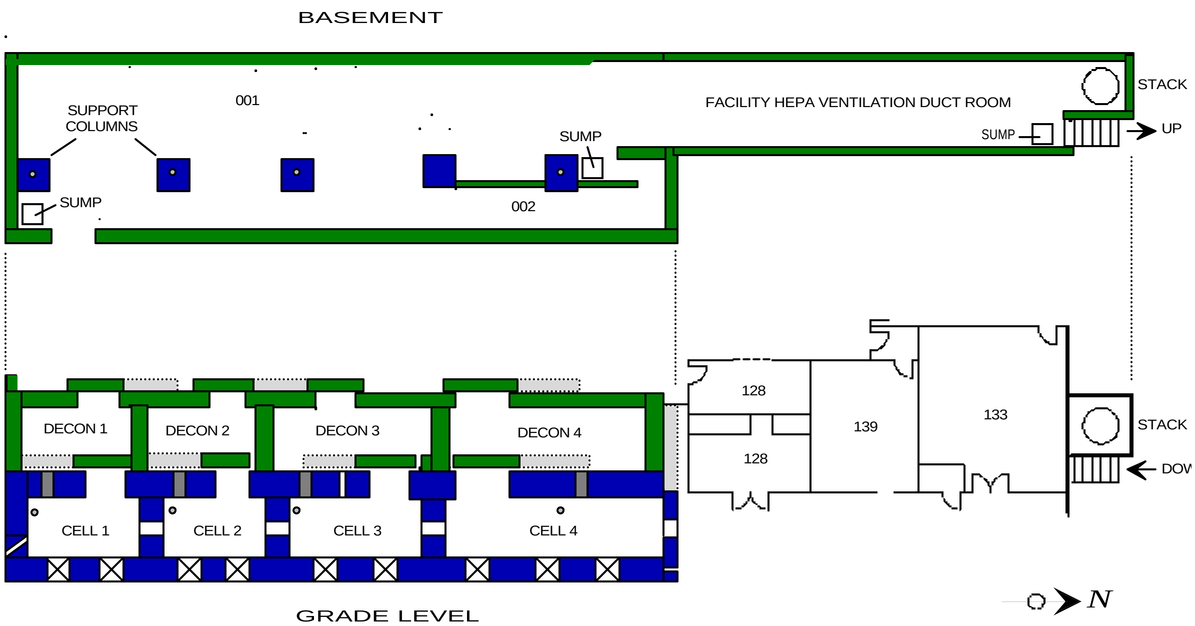


Figure 2-4. Plan View of the Building 4020 Basement, Shown Relative to the Hot Cells and Decon Room.

Figure 2-5. Building 4020 Basement During Construction. [00-5788B 8/22/58]

The facility included an emergency generator (Room 135) to ensure operation of the HEPA systems, air monitor systems, alarm systems, fire protection systems, and other vital systems in the event of a power outage to the building.

The Building 4020 radioactive drain system consisted of several drain lines that drained the individual controlled areas, including the hot cells, decon rooms, service gallery, hot support rooms, hot change room, and basement. Figure 2-6 is a schematic representation of the layout of the individual drain lines. This system was an all-butt-welded stainless steel piping system that joined in the basement and flowed through a double-walled pipe to the Building 4468 holdup tank. This drain line system was embedded in the support-area concrete slab and the rebar-reinforced concrete between the main floor of the building and the basement. The basement contained a drain subsystem which drained into three sumps, one at each end of the basement and one near the center, as shown in Figure 2-7. The contents of these sumps were automatically pumped into the Building 4468 holdup tank.

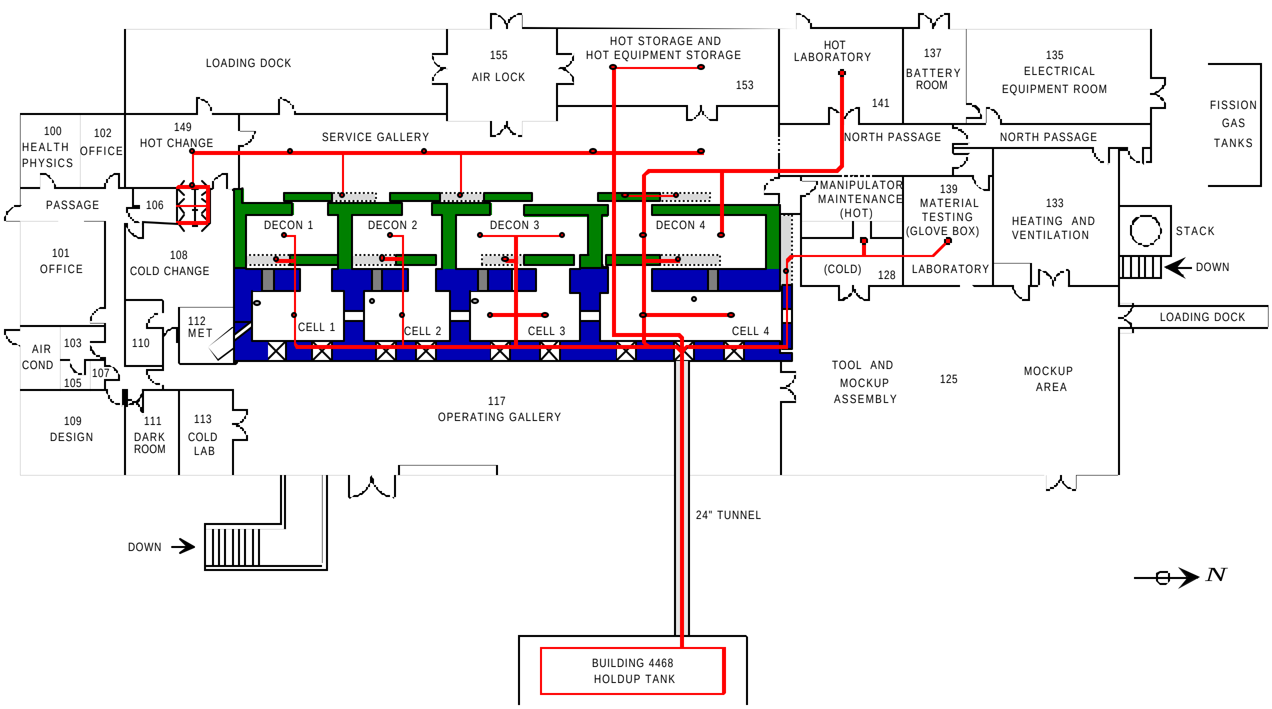


Figure 2-6. Schematic Representation of the Layout of the Hot Laboratory Radioactive Drain System.

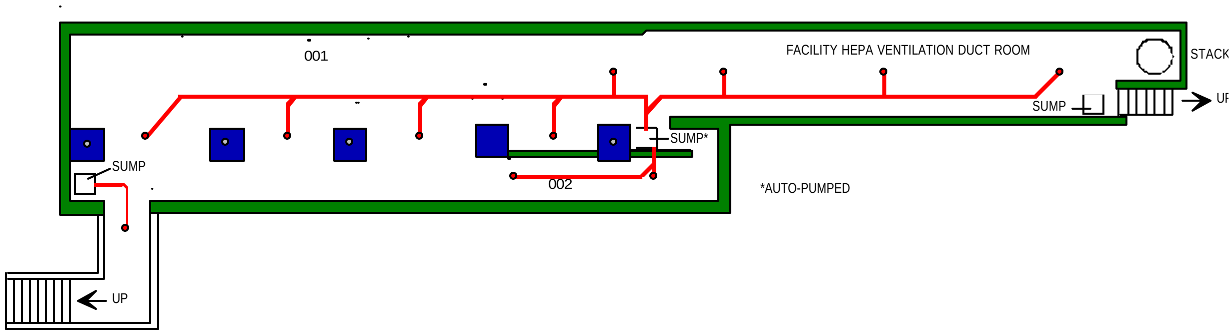


Figure 2-7. Schematic Representation of the Layout of the Building 4020 Basement Drain System.

2.2 RADIOLOGICAL STATUS AT THE START OF D&D

The Hot Laboratory facility was designed to control and minimize contamination. It was also standard practice during Hot Laboratory operations to decontaminate and clean the facility as well as practical at the end of each program. All project-related equipment and materials used in the completed program were removed and either surplused or disposed of as radioactive waste. The cells and decontamination rooms were washed down and the gross contamination was removed in preparation for the next program. Thus, when the DOE decided to D&D the Hot Laboratory facility following the completion of the Fermi Fuel declad program, the hot cells and decon rooms were relatively clean. This aided the D&D effort significantly.

Some degree of radioactive contamination did exist in most of the functional areas of Building 4020 at the start of D&D. For example, removable beta and gamma contamination were present in several areas. The highest levels (> 5000 dpm/100 cm^2) existed in the hot cells (Cells 1, 2, 3, 4) and in the adjoining decontamination rooms. Lower levels of contamination (1000 - 5000 dpm/100 cm^2) were present in most of the service gallery plus the hot side of the manipulator maintenance room, hot laboratory, hot storage area, air lock, and the loading dock. Minor contamination (< 1000 dpm/100 cm^2) was also present in the remainder of the service area plus the operating gallery, cold side of the manipulator maintenance room, and the passageway between the operating gallery and maintenance area.

Radiation levels in the hot cells averaged 50 mR/h, with drain openings reading 1 R/h. Most of the facility equipment remaining in the cells had contamination levels > 100,000 dpm/100 cm^2 and dose rates of up to 500 mR/h (near contact). The highest levels of radioactive material found during the decommissioning activities were in the radioactive drain system running from each of the cells to a header that connected to the Building 4468 radioactive water holdup tank. This contamination consisted primarily of old mixed fission products (^{137}Cs, ^{90}Sr, ^{147}Pm), plus ^{60}Co, small amounts of uranium (< 0.01%), and trace amounts of plutonium. It was determined during the D&D operations that contamination also existed behind the steel liners that comprised the inner surfaces of the hot cells. This contamination extended into the underlying concrete, particularly where cracks were present.

Radiation levels in the decontamination rooms ranged from 0.01 to 0.1 R/h, and localized contamination spots were present in the support areas with levels as high as 20 mR/h. Those localized spots were typically associated with cracks in the walls and floors that had been penetrated by radioactively contaminated water from previous cleanup operations. They were present in the hot change room, hot storage room and air lock. The operating gallery and mockup assembly area had some areas of fixed and suspected contamination. For example, the cell faces and utility trenches were known to be contaminated, and there was contamination under the floor tiles. Slight contamination was also suspected on the floor of the south end of the battery room from a known spill in the hood on the north side of the adjacent hot laboratory. The attic contained a considerable amount of dust-covered utility piping, which was suspected to contain radioactivity from airborne contaminants.

The general contamination level in the basement area at the start of D&D was about 1000 dpm/100 cm^2. The tank alcove had a radiation level of about 100 mR/h, and the pipes, pumps, and filter banks were generally contaminated internally. The basement floor was known to be contaminated as the result of at least one incident where the drain system hold-up weir had overflowed. When the facility was originally constructed, the facility radioactive drain was connected to two 500-gallon holdup tanks that were located in the north end of the basement. One of these tanks was designed for high-level waste and the other for low-level waste. The overflow incident occurred when these tanks were in use. It was recognized at that time that the storage capacity was inadequate for the wash-down of the cells, and resulted in the redesign of the system. The redesign removed the 500-gallon tanks, replacing them with a new 3,000-gallon tank in Building 4468. The storage system relocation reduced radiation exposure to personnel working in the basement area, and the new system was able to contain and control larger quantities of radioactive wastewater.

Outside of Building 4020, the loading dock and surrounding concrete and asphalt areas contained low levels of radioactive contamination. The concrete loading dock and the surface of an asphalt holdup yard to the west of the building were contaminated by past contact with contaminated radioactive containers, and a concrete pad at the north end of the building was contaminated during facility operations. The roof consisted of several layers of asphalt and gravel, since the building had been re-roofed several times,. Core samples established the presence of trace levels of radioactivity, and also established the presence of asbestos in the bottom layer of felt.

3.0 D&D OVERVIEW

As noted in the Introduction, the decontamination and demolition of the Hot Laboratory facility was initiated as a decontamination and decommissioning project, and was redirected to become a facility demolition and site remediation effort during the course of the program. All of the facility demolition and site restoration has been completed. This section provides a general perspective of program directions and activities.

3.1 OVERVIEW

A generalized flow diagram for the Hot Laboratory D&D activities is shown in Figure 3-1. Facility-associated equipment was first removed from the site. Radiological characterization and facility decontamination activities were then initiated, with emphasis on remediating those parts of the facility with the highest radiological contamination levels. The program was redirected to dismantle the facility in 1992, at which time the removal of the most highly contaminated components was initiated. Decontamination of other parts of the facility continued in parallel with this dismantlement effort, in order to minimize the quantity of low level radiological wastes generated when the remaining structure was dismantled. The selective removal of the most hazardous components (including the cell liners, drain lines, and ventilation system) was performed with the building structure intact in order to provide radiological containment. This significantly reduced the radiological hazards associated with the removal of those components. The decontamination effort and the removal of specific contaminated components also made it possible to use outside contractors with specialized skills for the demolition of the remaining facility structure. The use of those contractors provided significant cost and schedule savings in the facility dismantlement effort.

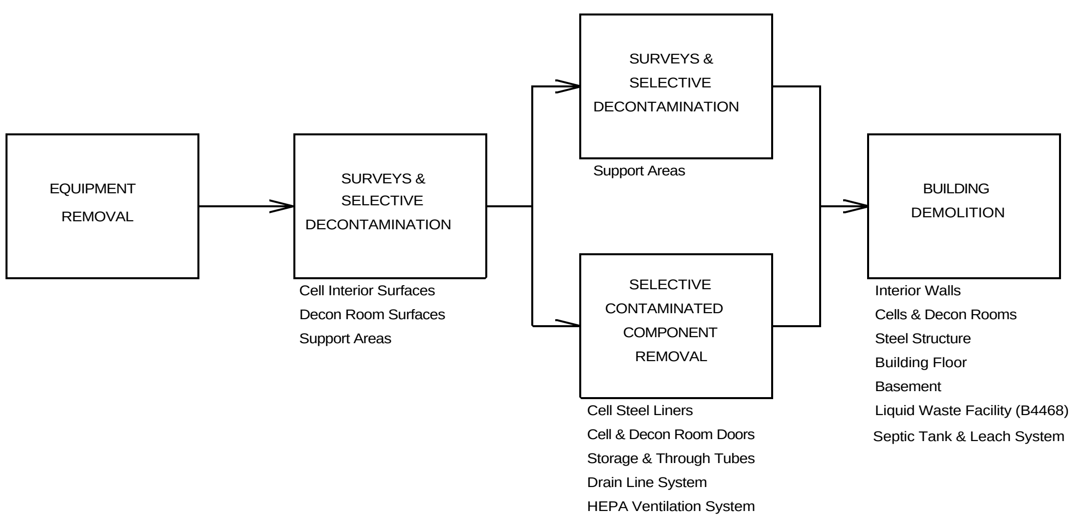


Figure 3-1. Generalized Flow Diagram for the Hot Laboratory D&D Activities.

Figure 3-2 presents a chronological summary of the Hot Laboratory D&D activities by major task. The sequencing and level of specific activities was driven by project direction and funding levels, as outlined below. Highlights and details of these individual activities are described chronologically by fiscal year in Section 6.

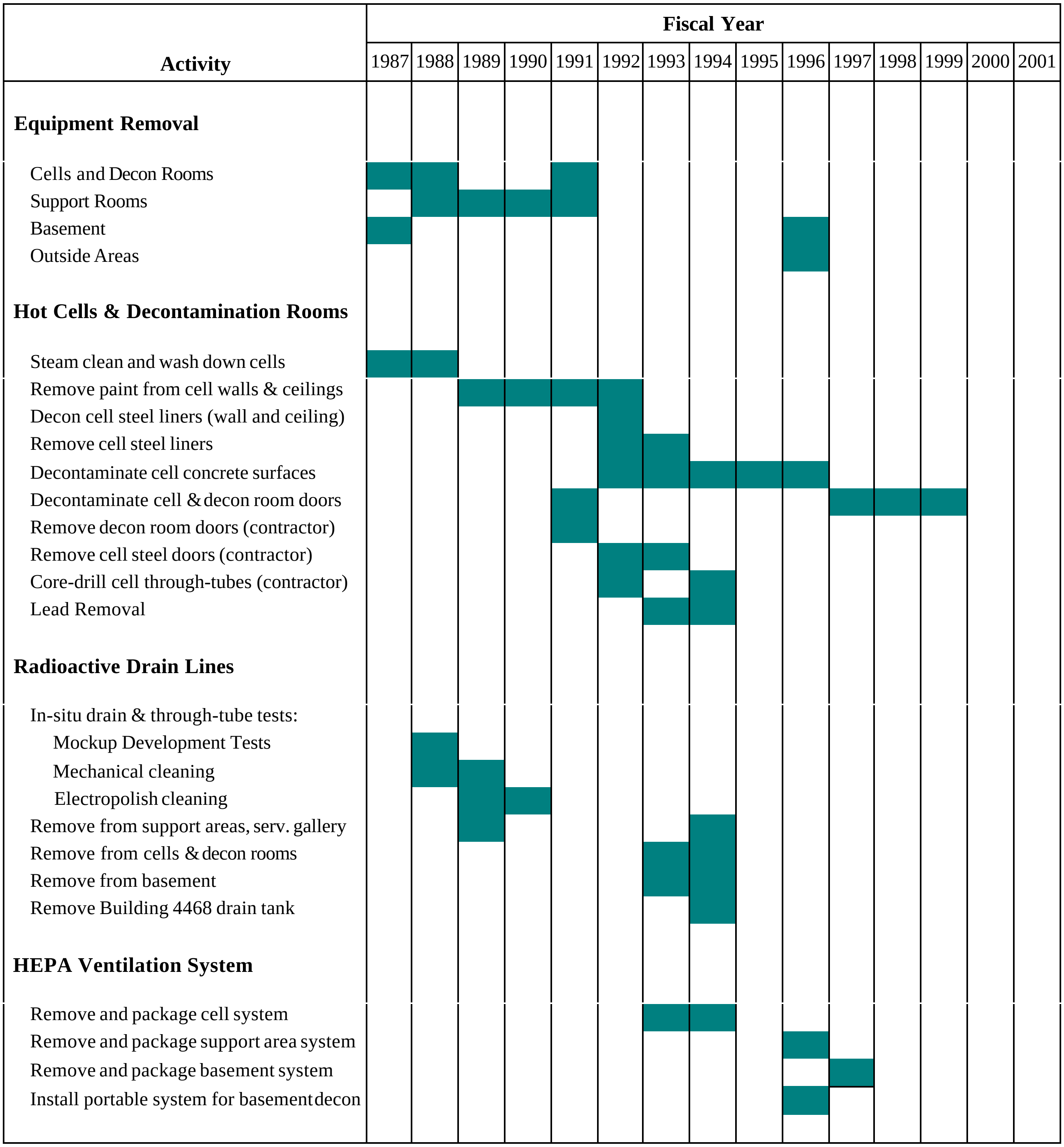
3.2 INITIAL DECOMMISSIONING PLAN

At the conclusion of the Fermi Fuel declad program in Fiscal Year (FY) 1986, all project-related equipment and materials were removed from the Hot Laboratory, and the cells and decontamination rooms were washed down in preparation for an anticipated Fast Flux Test Facility (FFTF) fuel declad program. However, at this point in time the DOE directed Rocketdyne to stop all FFTF preparation activities and utilize the balance of the year's funding to begin planning for the D&D of the Hot Laboratory. The original D&D goal was to remove all contaminated material and equipment, and then decontaminate the facility to radiological levels below Nuclear Regulatory Commission limits for release for unrestricted use. At the conclusion of this activity, the NRC would release this building to Rocketdyne for reuse in another capacity. Planning began in May 1987 and included the preparation of a D&D Program Management Plan (PMP) for the in-situ decontamination and release of the facility. A series of Detailed Working Procedures (DWPs) was then prepared, based on the PMP, for the near-term D&D activities.

3.3 INITIAL CHARACTERIZATION AND DECONTAMINATION ACTIVITIES

During the 1987-1991 time period, hazardous materials plus equipment not needed to perform the D&D work were removed from the facility and decontamination activities were initiated. The decontamination work focused on general contamination removal from several support areas plus the hot cell and decon room walls. Contamination removal techniques included wash-downs, paint removal, and concrete surface scabbling and jackhammering. Studies were performed to determine the feasibility and cost effectiveness of in-situ cleaning of critical areas. Here the key challenge was the removal of contaminants from the radioactive drain system. Hardware was developed and demonstrated for the mechanical honing and subsequent electropolish etching of the radioactive drain line piping and cell wall through-tubes. A remote survey device, incorporating alpha, beta, and gamma detectors, was also developed and demonstrated to verify the effectiveness of the cleaning process. The demonstrations were successful, but the approach was dropped for two reasons. First, the process generated a chromium-rich, corrosive solution that was categorized as a mixed waste and introduced disposal issues. Second, there was no way to validate the complete removal of contaminants in pipe-joint weld seams. An added complication was the prior accumulation of significant quantities of radioactive metal shavings in the piping from past fuel declad machining and grinding operations.

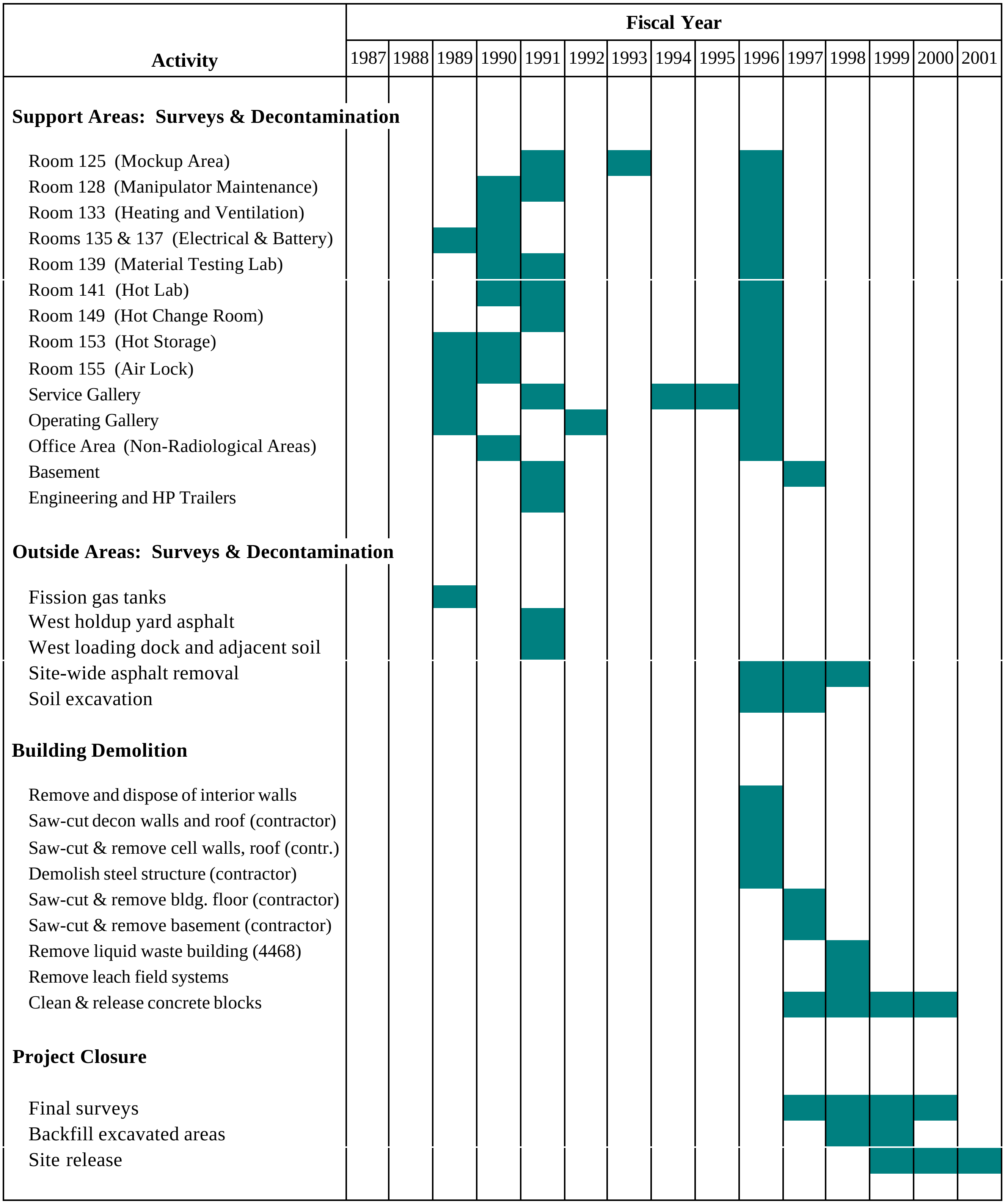
Figure 3-2 (page 1 of 2).
Chronology of Hot Laboratory Decontamination and Demolition Activities.



Notes:

Completed activities

Figure 3-2 (page 2 of 2).
Chronology of Hot Laboratory Decontamination and Demolition Activities.



3.4 PROJECT REDIRECTION AND SUBSEQUENT D&D ACTIVITIES

The DOE directed Rocketdyne to discontinue its in-situ decontamination operations in January 1992 and initiate complete dismantlement of the facility. This change in direction was instituted because neither the DOE nor Rocketdyne would accept liability associated with the possible presence of residual contaminants if the facility were reused and dismantled at a later date. Rocketdyne's redirected plan was to decontaminate the facility and then demolish the clean building and dispose of the rubble as clean waste. D&D emphasis shifted to include the sectioning and removal of contaminated components, and proceeded at a low-level rate because DOE complex-wide priorities resulted in significant decreases in funding. Small sections of the steel plates lining the cell walls were removed and the underlying concrete was found to be contaminated. This resulted in the sectioning and removal of the steel liners and the decontamination of the concrete. The drain line was accessed and removed by breaking up the encasing concrete. Contaminated cell wall through-tubes and floor storage tubes were removed by core drilling. Concrete surface decontamination continued through August 1995 using scabbling techniques.

Additional funding was made available in FY 1996 through the DOE Small Sites Initiative and accelerated the dismantlement schedule. This schedule acceleration dictated another change in Rocketdyne's Hot Laboratory D&D approach. The revised approach was to demolish the contaminated structure, decontaminate and dispose of the dismantled components and rubble as appropriate, and then remediate the remaining site for free release. Most of the contamination had been removed from the facility by that time. The building structure, including the concrete hot cells, concrete decon rooms, and steel enclosure, was sectioned and dismantled in FY 1996. Efforts during FY 1997 included demolition and removal of the basement, and the Rocketdyne release survey of the basement excavation. In FY 1998, the excavated building site was surveyed by outside parties, backfilled, and graded, and the auxiliary facilities and utilities were demolished. FY 1999 activities included additional verification and release surveys, plus the backfilling and grading of the auxiliary facility locations. The large-size waste components (concrete blocks comprising the facility structure and the hot cell shield doors) were decontaminated to the extent practical for waste minimization and disposed of during the FY 1996-99 time period.

3.5 CONTAMINATION CONTROL DURING D&D

The general philosophy of the D&D operations was to work from the areas of greatest contamination to the areas of lowest contamination. The purpose of this approach was to (1) minimize the potential of re-contaminating areas of lesser contamination, (2) eliminate those areas with the highest radiation levels early in the program to minimize personnel radiation exposure, and (3) maximize the effectiveness of in-process radiation surveys by lowering the area background levels. In addition, most of the D&D work was performed with the building structure and walls in place to provide containment for the decontamination activities.

A key component of the contamination control was the continued use of the facility negative-pressure, HEPA-filtered airflow system during D&D operations. This system remained in service through July 1996, and was effective in preventing airborne radioactive dust from escaping the facility during the cutting, scabbling, and jackhammering operations. In addition, mobile 55-gallon drum HEPA filter vacuums were utilized extensively at localized work areas to minimize the spread of contamination. A temporary HEPA system was placed in service for continued D&D operations when the facility system was dismantled in late 1996.

Another contamination hazard concern was the presence of asbestos-containing floor tile and its associated mastic adhesive throughout the facility. The tiles were removed by an asbestos abatement contractor trained to work in a radiological environment. HEPA-filtered, negative-air-pressure room environments were established using portable equipment to contain asbestos fibers, and workers wore HEPA-filtered masks and personal protective equipment. The mastic was removed by using a non-hazardous solvent in the operating gallery and shop areas, and by the scabbling of the service gallery floor. This radioactive asbestos-containing material was packaged for off-site disposal at Hanford.

3.6 WASTE DISPOSAL

Information on the generation of radioactive waste by the Hot Laboratory D&D operations is summarized in Section 7. Most of the radioactive waste disposal was by shipment to the Nevada Test Site (NTS), following NTS and Department of Transportation (DOT) packaging and shipping requirements and regulations. Several shipments were made prior to 1990, at which time the NTS revised its acceptance criteria, and Rocketdyne was required to develop detailed waste characterization accountability procedures in accordance with the new NTS requirements. Those procedures were audited extensively and approved by DOE-Nevada, and shipments resumed in 1994. The asbestos-containing floor tiles and roofing material were shipped to DOE-Hanford and Envirocare of Utah for disposal.

The final disposition of several other radioactive waste materials was determined after the Hot Laboratory was demolished. Most of the sectioned concrete blocks that comprised the hot cells and decon rooms were decontaminated and recycled, while those that could not be readily decontaminated were packaged and disposed of at NTS. The hot cell shield doors were partially decontaminated and sectioned, with the majority of the material recycled and the remaining contaminated components sent to NTS. Radiologically contaminated soil from the site was characterized chemically and radiologically by an outside analytical laboratory and sent to NTS and Envirocare. Solidified electropolish solution from the in-situ drain decontamination tests, mixed-waste filters from the HEPA ventilation system, and mixed-waste (lead-containing) paint chips from cell wall grit blasting were also characterized and shipped to Envirocare. The transuranic (TRU) waste material from the drain lines and drain tank remains in storage on-site; paths forward for its disposal are under investigation.

4.0 GOVERNING REGULATIONS, DOCUMENTS, AND PROCEDURES

The Hot Laboratory decontamination and demolition program is regulated externally by government requirements, and internally by Rocketdyne Safety, Health, and Environmental Affairs requirements and procedures. In addition, program directions were defined by program management plans, and specific procedures were prepared and approved prior to performing individual D&D activities. Those approvals included reviews by health and safety personnel, quality assurance personnel, and a licensed structural engineer as appropriate. The characterization and off-site shipment of generated wastes were subject to requirements and acceptance criteria specific to the individual disposal sites.

Day-to-day activities performed as part of the facility decontamination and dismantlement were documented in dated operational log books entitled “Building 020 D&D Log Book.” Information recorded in those log books also included the identification of work crews and other relevant operational details. Quality Assurance and Environmental Surveillance Records are maintained on file. Extensive sets of photographs were taken to document the decontamination and dismantlement activities; a few of those photographs are included in this report. Monthly progress reports were prepared and submitted to the DOE as part of the program documentation requirements, and constitute part of the work activity record.

4.1 GOVERNMENT REGULATIONS

Rocketdyne implemented applicable government documents to meet NRC, DOE, Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), State of California, and local environmental, health, and safety regulations, and interfaced with all of these agencies on a regular basis. Selected regulatory documents are listed below.

U.S. Nuclear Regulatory Commission, Special Nuclear Materials License No. SNM-21

State of California, Department of Health Services, Radiologic Health Section, Radioactive Materials License 0015-70

Code of Federal Regulations, Title 10, “Energy,” including Part 19, “Notices, Instructions, and Reports to Workers: Inspections and Investigations,” Part 20, “Standards for Protection Against Radiation,” and Part 835, “Occupational Radiation Protection,” Office of the Federal Register National Archives and Records Administration

Code of Federal Regulations, Title 40, “Protection of Environment,” Office of the Federal Register National Archives and Records Administration

Code of Federal Regulations, Title 49, “Transportation,” Part 173, “Shippers - General Requirements for Shipments and Packaging,” Office of the Federal Register National Archives and Records Administration

DOE Order 5400.5, “Radiation Protection of the Public and the Environment,” U.S. Department of Energy, Office of Environment, Safety and Health

DOE Order N5480.6, “Radiological Control Manual,” U.S. Department of Energy, Office of Environment, Safety and Health

DOE Order 5820.2A, “Radioactive Waste Management,” U.S. Department of Energy, Office of Defense Waste and Transportation Management

California Code of Regulations, “Title 17. Public Health,” Barclays Law Publishers

California Code of Regulations, “Title 22. Social Security,” Barclays Law Publishers

4.2 ROCKETDYNE REGULATIONS AND PROCEDURES

In addition to the government regulations, Rocketdyne has a division-wide set of requirements and procedures that regulate activities. Those documents that are applicable to the Hot Laboratory activities are listed below.

"Operating Requirements and Standards for Radiological Safety in Activities Authorized by the Energy Systems Group Broad Radioactive Materials License," Energy Systems Group Document ESG-83-22 (1983)

"Health and Safety Sections for Renewal Application of the Special Nuclear Materials License SNM-21, Docket 70-25, Issued to Energy Systems Group of Rockwell International," Energy Systems Group Document ESG-82-33 (December 1988 revision)

“Radiological Health,” *Boeing Canoga Park System of Procedures* C-400, and its predecessors, including “Environment, Health, and Safety,” *Rocketdyne System of Procedures (RSOP)*, the *Health, Safety & Environmental Procedures Manual* (572-L-1), and the *Rocketdyne Environmental Control Manual* (572-2)

Rocketdyne Radiological Controls Manual, Rocketdyne Operational Safety Plan N001OSP000004

Nuclear Materials Management Manual, Rocketdyne (February 1990)

“QA Inspection Requirements for Radioactive Shipments,” Boeing Canoga Park Quality Assurance Acceptance Document QA-00002, and its predecessor, “QA Inspection Requirements for the Shipment of R/A Materials,” Rocketdyne Quality Assurance Acceptance Procedure 094QAP-000

"ETEC Closure Training Plan," Boeing Canoga Park Engineering Information Document EID-04450, and its predecessor, "Radioactive Waste Handling & Shipping Training Plan," Rocketdyne Supporting Document N001TMP000001

"Procedure for Packaging and Off-Site Shipment of Radioactive Materials," Boeing Canoga Park Engineering Information Document EID-04493, and its predecessor, "Procedure for Packaging and Off-Site Shipment of Radioactive Material," Rocketdyne Operating Procedure N001OP000048

"Packaging and Shipment of Radioactive Waste," Boeing Canoga Park Engineering Information Document EID-04482

"Procedures for Surveys of Radioactive Shipments," Boeing Canoga Park Operating Procedure RS-000011, and its predecessor, "Procedures for Surveys of Radioactive Material Shipments," Rocketdyne Operating Procedure N001OP000030

4.3 HOT LABORATORY-SPECIFIC D&D PLANS AND PROCEDURES

4.3.1 General Plans and Procedures

Several general Rocketdyne planning and procedures documents were prepared to cover the Hot Laboratory D&D operations. They include the following:

"Rockwell Hot Lab Decommissioning Project Plan," 173PMP000001

"Rockwell Hot Lab Decommissioning Quality Assurance Program Plan," 173QPP000001

"Engineering Release Plan of Action for the Decontamination and Decommissioning (D&D) of the Rockwell Hot Lab," 173RPA000001

"Sampling and Analysis Plan for Radioactive Waste," Boeing Canoga Park Engineering Information Document EID-04487, and its predecessor, "Sampling and Analysis Plan for RIHL D&D Waste," 173ER000010

"Sampling Procedure for Containerized Materials," Boeing Canoga Park Detailed Working Procedure EID-04360, and its predecessor, "Sampling Procedure for Containerized Soils," Rocketdyne Detailed Working Procedure N001DWP000040

4.3.2 Detailed Working Procedures

The following Rocketdyne detailed working procedures were prepared and used for the performance and control of specific Hot Laboratory D&D tasks:

"RIHL Room 141 Decontamination," 173DWP000001 (May 1992)

"RIHL Rooms 139 and 128 Decontamination," 173DWP000002 (May 1992)

"Attic Area Decontamination," 173DWP000003 (April 1988)

"Hot Cell Equipment Removal," 173DWP000004 (June 1992)

"Hot Cell Window Removal," 173DWP000005 (June 1992)

"Hot Cell Penetration Decontamination," 173DWP000006 (June 1992)

"Hot Cell and Decontamination Room Liner Decontamination & Decommissioning (D&D), RIHL," 173DWP000007 (May 1991)

"Hot Cell Storage Tube Decontamination," 173DWP000008 (June 1992)

"'Clean' Support Area Decommissioning," 173DWP000009 (May 1991)

"Structural Surfaces Decontamination," 173DWP000010 (April 1973)

"R/A Exhaust System Decontamination and Removal," 173DWP000011 (September 1993)

"Glove Box Size Reduction," 173DWP000012 (June 1992)

"Glovebox Internal Decontamination," 173DWP000013 (June 1992)

"R/A Liquid Drain System Decontamination," 173DWP000014 (May 1991)

"3000-Gallon RA Liquid Tank System Decontamination and Decommissioning," 173DWP000015 (May 1988)

"Fission Gas Tanks Removal," 173DWP000016 (June 1992)

"Asphalt and Soil Decontamination," 173DWP000017 (February 1988)

"Basement Decontamination and Decommissioning (D&D), RIHL," 173DWP000018 (April 1993)

"Known and Suspect Contaminated Support Areas Decontamination," 173DWP000019 (July 1992)

"R/A Waste Handling Procedure," 173DWP000020 (September 1989)

"RIHL Final Radiological Survey Procedure," 173DWP000021 (May 1988)

"R/A Drain, Storage Tube, and Penetration Decontamination - Electropolishing," 173DWP000022 (June 1992)

"Repackaging of SEFOR and Advanced Fuel Glove Box TRU Waste," 173DWP000023 (February 1989)

"Determination of Glove Box Transuranic Activity Prior to Disposal," 173DWP000024 (February 1993)

"Removal of RIHL Drain Systems," 173DWP000025 (February 1993)

"Through-Tube Penetrations Electropolishing," 173DWP000026 (June 1992)

"Glove Box Removal Detailed Work Procedure," 173DWP000028 (June 1992)

"Glove Box Packaging Detailed Work Procedure," 173DWP000029 (June 1992)

"Decontamination Room Door Moving," 173DWP000030 (June 1992)

"Procedures for Sampling the RIHL Roof," 173DWP000033 (February 1994)

"Removal of Hot Cell 'Wall Penetrations'," 173DWP000034 (April 1992)

"Removal of Hot Cell 'Shielding Doors'," 173DWP000035 (May 1993)

"Lifting of Liquid Waste Tank and Removal," 173DWP000036 (September 1994)

4.4 DISPOSAL SITE REQUIREMENTS

Each waste disposal site has its own requirements for the characterization, packaging, and approval of radioactive wastes for final disposal. The following criteria and Rocketdyne application support documents apply to the Hanford Site, the Nevada Test Site, and Envirocare of Utah.

4.4.1 Hanford

"Hanford Site Solid Waste Acceptance Criteria," Westinghouse Hanford Company WHC-EP-0063-4 and predecessors

"Packaging and Shipment of Radioactive Waste," Boeing Canoga Park Engineering Information Document EID-04482, and its predecessor, "Packaging and Shipment of Radioactive Low Level Waste to Hanford Disposal Site," Rocketdyne Operating Procedure N001OP160003

"Radioactive Waste Certification Plan for DOE-Hanford Site," Rocketdyne Document N001ER000024

"Approved Waste Stream Profiles for NTS and Hanford," Boeing Canoga Park Engineering Information Document EID-06037

4.4.2 Nevada Test Site

"Nevada Test Site Waste Acceptance Criteria (NTSWAC)," DOE/NV-325, U.S. Department of Energy Nevada Operations Office, and its predecessor, "Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements," NVO-325 (Rev. 1), U.S. DOE, Nevada Field Office and Reynolds Electrical & Engineering Co.

"Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements. Laboratory Reference Document," NVO-325LRD (Rev. 1), U.S. Department of Energy, Nevada Field Office and Reynolds Electrical & Engineering Co., Inc. Waste Management Department (June 1992)

"Application to Ship Radioactive Waste to the Nevada Test Site (NTS)," Rocketdyne Document N001ER000021

"Packaging and Shipment of Radioactive Waste," Boeing Canoga Park Engineering Information Document EID-04482, and its predecessors, "Packaging and Shipment of Radioactive Waste - Low Specific Activity (LSA) to DOE-Nevada Test Site (NTS)," Rocketdyne Operating Procedure 173OP000007, and "NTS Waste Stream Characterization Procedure," Rocketdyne Procedure 173OP000010

"NTS Waste Stream BNRC - DD2000001 Characterization Document," Rocketdyne Report 173ER000005 (April 1994)

"NTS Waste Stream BNRC - DD2000002 Characterization Document," Rocketdyne Report 173ER000006 (April 1994)

"NTS Waste Stream BNRC - DD2000003 Characterization Document," Rocketdyne Report 173ER000007 (May 1994)

"NTS Waste Stream BNRC - DD2000004 Characterization Document," Rocketdyne Report 173ER000008 (May 1994)

"Decontamination and Decommissioning Waste, Waste Stream Characterization Document, Waste Stream No. BNRC-DD2000005" Rocketdyne Report dated January 1994 (no number)

"Approved Waste Stream Profiles for NTS and Hanford," Boeing Canoga Park Engineering Information Document EID-06037

4.4.3 Envirocare of Utah

"Packaging and Shipment of Radioactive Waste," Boeing Canoga Park Engineering Information Document EID-04482

"Qualification and Shipment of LLW and MLLW to Envirocare," Boeing Canoga Park Engineering Information Document EID-04495

5.0 PERSONNEL PROTECTION

Personnel safety is a central element of Rocketdyne's D&D practices. The Boeing Canoga Park System of Procedures (SOP), and its predecessor, the Rocketdyne System of Procedures, include safety, health, and environmental guidelines intended to protect workers in the field, and those guidelines are incorporated in the Detailed Working Procedures and other instructions for job performance. In addition, field personnel are required to complete training courses specific to operations where safety hazards potentially exist. For D&D work, including the Hot Laboratory project, radiation protection is a key area where specific controls, procedures, and monitoring programs have been implemented. The objective is to minimize any adverse effects to the health and safety of workers, the public, and the environment caused by operations that involve radioactive materials.

5.1 ALARA

Rocketdyne's policy for all activities associated with work areas where radioactive materials or radiation fields are present, including radioactive materials handling, is to maintain personnel radiation exposures As Low As Reasonably Achievable (ALARA). This policy, which is consistent with both DOE (Order 5480.1) and NRC (Guide 8.8 & 8.10) requirements, is spelled out in SOP C-401, "Radioactive Materials and Ionizing Radiation," and its subordinate and predecessor documents.

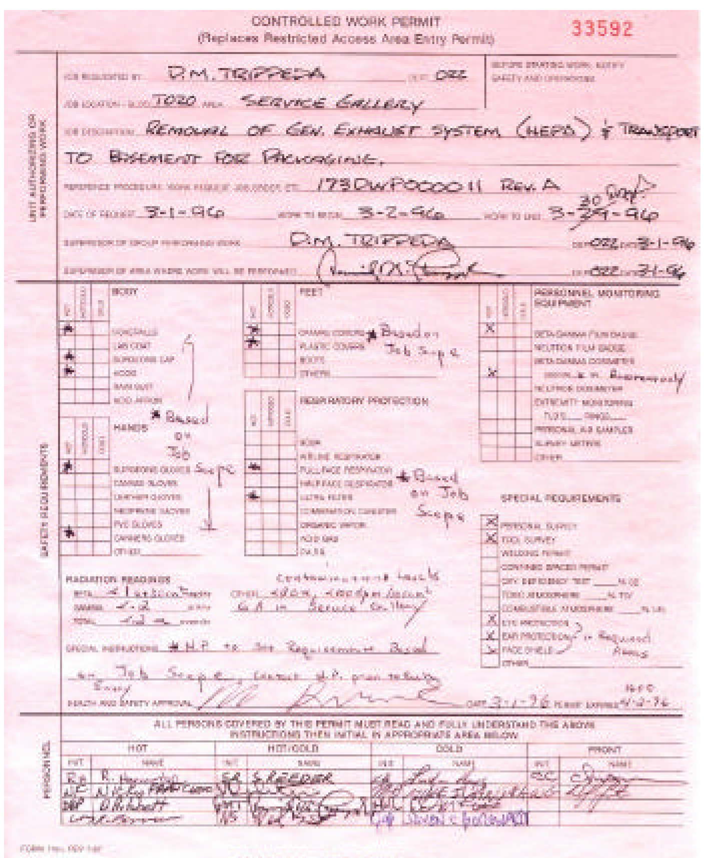
This policy is implemented site-wide through a Rocketdyne ALARA program, whose general objective is to minimize radiation exposures received both by individuals and by groups. Its mission is the prevention of exposures above regulatory limits, the mitigation of unnecessary exposures, and the optimized reduction of exposures deemed necessary for the performance of work. The program includes planning, reviewing, training, monitoring, surveillance, and the deliberate use of safeguards and administrative controls to achieve ALARA goals. By achieving these goals and using ALARA methods in effluent controls, effects on the public and the environment are negligible. Implementation of this program is the responsibility of Rocketdyne's Safety, Health, and Environmental Affairs (SHEA) organization (formerly Environment, Health and Safety).

5.2 ALARA IMPLEMENTATION

Radiation level, surface contamination, and airborne radioactivity concentration surveys were performed in all areas of the Hot Laboratory prior to, during, and following work activities. These surveys were performed by trained, experienced Radiation Safety technicians and engineers who were independent of the operations groups. They specified allowable work times, personnel monitoring devices (pocket dosimeters, film badges, thermoluminescent dosimeters [TLDs], and finger rings as appropriate), and the requirements for specialized protective equipment (protective clothing and respiratory devices). Radiation Safety personnel reviewed engineering designs and operating procedures to assure control of radiological hazards, and had the responsibility and authority to halt potentially unsafe operations.

Entry was controlled into facility areas where the radiation level or airborne radioactivity was likely to exceed acceptable levels for continuous work. Each such area was posted with a Controlled Work Permit (CWP, Rocketdyne Form 719-L), which was used to define access permissions and restrictions based on potential hazards. The facility manager had the responsibility of originating the CWP, and Radiation Safety personnel the responsibility of specifying the required protection and restrictions. Management and Radiation Safety then concurred on each CWP and all personnel signed the form in agreement to comply with it before commencing work. The CWP described the activity to be performed and the measured radiation levels, and defined the work location, applicable detailed work procedures, required safety equipment, any special safety instructions, and the CWP's period of validity. An example CWP is shown in Figure 5-1.

Maximum personnel radiation dose limits were based on the SOP Planning Guide limits of 1.0 rem per calendar quarter and 2.0 rem per year (whole-body dose). For comparison, federal regulatory limits are 5 rem per year. Individual doses were measured to ensure compliance, and group doses were monitored based on the individual dose results.



CONTROLLED WORK PERMIT
(Replaces Restricted Access Area Entry Permit)
33592

D.M. TRIPPEDA 022
T020 SERVICE GALLERY
REMOVAL OF GEN. EXHAUST SYSTEM (HEPA) & TRANSPORT
TO BASEMENT FOR PACKAGING.
173DWP00001 1 REV. A
3-1-96 3-2-96 3-29-96
D.M. TRIPPEDA 022 3-1-96
022 3-1-96

BODY
FEET
PERSONNEL MONITORING EQUIPMENT
RESPIRATORY PROTECTION
SPECIAL REQUIREMENTS
RADIATION READINGS
ALL PERSONS COVERED BY THIS PERMIT MUST READ AND FULLY UNDERSTAND THE ABOVE INSTRUCTIONS THEN INITIAL IN APPROPRIATE AREA BELOW
HOT HOT/COLD COLD FRONT
ORIGINATOR (POST AT WORKSITE)

Figure 5-1. Example Controlled Work Permit for Hot Laboratory D&D Operations.

6.0 CHRONOLOGICAL SUMMARY OF D&D ACTIVITIES

A chronological summary of the Hot Laboratory D&D activities by major task was presented in Figure 3-2. As discussed in Section 3, the flow of activities was driven by project direction and by available funding levels. The D&D approach had two major changes since program initiation, and DOE complex-wide priorities resulted in significant decreases in funding during the middle of the project. The following subsections highlight Hot Laboratory D&D activities by fiscal year, with an emphasis on accomplishments. Section 9 summarizes the innovative technologies employed and other lessons learned that may be of value to other sites planning hot cell D&D projects.

The standard operating policy of the Hot Laboratory during its operational years was to (1) utilize secondary containment (glove boxes) to perform those operations that had a high probability for airborne contamination or for the spread of contaminated or activated material (e.g., from fuel cladding or grinding operations); and (2) decontaminate the hot cells at the completion of each project. This policy maintained the hot cells at the lowest possible radiation levels, precluded the buildup of in-cell waste storage, and permitted the prudent use of personnel for in-cell tasks while maintaining strict adherence to ALARA requirements.

An important consequence of this policy was the removal and disposal of all equipment and materials used in the Fermi Fuel declad program at its conclusion, and the wash-down and gross decontamination of the hot cells and decon rooms in anticipation of the follow-on FFTF declad program. When the DOE instead decided to initiate the D&D of the facility in 1987, the hot cells were relatively clean and nearly empty of project-specific materials and equipment.

6.1 FY 1987 ACTIVITIES

The DOE directed Rocketdyne to stop all preparatory operations for the FFTF program in May 1987 and to utilize the balance of the year's funding to begin planning for the D&D of the Hot Laboratory. The first step was the preparation of a Program Management Plan (PMP), which was submitted to Rocketdyne management and to the NRC for approval. Facility licensing was through the NRC because of Rocketdyne's ownership of the Hot Laboratory. The PMP was based on the objective of decontaminating the facility in-situ, releasing it for unrestricted use, and then reusing it for non-radioactive programs. The decontamination approach, as described in Section 3.5, was to work from areas of greatest to lowest contamination to minimize contamination spread, reduce background levels quickly, and meet ALARA objectives. A series of Detailed Working Procedures was prepared based on the PMP for the performance of specific near-term D&D activities.

Material and equipment removal, plus initial cleaning efforts, were initiated during FY 1987. First, all remaining Special Nuclear Material (SNM) was removed from the facility and transferred to the SSFL's Radioactive Materials Handling Facility (RMHF) for packaging and disposal. All non-essential equipment in the cells and decon rooms were decontaminated where practical, and otherwise size-reduced and packaged for disposal as radioactive waste. All materials, tools, and equipment were removed from the radioactive materials handling glove box in Decon Room 4, and the glove box was wiped down and cleaned to minimize the potential for contamination spread prior to being size-reduced. All equipment was removed from Cell 2 and Decon Room 2, which were then steam cleaned in preparation for a preliminary radiological survey. Auxiliary systems, including piping from the unused fission gas sampling system and the obsolete refrigeration systems, were removed from the basement and surveyed. The radiologically clean materials were released for recycling and the contaminated materials were size-reduced and packaged for disposal. During these initial phases of cleanup, the cell master/slave manipulators and in-cell electro-mechanical manipulators and hoists remained in operation and were used to minimize personnel cell entries and exposure.

6.2 FY 1988 ACTIVITIES

Initial FY1988 activities included several controlled entries into the hot cells and decon rooms to complete the removal of equipment and to perform gross decontamination of accessible surfaces. Work was started first in Cells 1 and 2, the two cleanest of the four cells. This deviation from the general plan to work from areas of greatest to lowest contamination conformed with ALARA principles, by providing needed experience to optimize procedures, improve efficiency, and solve routine problems before working in the areas of greatest exposure. Work activities included the emptying and decontamination of inter-cell storage and transfer boxes, removal of equipment, and size-reduction of the glove box in Decon Room 4. The glove box size-reduction utilized plasma arc torches inside a temporary, fire-retardant plastic containment tent to prevent the spread of smoke and potential contamination to the rest of the room. Following equipment removal, the walls and ceilings of the four hot cells were washed with a non-hazardous foam cleaning solution, in conjunction with localized brushing with a non-hazardous detergent, to remove surface contamination. Particular attention was given to the use of non-hazardous materials to eliminate the generation of mixed wastes. Waste liquids were drained through the radioactive drain line system into the facility holdup tank and were transferred from there to the RMHF for evaporation.

The operating gallery face contained over 270 through-tube penetrations into the hot cells for instrumentation and equipment. Additional penetrations into the hot cell and decon room ceilings and floors carried wiring for interior lighting, power, and inert gas supplies. Each of the cell wall through-tubes was constructed of two concentric stainless steel tubes with a welded joint on the outer surface of the inner tube. This joint produced a step in the tube which, combined with stepped shield plugs, prevented radiation streaming along the tube surface from the cell to the operating gallery. The cell wall shield plugs were removed from the Cell 1 through-tubes early in FY 1988, surveyed, and decontaminated or packaged for disposal. The wall penetrations were then sealed using styrene foam plugs on the cell and operating gallery wall faces to avoid increasing contamination levels on the tube interior surfaces, and to prevent the spread of contamination from the hot cell to the operating gallery. Figure 6-1 shows the status of the operating gallery face of Cell 1 after the master/slave manipulators, penetration shield plugs, and small window had been removed.

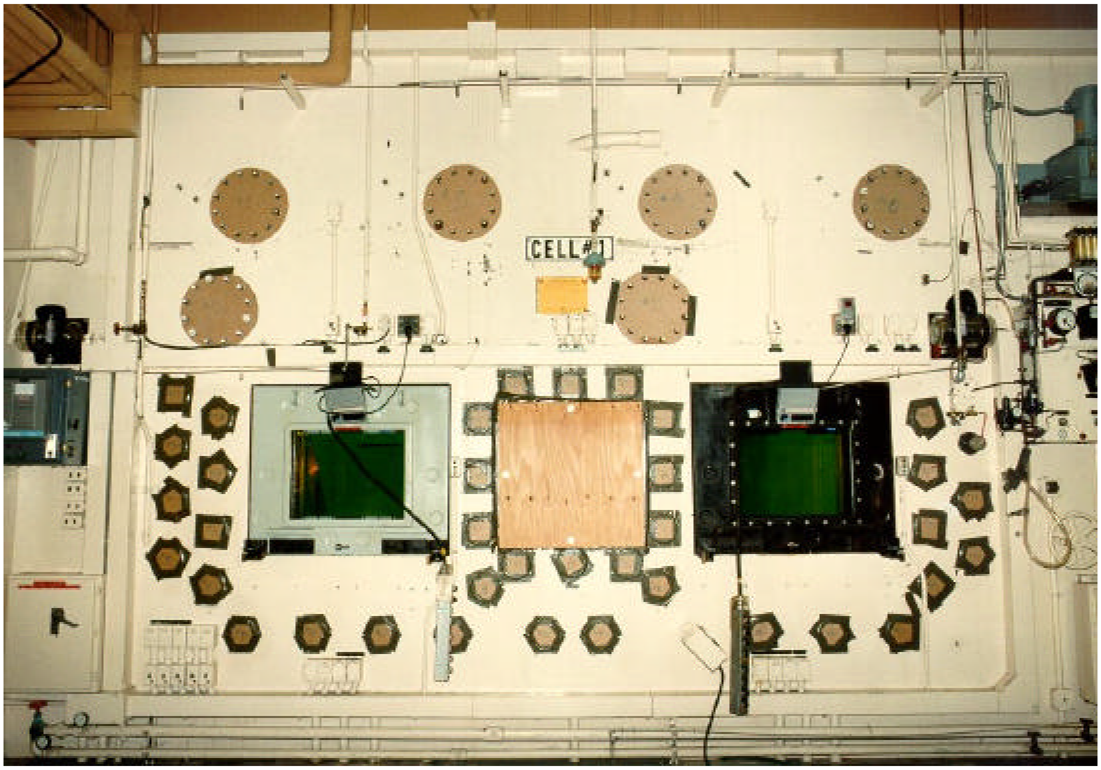


Figure 6-1. Operating Gallery Face of Cell 1 Following Removal of the Master/Slave Manipulators, Through-Tube Shield Plugs, and Small Window. [6DH36-12/9/87-S1A]

It was recognized from the beginning of the D&D effort that the cleaning of the Hot Laboratory drain system and hot cell penetrations would be a major challenge for the decontamination of the facility. All of the facility's radiologically controlled areas were connected to a common radioactive drain system, as shown schematically in Figure 2-6. This system consisted of floor drains in the hot cells, decon rooms, service gallery, hot change room, and other support rooms. Each drain connected to a 4-inch-diameter welded stainless steel drain line buried within the concrete structure. Those drain lines were connected through a common drain in the facility basement that discharged into the 3000-gallon radioactive liquid holdup tank in Building 4468.

A trade study was performed during FY 1988 to establish an in-situ decontamination process for both the through-tubes and the drain line system. The drain line cleaning ultimately required a multiple-step process that included the following steps: (1) visual inspection of the lines using remote video equipment to determine general surface conditions, identify potential weld cracks, and locate major obstructions and concentrations of debris buildup from 30 years of operation; (2) mechanical cleaning to remove gross debris; (3) mechanical honing to remove surface scale and corrosion; (4) electropolishing and etching to remove surface contamination remaining after mechanical honing; (5) rinsing to neutralize and remove electropolish residuals; and finally (6) remote radiological surveying for residual alpha, beta, and gamma contamination to verify the effectiveness of the cleaning process and to identify any areas requiring further cleaning. Each of the systems used in these steps required the ability to snake through up to 60 feet of piping with multiple bends. The through-tube cleaning required the same basic process, but the equipment complexity was reduced significantly because the through-tube lengths were nominally 4 feet.

An in-situ decontamination process was developed, a mockup drain piping system was built for testing, and extensive development tests were performed prior to applying the process to the facility drains. Figure 6-2 is a photograph of a cutaway of an electropolished drain mockup section, showing the remote electropolish electrode assembly. The use of non-radioactive mockups to optimize and validate processes and procedures had been used extensively throughout the 30-year operating life of the facility and proved to be cost effective in all applications. The added cost of the mockup tests was consistently less than the cost in time and personnel exposure to move directly into contaminated areas. The use of mockups and "dry runs" was one of the most cost-effective aids in efficient hot cell operation and proved of equal value in this and other D&D projects at Rocketdyne.

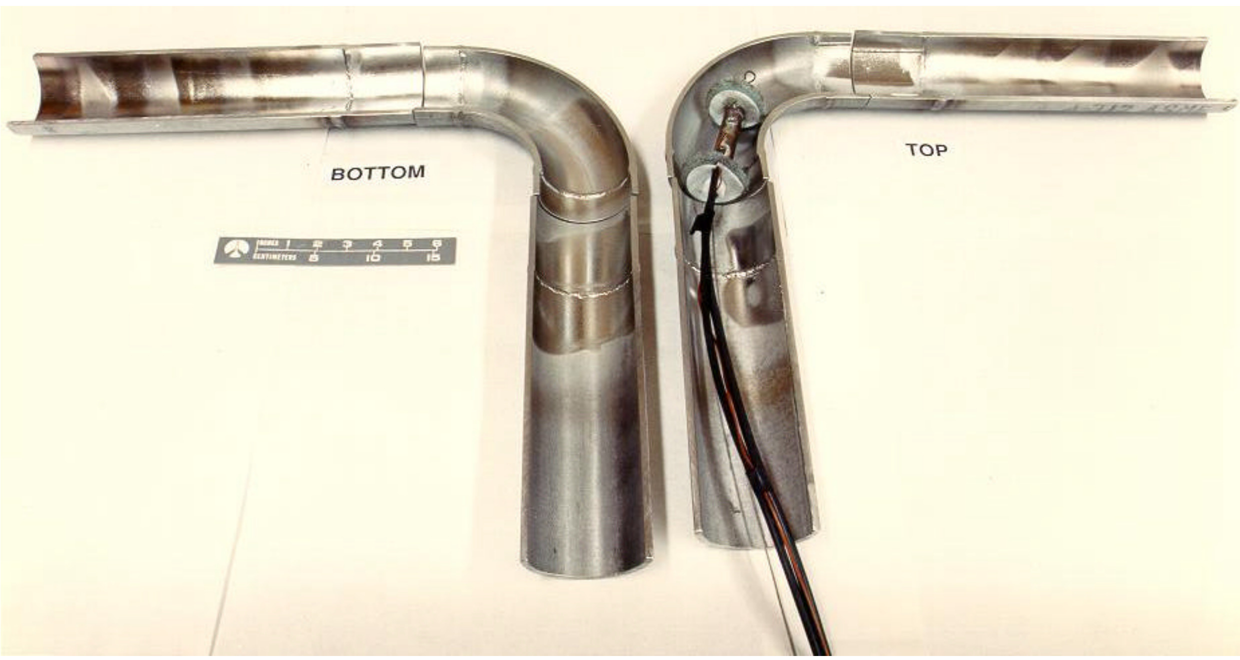


Figure 6-2. Cutaway of an Electropolished Drain Mockup Section, Showing the Drain Line Electropolish Electrode Assembly. [3AZ41-10/5/88-C1A]

Following process verification using the mockup, the drains and through-tubes of Cell 1 were used to optimize and demonstrate the effectiveness of the process in a contaminated area. The demonstration tests were initiated in late FY 1988. The process was generally effective, but extremely time consuming. The principal drain line problems were associated with the development of effective cutting tools to remove gross contamination at extended distances down the drain lines. Several types of cutting tools were developed, based in part on standard sewer line cleaning equipment. Those cutting tools would break off from the cable used as a drain-line snake and had to be retrieved remotely. This was difficult because of the extended lengths of the drain lines. The through-tube interior surfaces were much easier to work on, because of their short (about 4-foot) lengths, and were initially cleaned using non-hazardous detergents followed by grit-blasting.

Pitting and corrosion of both the through-tube and drain line interior surfaces required additional cleaning steps for decontamination. The application of the honing device developed for the through-tubes, shown in Figure 6-3, resulted in the removal of significant amounts of additional contamination. However, the honing technique was not practical for complete contamination removal because of the extent of the pitting, and was followed by a final cleaning step using an electropolish process based on equipment developed in-house. The electropolish solution used a phosphoric acid-based cleaning fluid which resulted in the buildup of a corrosive, chromium-rich (hexavalent) spent solution. That solution was classified as a mixed waste, and thus became a major contributor to the termination of the in-situ process. The successful continuation of the process would have required the substitution of a non-hazardous solution and/or the incorporation of a neutralization and stabilization step as part of the cleaning process.

Another difficulty was the inability to use nondestructive techniques to verify the radiological cleanliness of the space between the two concentric through-tube pipe sections at the stepped weld joints. A review was subsequently initiated in FY 1989 to identify alternative methods to decontaminate or verify complete decontamination of the through-tube sleeves at the weld joints.

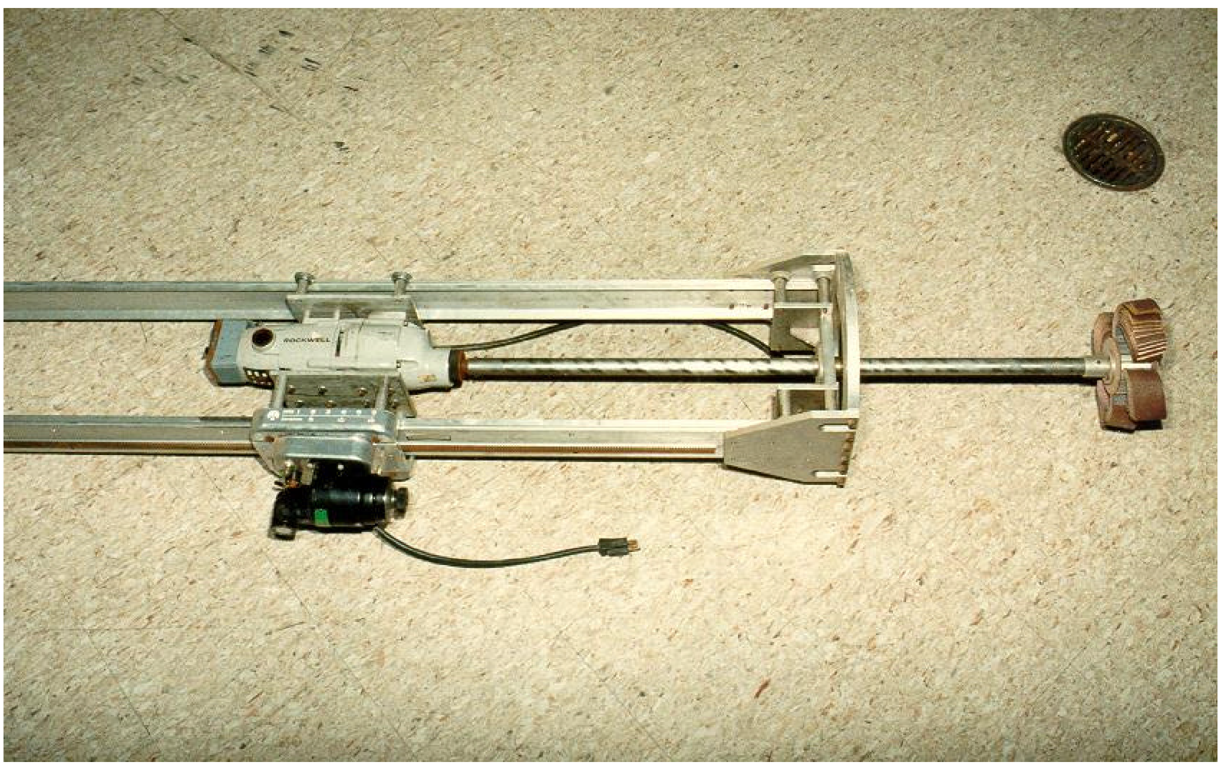


Figure 6-3. Photograph of the Through-Port Honing Device Used for Internal Pipe Surface Scale Removal. ***[6DH36-12/9/87-S1B]***

6.3 FY 1989 ACTIVITIES

Work continued in FY 1989 on developing procedures for the in-situ decontamination of the drain lines and hot cell through-tubes. The drain line system mockup, which had been used for development tests in Building 4009, was disassembled, moved to the Hot Laboratory, and reassembled. The development of improved techniques and tools for tube cleaning and inspection continued, first with the mockup and then in Cell 1. A camera system was developed which could be snaked through the drain system for the inspection of blockages and internal structures which were breaking the mechanical cutters. Mechanical cleaning operations on the Cell 1 drain system continued. When the mechanical cleaning of an individual drain section was determined to be adequate, a plug was installed downstream of the cleaned section. This plug was used to isolate the section for the electropolishing operation, in order to minimize and control the volume of electropolish solution in use at any one time.

When the electropolishing of the Cell 1 drain lines was completed, the lines were surveyed using the in-house developed survey module to validate the cleaning process. This survey module, shown in Figure 6-4, included alpha, beta, and gamma detection capabilities. The radiological survey validated the basic mechanical/electropolish cleaning process, and identified the need for iterative cleaning and surveying in some areas. Preliminary survey data were presented to NRC inspectors during routine inspections. The data were judged to be generally acceptable in informal discussions, but questions were raised on the ability to verify that no contamination had penetrated the drain lines through cracks or weld defects into the surrounding concrete and soil. The absence of alpha and beta contamination outside of the drain line could not be verified in-situ, because the pipe walls shielded the drain line probe from detecting such contamination. This raised questions on the ability to release the drain line system in-situ after D&D operations are complete.

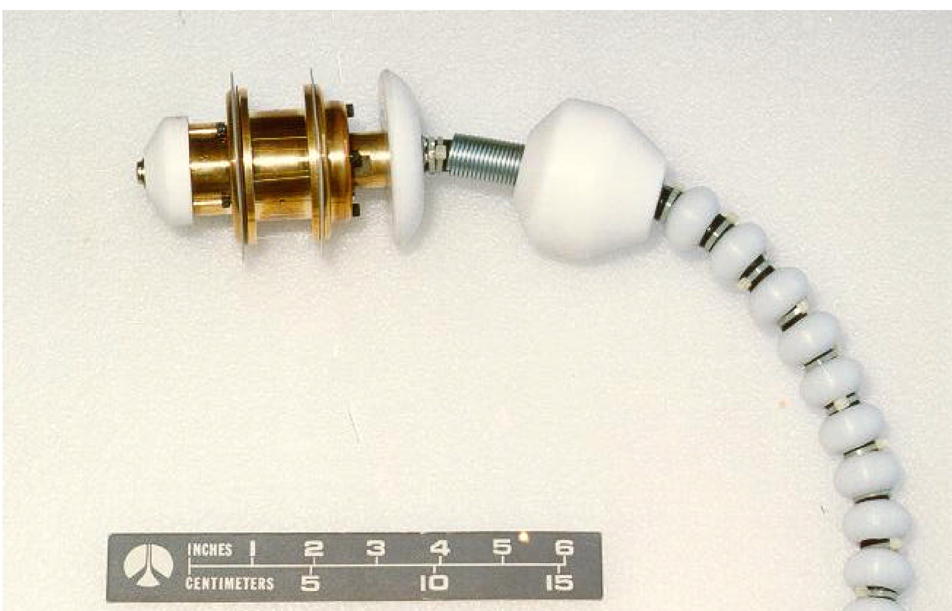


Figure 6-4. Remote Survey Probe Used for Drain Line Cleaning Verification. [6DH56-2/23/90-S1H]

Several Building 4020 support areas were also connected to the radioactive drain line system, as indicated in Figure 2-6. The drain lines in those areas, buried beneath the 6-inch-thick slab floors, were relatively easily accessible. In contrast, the hot cell and decon room drain lines were buried within the 4-foot-thick cell walls, floor, and basement support columns. A decision was made early in the D&D program to physically remove the support area drains and associated lines. This work was initiated in the hot storage area (Room 153) in FY 1989, as shown in its beginning stages in Figure 6-5. In this photograph, the concrete above the lines is in the process of removal for drain line access.

Figure 6-5. Initial Stages of Drain Line Removal in the Hot Storage Area. [6EH36-1/20/89-S1B]

The D&D plan for decontaminating the hot cells was based on the assumptions that the welded steel cell liners were intact and that radiological contamination was limited predominantly to the steel liner surfaces and the paint that coated them. Therefore, paint removal was initiated to remove this contamination after the cell walls and ceilings had been washed down. This was a multi-step process, first used in Cell 1 because that was the least contaminated of the four cells. The epoxy paint was removed first using needle guns, as shown in Figure 6-6. This was followed by additional scabbling and grit blasting to remove the primer and residual contaminated paint. The cell face and the slave ports were also grit blasted, with the cell face results shown in Figure 6-7. This operation resulted in the accumulation of paint chips and grit blast material in the cell. Those loose materials were vacuumed up and packaged for disposal as radioactive mixed waste, based on the lead content of the primer coat. The cell walls were then surveyed and any remaining contamination identified. Paint removal was also started on the one steel wall and three plaster walls of Decon Room 1. Figure 6-8 shows the walls of Decon Room 1 following paint removal.

Figure 6-6. Surface Paint Removal in Cell 1. [6EH36-3/3/89-S1D]

Figure 6-7. Cell 1 Face Following Window Removal and Grit Blasting. [6DH12-5/23/89-S1D]

Figure 6-8. Walls of Decon Room 1 After Paint Removal by Grit Blasting. [6DH12-5/23/89-S1A]

Scoping radiation surveys were performed in the support areas. Contamination was found on the ceiling light fixtures and in the attic above the service gallery, shown in Figure 6-9, which resulted in the removal of the lights and the false ceilings. Most of the contamination present in the attic was in the accumulated dust and was removed by vacuuming. The crane and ceiling lights in the hot storage room (Room 153) were removed. Extensive contamination was found at the base of the walls in Room 153, in the air lock (Room 155), and in the north passage (Figure 2-1), which led to the removal of the lower 18 inches of the interior walls. This contamination originated from routine decontamination procedures in the rooms during normal facility operation. Studs were removed and the concrete floor under the removed studs was scabbled. The concrete floor in Room 155 was also scabbled, as shown in Figure 6-10, to remove surface contamination. Areas of localized contamination were also removed from the battery room floor (Room 137) and the electrical equipment room floor (Room 135).

The three unused underground fission gas tanks located in the north yard were examined and found to be dry and radiologically clean. The tanks were excavated, as shown in Figures 6-11 and 6-12, surveyed clean, and disposed of as scrap metal. The excavated area was backfilled with clean soil, compacted, and repaved.

Figure 6-9. Service Area Attic. [6EH36-11/18/88-S1D]

Figure 6-10. Concrete Floor Scabbling Operations in the Air Lock Room. [6EH36-3/17/89-S1B]

Figure 6-11. Excavation of the Unused Underground Fission Gas Tanks. [6DH21-8/30/89-S1C]

Figure 6-12. Removal of the Underground Fission Gas Tanks. [6DH21-8/30/89-S1B]

6.4 FY 1990 ACTIVITIES

The electropolish cleaning demonstration test on the Cell 1 operating gallery through-tubes was completed in FY 1990. Figure 6-13 shows the electropolish circulation equipment in place during work on the cell face. Paint removal was completed for the interiors of Cell 1 and Decon Room 1, and the surveying of the interior walls was substantially completed. Paint removal was initiated on the steel cell face of the operating gallery. This work was performed in a temporary HEPA-filtered negative air tent, as shown in Figure 6-14, to ensure contamination control and containment of all dust.

The floor tiles and underlying mastic were removed in the manipulator maintenance room (Room 128), as pictured in Figure 6-15. This photograph also shows the personnel protective clothing used for this type of activity. Radiological surveys identified contamination on the roof support beams in the air lock (Room 155) and the hot storage room (Room 153). The contamination was removed; in some areas the beams were jacked up to permit the removal of contaminated grout. All equipment was removed from the battery room (Room 137). Contamination in this room was found to be limited to the lower portion of the wall common to the hot metallurgy laboratory (Room 141). This entire wall was removed and disposed of as radioactive waste because of extensive contamination on the hot metallurgy lab side of the wall.

DOE requested a shift in emphasis in the D&D program during FY 1990 to accelerate the cleanup of the cells. Due to budget constraints, decontamination activities for the support areas were suspended at that time and rescheduled for FY 1991.

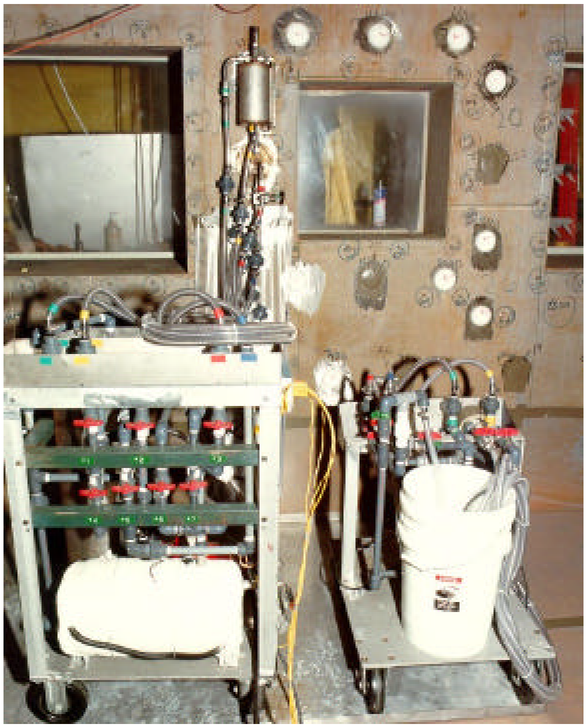


Figure 6-13. Electropolish Cleaning Equipment in Front of Cell 1. [6DH29-6/8/90-S1M]

Figure 6-14. Grit Blasting Tent and HEPA Vacuum System Used for Paint Removal, Shown in Front of Cell 2. ***[6HD29-07/06/90-S1I]***

Figure 6-15. Floor Tile and Mastic Removal in the Manipulator Maintenance Room. [6DH66-7/5/90-S1D]

6.5 FY 1991 ACTIVITIES

All remaining support equipment was removed from the hot cells and from Decon Room 3 and Room 4 during FY 1991. This included the in-cell cranes, electromechanical manipulators, manipulator rails, remote viewing periscopes, air ducting, nitrogen gas supply piping, storage well plugs, and filter racks. Equipment was transferred to other programs or applications where practical, and otherwise disposed of as clean or radioactive waste as appropriate. For example, manipulators, cell components, and other equipment that could be reused beneficially by the University of Missouri in a DOE-sponsored program were decontaminated to meet university requirements and shipped to the university. Figure 6-16 shows one of the oil-filled cell windows during packaging for shipment.

Paint removal was completed in Cell 2 and in Decon Room 2. By the end of FY 1991, Cells 1 and 2 and Decon Rooms 1 and 2 were surveyed and ready for the removal of localized areas of contamination. Cell through-tube decontamination work continued during the early part of FY 1991. For example, Figure 6-17 depicts through-tube honing operations on Cell 3 wall penetrations, from the operating gallery side. Figures 6-18 and 6-19 show the status of the operating gallery cell faces in January 1991.

Figure 6-16. Hot Cell Window Palletized for Shipment to the University of Missouri for Reuse in Another DOE Program. ***[6DH91-11/8/90-S1H]***

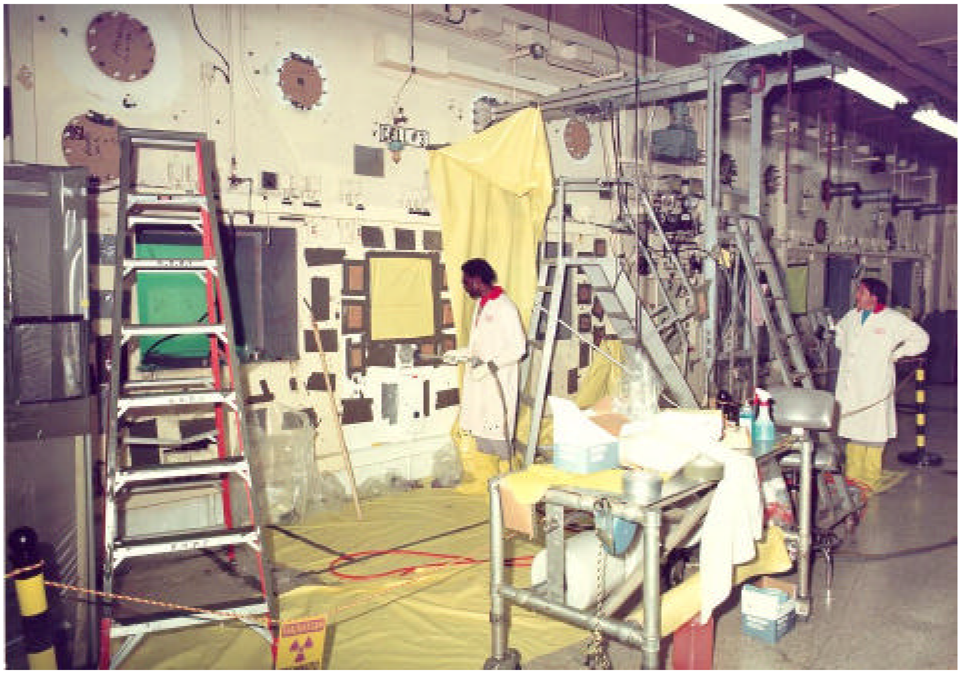


Figure 6-17. Cell 3 Through-Tube Honing Operations, Performed from the Operating Gallery Side of the Cell Wall. [6DH29-10/12/90-S1A]

Figure 6-18. Status of Operating Gallery Faces of Hot Cells 3 and 4 in January 1991. [6HD29-1/24/91-S1B]

Figure 6-19. Status of Operating Gallery Faces of Hot Cells 1 and 2 in January 1991. [1CZ22-5/14/91-S1D]

The Building 4020 facility included nine large shielding doors: four decon room doors, located on the service gallery side of those rooms, and five hot cell doors, separating the cells from the decon rooms and the mockup area (Figure 2-1). The decon room doors were constructed of concrete and weighed from 20,000 to 30,000 lb., while the hot cell doors were cast steel and ranged in weight from 61,000 to 88,000 lb. The D&D Program Management Plan called for in-place door decontamination in order to maintain the integrity of the cells for future use. This included a task to lift the doors off the rails and move them out from the walls, to facilitate complete decontamination by accessing the backs and undersides of the doors and the overhead trolley components. Initial decontamination was performed using in-place high pressure water cleaning to dislodge removable contamination from all exposed surfaces. Figure 6-20 provides a view of the decon room doors from the service gallery during the initial stages of decontamination.

At this point in time, Rocketdyne received redirection from the DOE to abandon its plan to D&D the facility for release and reuse, and instead implement a plan to decontaminate the facility, obtain its release for unrestricted use, and then demolish the released structure. This redirection was based on questions of future liability associated with the potential discovery of residual contamination at some later date. The direct effect of this decision was the termination of the in-situ drain line and through-tube electropolish cleaning task, the termination of the in-situ door

Figure 6-20. View of the Decon Room Shielding Doors from the Service Gallery During the Initial Stages of Decontamination. [6DH29-11/30/90-S1A]

decontamination task, and a review of all other tasks to identify cost savings that could be realized by process modifications. The sequencing of D&D activities was also reviewed to ensure that key areas (including personnel change rooms, electrical distribution centers, and the HEPA ventilation system) were maintained in a functional status as long as practical to maximize safety, radiological containment, and productivity while minimizing cost.

As a result, a specialty heavy-lift rigging contractor was hired to remove the shielding doors for subsequent decontamination at the RMHF. The four decon room doors were removed and transferred to the RMHF in FY 1991. Figure 6-21 shows the removal of the Decon Room 2 shield door, and Figure 6-22 documents the transport of two doors by flatbed truck. Temporary plywood covers with personnel doors were installed on the decon room door openings to maintain radiological containment and air flow in the cells and decon rooms. Hot Laboratory technicians removed and disposed of the door trolleys and support rails.

Figure 6-21. Removal of the Decon Room 2 Shield Door from Building 4020. [6DH29-4/17/91-S1H]

Figure 6-22. Transport of the Decon Room Doors to the RMHF. [6CZ26-4/16/91-S1G]

The re-planning of the D&D to support facility demolition included a study to determine the most cost-effective method of removing the cell wall through-tubes. This included an evaluation of whether the tubes could be pulled from the concrete mechanically. It was concluded that the weld joint between the two tube sections was not designed to withstand the potentially large load that would be placed on a tube if the tube-to-concrete bond strength was high. This approach would also require a significant investment in development and special tooling. The study concluded that the preferred approach was to use a contractor with expertise in core drilling to remove the tubes intact. This would contain any potentially contaminated concrete located at the interface of the two sleeves by performing the core cutting only in the clean concrete surrounding the tube/concrete interface. An approach was developed that permitted the core-drilling of the tubes from the clean operating gallery side of the cell walls. This ensured full containment of contamination, prevented contamination of coring equipment, and minimized both training requirements and potential exposure to contractor personnel.

Work resumed on equipment removal from, and decontamination of, the support areas that contained low levels of radioactivity. Those areas included the glove box laboratory (Room 139), the hot laboratory (Room 141), and the manipulator maintenance room (Room 128). Room 139 contained two glove boxes that had been installed for the handling of alpha-emitting materials, one of which is depicted in Figure 6-23. One of the two glove boxes had not been used and was removed for recycling after surveys confirmed that it was clean. The second glove box was contaminated, and underwent extensive decontamination to enable its packaging and disposal as low level radioactive waste.

Figure 6-23. One of the Two Glove Boxes in Room 139 Prior to Removal. [6HD29-5/18/90-S1G-8]

The manipulator maintenance room (Room 128) had been partitioned into a "cold" (non-radioactive) side and a “hot" (radioactive) side during facility operation. This paralleled the operational use of the manipulators, which extended from the operating gallery into the hot cells. The cold side of Room 128 was found to be relatively clean. The hot side of this room contained widespread, but low-level, contamination on the floors and in the walls, ceilings, and attic. Large sections of the walls and partitions in Room 128 and in adjoining Room 139, plus sections of the lower walls in Room 141, were removed, packaged, and disposed of as contaminated waste. The false ceilings above all of the labs were also removed, packaged, and disposed of as low-level radioactive waste. The HEPA plenums for Rooms 128 and 141 were removed and replaced with temporary units to permit further decontamination work in the support areas while maintaining filtered air control.

The floor tile and underlying mastic in several support rooms was sampled and analyzed for the presence of asbestos. The tile in Room 141 was found to contain asbestos and was removed by a licensed asbestos abatement contractor whose personnel were given the required radiation worker training. The double-bagged asbestos waste was then packaged for final disposal by Hot Laboratory technicians. The floor tile in the other rooms was asbestos-free and Hot Laboratory personnel performed the removal and packaging operations.

The bare concrete floors were surveyed for radiological contaminants following removal of the floor tiles. Localized contamination spots were identified in the concrete and removed by mechanical scabbling procedures. Those procedures included the use of rotary hammer-head floor scabblers, capable of cleaning a 24-inch-wide path, for first-pass cleaning, followed by the use of small hand-held single-head and needle-head scabblers for small localized areas. Pneumatic 90-lb. jackhammers were used where contamination penetrated deeply into and through major cracks. In particular, contamination was found to extend into the soil beneath the floor through a seam that ran the length of the manipulator maintenance room (Room 128). This seam was the cold joint between the basement roof slab edge at the west wall and the support area floor slab running west of the basement. Localized areas of contaminated soil were identified and removed.

Decontamination of the service gallery and north passage (a hallway used for the movement, temporary storage, and packaging of radioactive equipment and materials during facility operations) proceeded in parallel with the decontamination of the support rooms. Contamination was found in localized areas under floor tiles and in floor cracks. The bottom two-foot section of the service gallery exterior wall was removed. New sheet metal was installed in this area and joints were sealed with expandable foam to maintain proper air flow within the controlled areas. As was done for the other support areas, the ceiling and light fixtures in the service gallery were removed due to widespread low-level contamination. Very low levels of contamination were also found on the floor and lower walls of the hot change room (Room 149). This contamination was marked, but decontamination was delayed until later in the program in order to use the room to support the D&D of other parts of the facility.

Equipment located in the support areas outside of the radiological control areas was removed. The equipment from the mockup area was surveyed, wiped down as necessary to remove any contaminated dust, free-released, and transferred to an adjacent facility for further use in support of the D&D project. The only significant contamination found in the mockup area was adjacent to the Cell 4 north door, where shielded cask transfers were conducted during facility operations. Non-essential equipment was removed from the heating and ventilation room (Room 133) and from the battery room (Room 137). The emergency generator, required for the HEPA system, and the facility air supply and heating system remained in operation. Equipment and furnishings were also removed from the Engineering and Health Physics support trailers, located within the facility perimeter, in preparation for release surveys.

Several Building 4020 exterior areas were also surveyed. The radioactive materials holdup yard, located west of the building, had two layers of asphalt paving with areas of known contamination between the two layers. Those contaminated areas were removed and packaged for disposal. The soil beneath the asphalt was surveyed, and localized contamination was identified and removed. Contamination was also found on the west loading dock deck, the west vertical wall of the dock, and in the soil immediately adjacent to the dock. Light (less than ½-inch depth) scabbling of the entire dock and the ramp from the dock to the holdup yard removed the floor contamination. The soil adjacent to the dock was removed to a depth of about two feet and packaged for disposal.

The DOE Nevada Test Site, to whom several Hot Laboratory waste shipments were made in prior years, implemented a revised set of Defense Waste Acceptance Criteria in 1990. Rocketdyne modified its waste packaging procedures during 1991 for compliance with the new criteria. These modifications included complete oversight by Quality Assurance (QA) inspectors during packaging operations. In addition, new requirements were implemented which required review of all waste containers by Rocketdyne Safety, Health, & Environmental Affairs (SHEA) engineers prior to container closure to validate the exclusion of potentially hazardous constituents. In parallel, the in-house waste packaging Shop Traveler was upgraded to require extensive QA and SHEA sign-off for validation of package contents and proper implementation of waste handling procedures.

6.6 FY 1992 ACTIVITIES

Paint removal was completed in Cells 3 and 4 and in Decon Rooms 3 and 4 during FY 1992 using needle guns and grit blasting. Radiological surveys performed in those rooms following initial decontamination identified several areas of residual localized contamination, which were then removed using hand-held grinders. This process of iterative surveying and decontamination was used routinely, particularly for the cell steel liner surfaces. It was required because each decontamination step lowered the general radiation background in the work area to a point that allowed the identification of additional areas with lower contamination levels. Decontamination work in the hot cells and decon rooms utilized portable HEPA air filtering units to protect personnel and avoid recontamination of cleaned areas.

Decontamination of the operating gallery side of the hot cells, initiated in 1990, was resumed. Paint removal by grit blasting within containment tents was completed and the gallery was surveyed. Areas of localized contamination on the cell face were identified and removed by grinding. Extensive low-level contamination was also found in the first several inches of electrical conduits and in the electrical trench in front of the operating gallery cell face.

Work on removing the through-tubes from the cell walls by core drilling was initiated. In preparation, the stepped shield plugs that remained in the through-tubes were removed, surveyed, and decontaminated or packaged for radioactive disposal. The penetrations were sealed using styrene foam plugs on both the cell interior wall face and operating gallery exterior wall face. This eliminated a potential pathway for increasing contamination levels on the tube interior surfaces and for spreading contamination into the operating gallery.

The core drilling operations were performed by an outside specialty contractor, who drilled from the operating gallery side, with its radiologically clean cell face, toward the contaminated interior cell face. This operation is pictured in Figure 6-24. The coring operation was stopped about 1 inch short of penetrating into the cell, leaving an intact barrier. This enabled the contractor operations to be conducted in a clean, non-radioactive environment. The cores were then broken loose and removed from inside the cells by Rocketdyne radiation workers, as depicted in Figure 6-25. The excess clean concrete was broken off from the core surfaces and the remaining cores, containing the steel tubes, were packaged and disposed of as radioactive waste. The cooling/lubricating water from the drilling process was collected, verified to be radiologically clean, and disposed of as clean waste. This collection method prevented the flow of cooling water into the contaminated cells, which could spread contamination and generate additional radioactive waste. During the period June to August 1992, a total of 466 cores were drilled with diameters ranging from 5 to 9 inches.

Figure 6-24. Core Drilling Operations to Remove the Hot Cell Penetration Through-Tubes. [ETEC-6/8/92-393174]

Figure 6-25. Removal of Concrete-Encased Through-Tube Cores by Rocketdyne Radiation Workers. [ETEC-6/8/92-393168]

Based on the success and efficiency of the through-tube removal by core drilling, a similar procedure was used to remove the cell window frames and the large-diameter master/slave manipulator through-tubes. Here the core drilling technique was used to drill a series of holes around the perimeter of each of the windows and manipulator ports. These ports were then broken free, size-reduced, and packaged for disposal. This procedure was found to be far more cost-effective than cutting out the frames and manipulator tubes and then jack hammering out the surrounding contaminated concrete. When the cores were removed, the holes were re-plugged with Styrofoam seals to control building ventilation and maintain a negative, HEPA-filtered air flow in the cells and decon rooms.

The steel plates lining the hot cell interior walls, and covering the face of the operating gallery, were originally installed before the concrete cell walls were poured during building construction. The liner plates were welded to horizontal and vertical stiffeners (3-inch steel struts on 2-foot centers) and were used as the forms to pour the concrete. Figure 6-26 shows this structure from above during building construction, before the concrete was poured. Following construction, they served as the inert gas containment boundary during operation of the cells. In the fall of 1991, small random sections of the Cell 1 liner were removed. The purpose was to validate that complete liner removal was not required, by verifying that there was no contamination behind the liner or in the underlying concrete. However, widespread contamination was found on the back side of the liner, on the exposed concrete face, and in cracks in the concrete.

Contamination pathways included cracks in the liner weld seams and penetrations made through the liner for hardware wall attachments during facility operation. These results showed that it was necessary to remove the entire liner in each cell to assure complete removal of all contamination from the concrete cell walls.

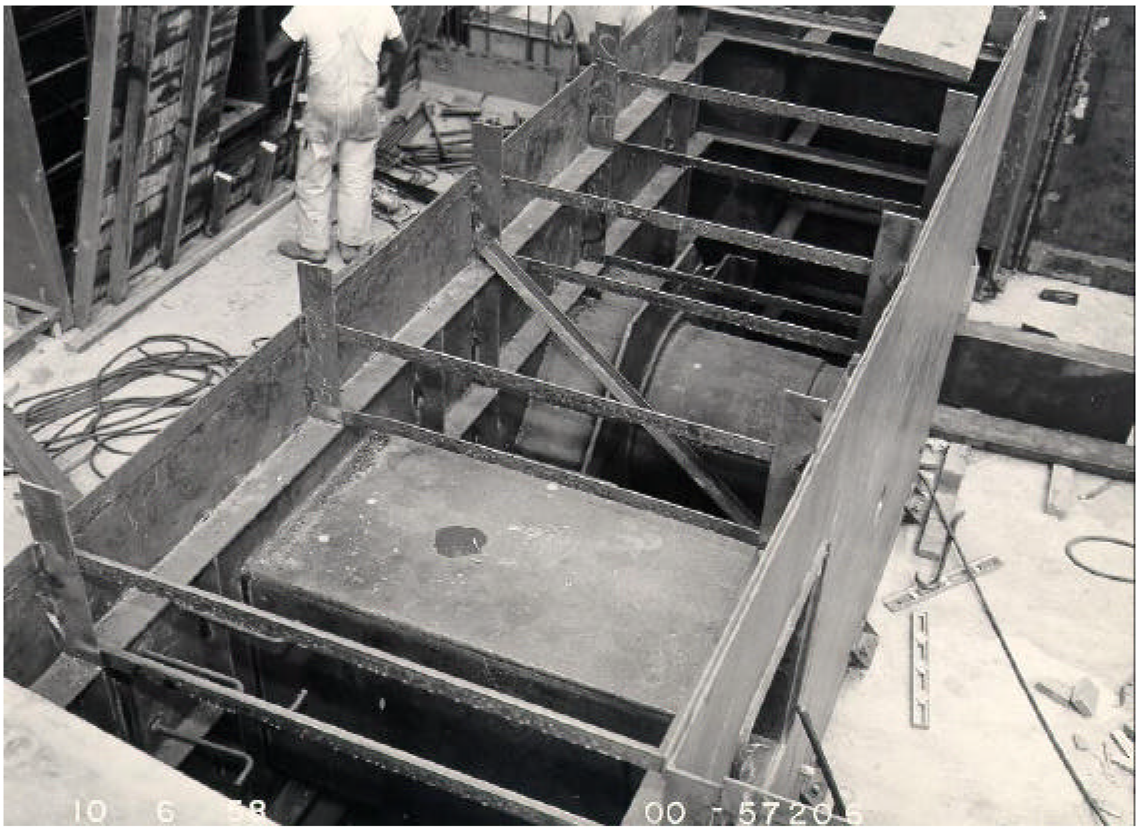


Figure 6-26. Cell Liner Structural Assembly Before the Concrete Cell Walls Were Poured. [00-57206 10/6/58]

Removal of the Cell 1 wall liner was initiated using oxygen/acetylene torches by Rocketdyne technicians. This was a tedious procedure, as removal required cutting individual pieces within the steel strut support grid. By the end of FY 1992, all of the wall and ceiling liner plate had been removed from Cells 1, 2 and 3, and approximately 90 percent of the liner in Cell 4 was removed. Figure 6-27 is a photograph of the ceiling and upper walls of one of the cells during removal operations, showing the liner and the steel support grid in areas where the liner had been removed. Figure 6-28 is a view of a cell interior wall with the liner removed, again showing the steel support structure. The concrete walls were surveyed following liner removal, and areas of contamination were marked and removed by scabbling. The decontamination of cracks in the concrete and contaminant pathways along the steel struts in the concrete required significant effort. Gamma radiation levels of up to 2 R/h were found along the steel struts near cell crane rails at concrete depths of 2 to 3 feet. They were the result of cell wash-down water carrying contamination into the cracks during facility operations.

Figure 6-27. View of the Ceiling and Upper Walls of One of the Cells During Liner Removal Operations. [ETEC-03/16/92-P393063]

Figure 6-28. View of a Cell Interior Wall Following Liner Removal. [ETEC-03/16/92-P393061]

The removal of the decon room concrete doors took place in FY 1991, as described in Section 6.5. In FY 1992, work was initiated to remove the larger steel hot cell doors. The four cell shield doors that separated the hot cells from the decon rooms were too tall to pass through the existing decon room door openings. A specialty concrete sawing contractor was hired to cut notches above the decon room door openings for clearance to remove the cell doors. This involved the use of diamond-blade sawing, as shown in Figure 6-29. In addition, the west wall of the service gallery was opened up to allow door removal from the building, and the north doorway of the mockup area was enlarged to provide clearance for the cell door located on the north wall of Cell 4. Figure 6-30 is a view through the service gallery door to the Decon Room 1 opening, showing the notches cut in both doors.

The cell doors from Cells 1, 2, and 3 were removed by the specialty rigging contractor who had removed the decon room doors in FY 1991. This process is depicted in Figures 6-31, 6-32, and 6-33. Figure 6-31 shows the removal of the Cell 1 door from its support beam, Figure 6-32 shows the rigging used for its movement out of the building, and Figure 6-33 is a view of the lifting operation for loading the door onto a flatbed transport trailer. The doors were transported to the RMHF for decontamination.

Figure 6-29. Diamond-Blade Sawing of the Decon Room Door Notches for Removal of the Cell Doors. [ETEC-8/4/92-P393286]

Figure 6-30. Service Gallery and Decon Room 1 Door Openings with Notches Cut for Removal of the Cell 1 Shield Door. [SF-8/12/92-S1012]

Figure 6-31. Removal of the Cell 1 Shield Door from Its Support Beam. [SF31-8/11/92-S1007]

Figure 6-32. Cell 1 Shield Door Rigged for Movement Outside Building 4020. [SF31-8/11/92-S1009]

Figure 6-33. Transfer of the Cell 1 Shield Door to a Transport Trailer. [SF31-8/12/92-S1002]

6.7 FY 1993 ACTIVITIES

The remaining steel wall liner in Cell 4 was removed in October 1992. The two large shield doors from Cell 4 were then removed and transported by the rigging contractor to the RMHF for decontamination. The north wall opening in Cell 4 was temporarily sealed with plywood.

The steel plate that lined the floors in the cells and decon rooms was removed in FY 1993. In preparation, cover plates were welded onto the cell and decon room drain line inlets and the cell storage tube openings to seal them for contamination control and shielding purposes. The torch cutting of the steel floor plates was performed by an outside specialty contractor. This switch to a contractor was made to improve D&D efficiency by using higher temperature, and thus more efficient, oxygen/propane cutting methods. ETEC personnel worked directly with the contractor, performing all materials handling and waste packaging operations. The cutting operation is shown in Figure 6-34. Removal of the floor liners was completed in January 1993.

Figure 6-34. Oxygen/Propane Cutting of the Decon Room 3 Floor Liner for Removal. [AA33-1/26/93-S1002]

The concrete under the floor liners in the cells and decon rooms was found to have widespread contamination, as was previously observed for the walls. Concrete was removed from the floors in all of the cells and decon rooms to depths up to 6 inches using scabblers and jackhammers, and was packaged as radioactive waste. Contamination was also found in the expansion joint between the Cell 4 north wall and the mockup area concrete floor around the north shield doorway, and was removed. Concrete removal equipment included small scabblers, 90-lb. jack hammers, and two specialty vehicles that were capable of working inside the cells and were employed to expedite concrete removal and reduce personnel fatigue. One of those vehicles was a small track-mounted backhoe, pictured in Figure 6-35, which was equipped with two interchangeable end effectors: a 200-lb. pneumatic hammer and a small bucket. The second vehicle, shown in Figure 6-36, was a wheel-mounted skip loader that operated a similar hydraulic ram and a larger bucket. Hydraulic fluids were replaced with nonhazardous fluids, similar to those used in vegetable processing plants, in order to avoid the potential generation of mixed wastes in the event of a fluid leak. Extensive monitoring was performed to determine whether exhaust fumes from the diesel motors posed a personnel hazard in the confined work spaces. This was found to be a non-issue because of the rapid air turnover by the facility ventilation system. Both specialty vehicles proved to be efficient and cost-effective.

Figure 6-35. Track-Mounted Backhoe Used for Floor Concrete Removal Inside the Hot Cells and Decon Rooms, Shown with the Hydraulic Hammer Attached. [AA31-07/14/93-S1002]

Figure 6-36. Wheel-Mounted Vehicle Used for Concrete Removal Inside the Hot Cells and Decon Rooms, Shown with the Concrete Breaker Attached. [AA31-3/3/93-S1006]

The cell radioactive exhaust ducts that serviced the hot cells were located in the cell floors and ran to plenums and the central HEPA filter/blower system in the basement. The Cell 3 exhaust duct, for example, is pictured in Figure 6-37 (during removal). The hot cell and decon room drain lines (Figure 2-6) were encased in the cell floor concrete and ran to headers and then to a central line that led to the radioactive holdup tank in Building 4468. In many locations, the drain lines and the HEPA duct system intersected or were oriented in a manner that caused access interference. The HEPA ducts were removed first in order to provide access to the radioactive drain lines embedded below them. This included the back-to-back inlet ducts in Cell 1 (north side) and Cell 2 (south side), plus the encasing concrete, and the exhaust duct elbows (Figure 6-38) from all four cells. In many cases, duct removal from the 4-foot-thick cell floor slab required concrete removal from the top (cell floor) and the bottom (basement ceiling), with the latter requiring overhead work. Exhaust duct size-reduction and packaging were performed in an isolated section of the basement. Gasketed joints between duct sections contained asbestos and were segregated for separate packaging and disposal. The exhaust duct valves and ducting in the basement below all four cells were then removed, size reduced, packaged, and transferred out of the basement. The exhaust system for the decon rooms was maintained in service to ensure proper ventilation during final stages of cell decontamination.

Figure 6-37. Cell 3 Exhaust Duct During Removal. [ETEC-07/28/93-393883]

Figure 6-38. Removed Cell Exhaust Duct Elbows. [SF31-6/17/93-S1 021-288]

Access to the drains in the cells and decon rooms required the removal of substantial amounts of concrete from the floors, from the walls between cells (and beneath them), and from the basement ceiling. Examples are shown in Figures 6-39 and 6-40. Radiation levels were significant, with the highest readings adjacent to the drain lines. Those levels increased as the overlying concrete was removed above the Cell 2, 3, and 4 drain lines. Contact gamma radiation readings for removed drain lines included values up to 1 R/h for lines from Cell 2 and up to 5 R/h for lines from Cell 3. Their origin was debris inside the piping, principally metal shavings from 30 years of nuclear fuel declad and reactor disassembly operations. Localized shielding was used around exposed pipes for personnel protection, and debris was cleaned from the drain line sections as they were removed. Removal of the debris reduced drain pipe contact readings to 20-25 mR/h. Preliminary measurements of the debris suggested that it contained transuranic (TRU) material at levels in excess of 100 nCi/g, in addition to ^{60}Co. The debris was placed into vented one-gallon cans in shielded drums with HEPA filter vents and transferred to the RMHF for interim storage in a below-grade shielded vault.

Figure 6-39. Radioactive Drain Line Removal in Cell 1. [AA31-03/22/93-S1003]

Figure 6-40. Radioactive Drain Line Removal in Cell 1 and Decon Room 1. [AA31-03/22/93-S1002]

The inlet at the top of the radioactive drainline holdup tank in Building 4468 was preceded by a weir that trapped much of the sediment that had been transported down the drain lines. This weir contained debris similar to that in the drain lines and was removed and transferred to the RMHF for later debris removal, size reduction, and packaging for disposal. The 4-inch drain line at the inlet to the weir/drain tank was cut just inside the west wall of the building. Remote video cameras were used to inspect the line, and identified centering lugs welded to the pipe that prevented removal of the drain line by pulling it through its outer secondary containment casing. Special tooling was made to cut the drain pipe supports from the casing.

A large quantity of lead was incorporated in the facility structure during construction, including both blocks and poured-in-place shields. Its purpose was to prevent radiation streaming in critical areas. Figure 6-41, for example, is an old construction photograph that records the placement of lead blocks in a cell wall steel liner frame before the cell wall concrete was poured. Approximately 34,000 pounds of lead were removed from the cell and decon room areas during the D&D operations. Extra precautions were taken during the removal of the lead and the surrounding contaminated concrete to prevent radiological contamination of the lead. Nearly half of the lead removed required no decontamination prior to release for recycling. The balance was transferred to the RMHF for decontamination and recycle, or disposal where decontamination was not practical.

Figure 6-41. Construction Photograph Showing the Placement of Lead Shielding in the Cell 4 Steel Wall Frame Before the Concrete Was Poured. [00-57204, 10/6/58]

6.8 FY 1994 ACTIVITIES

The removal of the penetrations in the hot cells and decon rooms was completed in FY 1994. Those penetrations had been left in place until this time because of elevated exposure levels. Subsequent facility D&D work significantly reduced those levels, and the concrete core drilling contractor used for previous operations was brought back in to complete the task. The core drilling technique was also used successfully to remove the 13-foot-deep vertical storage tubes located in the floor of each cell. Those tubes can be seen protruding from the tops of four of the concrete basement columns in the Figure 2-5 construction photograph (page 18). Figure 6-42 shows the core drilling operation, and Figure 6-43 is a photograph of the special storage tube lifting fixture that was fabricated to handle the large cores. The drilled cores were removed using a forklift, as shown in Figure 6-44, and size-reduced in the basement for packaging and disposal.

Attention to worker safety continued to be a critical element of the D&D operations. The removal of contaminated sections of the concrete floor, plus the HEPA inlet ducts and the cell floor drains, left the cell floors with multiple trenches, scabbled recesses, and penetrations through to the underlying basement. To ensure safe and stable working conditions, and to enable the use of mobile personnel lifts and fork lifts in the cells, the cell floors were covered with temporary 1-inch steel plates. This had a cost impact, and deviated from the standard practice of starting at the upper facility levels and working down. In this case, a trade-off was made to remove the high-level radioactivity (the drain lines) first, both for ALARA purposes and to provide the ability to survey for lower-level contaminants.

Figure 6-42. Core Drilling to Remove the Vertical Storage Tube in Cell 4. [AA33-10/18/93-S1001]

Figure 6-43. Vertical Storage Tube Lifting Fixture. [AA33-02/22/94-S1006]

Figure 6-44. Removal of a Vertical Storage Tube After Coring. [AA33-02/22/94-S1016]

Further work was performed on drain line removal. The drain header in the east wall and the drain lines in Cell 3 were removed, and the debris from inside the drain lines was placed in vented one-gallon containers inside shielded 55-gallon drums. Concrete removal was completed around the Cell 4 north door drain line and around the service gallery header under Cell 4.

Jackhammering was also performed to remove the concrete around the drain line in the east basement wall, to expose the underground drain line that ran into the liquid holdup tank. The restraints anchoring the drain line within the double containment casing between the basement and drain tank were severed, and the 30-foot section of drain line was pulled out of the casing into the basement. As it was pulled into the basement, it was cut into 5-foot segments, the debris was removed and packaged in the standard-configuration 1-gallon cans within 55-gallon shielded drums, and the emptied drain pipe was packaged for disposal. The lower sections of the drain line were found to be 50% to 60% full of debris upstream from elbows and obstructions from 30 years of operations. This was far in excess of that anticipated by operations personnel or management. A total weight of 290 pounds of debris was removed from inside the 30-foot line. After the last segment of drain line was removed, the radioactive drain tank was removed from Building 4468 (Figure 6-45), wrapped in plastic, and transported to the RMHF (Figure 6-46). At the RMHF it was placed in interim storage in a below-grade shielded vault for later removal of the remaining sludge and debris, size reduction, and packaging for disposal.

Figure 6-45. Removal of the Radioactive Drain Tank from Building 4468.

Figure 6-46. Transport of the Wrapped Drain Tank to the RMHF.

The completion of the drain line removal from the cells and decon rooms lowered the radiation background levels sufficiently in those areas to allow the initiation of surveys to identify areas of localized contamination. The surveys were performed in conjunction with the removal of contaminants from the floors, walls, and ceilings of the cells and decon rooms. Scabbling of the service gallery floor was also initiated at this time.

The remaining radioactive exhaust system ducting that penetrated the floor of each cell was cut free, lowered into the basement, size-reduced, and packaged for disposal. The opening at each of the removed duct locations in the cells was blanked off to maintain ventilation system integrity. The ventilation ducting system associated with the decon rooms was left intact to ensure proper air flow during the final stages of cleanup in the decon rooms.

An additional 40,000 pounds of lead was removed from the pass-through shields in Cells 1, 2, 3, and 4. Approximately 10,000 pounds of this lead was contaminated and was transferred to the RMHF for consolidation with contaminated lead that had been removed previously. About 27,000 pounds of the total 74,000 pounds of lead removed from the cells was categorized as contaminated waste. This lead was double-wrapped with heavy-gauge plastic to meet "macroencapsulation" requirements for interim storage, and stored at the RMHF pending the identification of acceptable disposal options.

6.9 FY 1995 ACTIVITIES

Removal of areas of localized contamination from the floor of the service gallery was completed in January 1995. The identification and removal of localized contaminants continued for the duration of the fiscal year in the hot cells and decon rooms. The significantly reduced radiation levels achieved by previous years' activities allowed the optimization of D&D operations by using two crews in the controlled-entry hot cells and decon rooms. The crews worked in adjacent rooms and shared the same safety-watch ("cold") support person stationed outside the immediate work areas. Figure 6-47 shows the status of the service gallery in March 1995, with a cold support person stationed outside one of the plastic-sealed work areas. The work plan called for the completion of the final room (Decon Room 2) in January 1996.

Approximately 100 containers of waste generated by Hot Laboratory D&D activities during the 1988-1990 time frame had been set aside because of the re-certification required to ship radioactive waste to DOE-NTS. The re-certification process took place in 1991-1992, and required the inspection and re-characterization of the waste container contents to validate the absence of hazardous constituents and verify conformance to the new DOE-NTS acceptance criteria. The last six months of FY 1995 were spent examining, characterizing, and repackaging these "backlog" waste containers and preparing complete documentation on their contents.

Figure 6-47. Status of the Service Gallery in March 1995, During Removal of Localized Contaminants from Adjacent Rooms. [SF31 03/20/95-S1001]

6.10 FY 1996 ACTIVITIES

The D&D of the Hot Laboratory was slowed during FY 1994, FY 1995, and early FY 1996 because of funding limitations. Additional funding was made available three months into FY 1996 through the DOE Small Sites Initiative for the purpose of accelerating the demolition schedule. The FY 1996 goal under this accelerated schedule was to remove the building structure, including the hot cells and decon rooms, to ground level.

Previous years' D&D work had removed most of the contamination from the building, but there was still some residual low-level contamination in the auxiliary systems in the facility support areas. This included the piping systems, air conditioning ducts, and the few remaining ceilings. It was concluded that the accelerated schedule would preclude decontamination, an in-house release survey, a third-party confirmation survey by the Oak Ridge Institute for Science and Education (ORISE), and subsequent demolition of the structure within the allotted 9-month time frame. ETEC proposed and received DOE-Oakland Operations Office concurrence to modify the D&D plan to dismantle the concrete cell/decon room structures and the steel building structure first, and then survey and release the resulting waste material. A clear distinction was made in the D&D plan between the decon room, the hot cells, and the steel building structure. The differences in their construction can be seen clearly in Figure 2-2 and in Figure 6-48, the latter a photograph taken during the 1958 assembly of the steel building. In that photograph, a steel-clad hot cell is on the right, with the corner of a concrete decon room visible behind the taller hot cell walls.

Figure 6-48. October 1958 Building 4020 Construction Photograph, Showing the Distinct Structures of the Steel Building and the Hot Cell/Decon Room Assemblies. [00-57224 10/22/58]

The success of previous concrete core drilling and sawing operations, plus follow-on discussions with contractor personnel, led to the decision to dismantle the concrete hot cells and decon rooms by saw-cutting the monoliths into manageable-sized blocks for subsequent decontamination at an on-site facility. Separate specifications were prepared for the dismantlement of the decon rooms and the hot cells. The strategy was to dismantle the normal-density concrete decon rooms first, identify any problems or potential areas of improvement, and incorporate the lessons-learned in the specification for the high-density concrete cell roof and walls. A third specification was prepared for the demolition of the steel building structure. The decon room demolition specification was released for bid in early January 1996.

The demolition of the above-ground building required the relocation of personnel support facilities. Temporary office and health physics space, and rest room/shower facilities, were established in trailers adjacent to the building. All building utilities were disconnected to ensure that workers did not encounter unexpected live electrical circuits, and temporary power was brought into the facility for the final phases of facility demolition. All remaining D&D materials were relocated in temporary storage sheds adjacent to the facility.

The exhaust system from the decon rooms was deactivated and the ducting was removed. Portable units were installed to maintain proper air control in the work areas. The ducting was sectioned into pieces that could be handled by two mechanics, and each section was vacuumed as it was cut to remove loose contamination and to preclude re-contamination of cleaned areas.

Following duct removal, the risers into the decon rooms were removed using core drills and jackhammers to free them from the surrounding concrete, as depicted in Figure 6-49. The asbestos-gasketed sections were segregated, and all ducting was size-reduced, packaged, and transferred to the RMHF for final disposal.

Figure 6-49. Removal of a Decon Room Exhaust Duct Riser (Basement View). [ETEC-2/8/96-394435]

Decontamination of the support areas continued. Work on the hot change room was completed, including scabbling of the concrete floor and removal of the lower 18 inches of the walls to provide access to contaminated areas, as shown in Figure 6-50. The interior walls adjacent to the service gallery were removed and replaced with a temporary barrier of plastic sheeting to improve access while maintaining air control. Decontamination and dismantlement work progressed generally clockwise around the facility from the service gallery. The inner walls and ceilings of the air lock, hot storage room, battery room, and mockup area were removed, as pictured in Figure 6-51. The few remaining light fixtures, the air conditioning ducts, and overhead piping (Figure 6-50) were removed and temporary portable lighting was installed. All of the overhead piping systems were vacuumed and wet-wiped prior to cutting and removal to minimize the spread of residual contamination. The facility air compressors and boiler systems were removed from the heating/ventilation and equipment rooms. That equipment was cleaned, released, and recycled where possible. The large facility air conditioning plenum was found to be contaminated. It was lowered to the floor, size-reduced, and cleaned for free release.

Figure 6-50. Hot Change Room Following Decontamination, Showing the Overhead Piping and the Removal of the Lower Portions of the Walls. [ETEC-3/1/96-394480]

Figure 6-51. View from the Battery Room Toward the Airlock with Interior Walls Removed. The Service Gallery Is to the Left of the Posts. [ETEC-3/1/96-394486]

A contractor was selected for the demolition of the decon rooms and demolition work was initiated in March 1996. The decon rooms were constructed of standard reinforced concrete with 24-inch-thick walls and 12-inch-thick ceilings. The contractor was responsible for preparing the blocks prior to cutting for handling and for cutting the blocks to maximum weights of 10,000 pounds each. Handling preparations included core drilling holes in the walls, as shown in Figure 6-52, to allow a forklift to remove cut wall sections by inserting its forks into the holes (Figure 6-53). A large concrete saw with diamond-tipped blades was used to make the cuts (Figure 6-54), and the final cut was made with the forklift holding the weight of the block. A special-purpose fixture was designed and fitted to a large-capacity forklift to support the ceiling blocks during cutting and to handle them after the cuts were complete. The removal of a ceiling block using this fixture is illustrated in Figure 6-55.

Rocketdyne personnel were responsible for the removal, handling, and decontamination of the blocks. After removal, the blocks were moved to a side work area where they were cleaned using brushes and a high pressure water wash. The blocks were surveyed and localized spots of contamination were removed by hand scabbling. A total of 103 blocks were removed. All but four of those blocks were successfully decontaminated. The remaining four blocks contained metal door and window frames, and were size-reduced and packaged as low-level waste.

Figure 6-52. Core-Drilled Decon Room Walls for Forklift Access. [ETEC-5/24/96-394571]

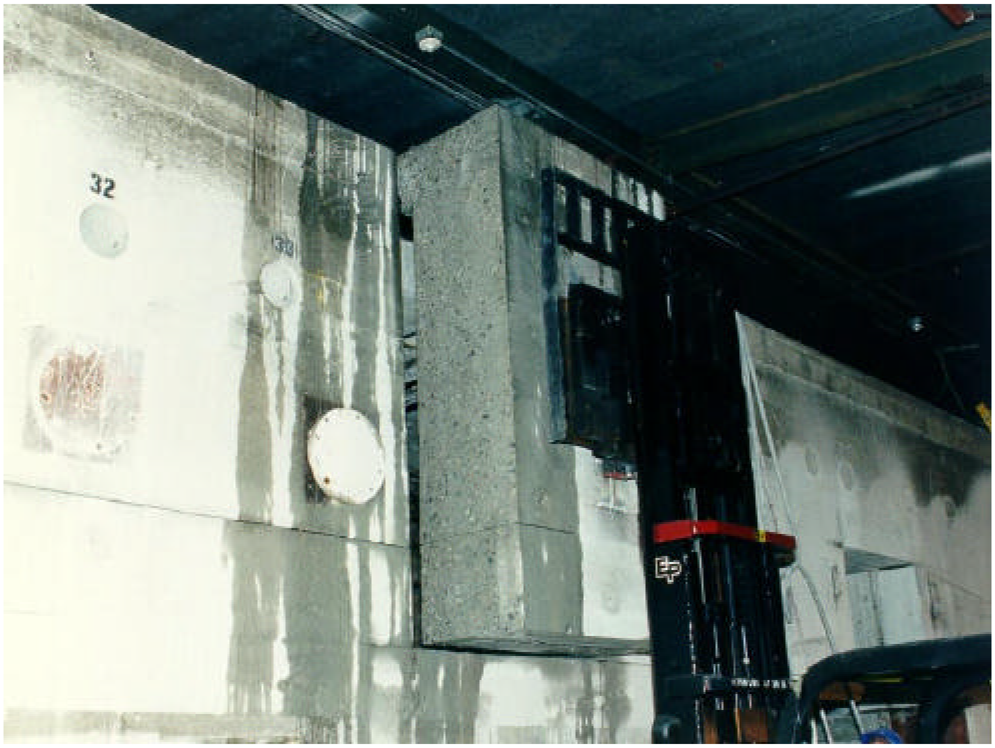


Figure 6-53. ***Forklift Removal of a Concrete Decon Room Wall Block.*** [ETEC-4/26/96-394546]

Figure 6-54. Saw Cutting of the Decon Room Concrete Walls. [ETEC-5/24/96-394587]

Figure 6-55. Removal of a Decon Room Ceiling Block Using a Special-Purpose Fixture. [ETEC-4/19/96-394537]

Demolition of the decon rooms was followed by the removal of the Building 4020 roof. The building had been re-roofed several times, and its roof consisted of several layers of asphalt and gravel beneath a metal covering. Core samples were taken from eight locations and volumetrically analyzed for radioactivity using a Canberra HPGe radiation detector. The results showed trace levels of contamination, which could have originated from the combination of trace building stack emissions over a thirty-year operational period and atmospheric fallout associated with past world-wide nuclear weapons testing. The samples were also analyzed for asbestos, which was found in the felt layers. The entire roof was removed by an outside asbestos abatement contractor and placed in enclosed 15-yard gondolas. The gondolas were transferred to the RMHF pending disposal at an authorized off-site location as asbestos-containing radioactive waste. Roof removal activities are shown in Figure 6-56 (metal covering) and Figure 6-57 (underlying asbestos-containing asphalt)

Figure 6-56. Removal of the Building 4020 Overlying Metal Roof. [ETEC-6/13/96-394599]

Figure 6-57. Removal of the Building 4020 Underlying Asbestos-Containing Asphalt Roof. [ETEC-6/13/96-394598]

The successful dismantlement of the decon room by saw cutting led to the placement of the second building dismantlement contract, to cut, remove, and transfer the hot cell roof and wall blocks to an on-site decontamination facility. The cell walls were constructed of 42-inch-thick high-density concrete, while the cell roof was constructed of standard reinforced concrete with thicknesses varying from 30 inches at the outer roof edge to 42 inches at the roof peak. The maximum permitted block weight was 40,000 pounds, selected to minimize the number of blocks generated while staying within the lift capacity of the decontamination facility mobile hoist.

The cell roof was sectioned into blocks by core drilling. This process, pictured in Figure 6-58, was used to perforate the roof into sections, as shown in Figure 6-59. Core drilling was selected over saw cutting because it was considered to be as efficient as saw cutting for this application and eliminated the dangers associated with performing overhead cutting operations. Saw cutting would have required cuts from both the top and underside of the roof because of limitations in the saw-blade diameter. Concurrent with the core drilling, horizontal cuts were made at the tops of the walls from the outside to detach the roof blocks from the walls (Figure 6-60). The cut depths were just short of penetrating the full wall thickness. Jacks were then used to detach the roof blocks, which were removed by overhead crane (Figure 6-61).

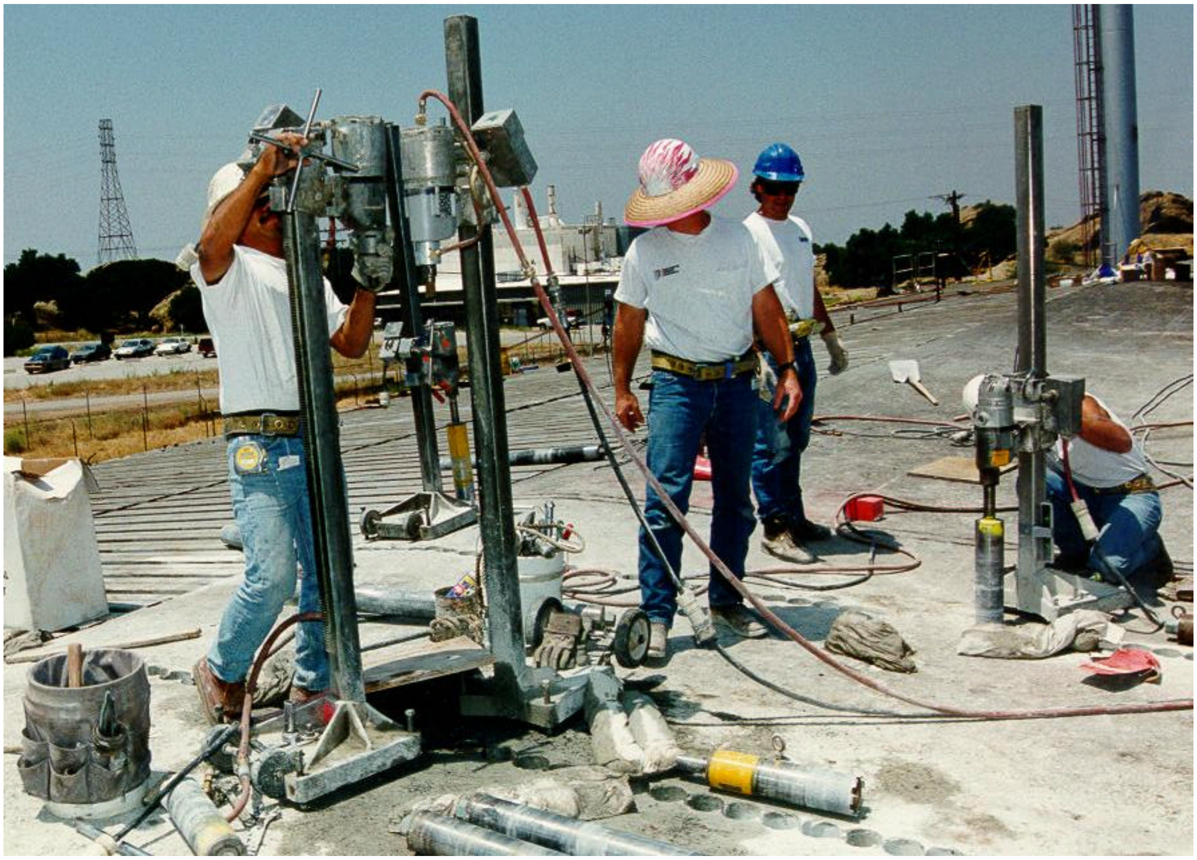


Figure 6-58. Core Drilling Operations to Section the Concrete Cell Roof. [ETEC-6/13/96-394606]

Figure 6-59. Core-Drilled Concrete Cell Roof Block Segment. [ETEC-6/13/96-394608]

Figure 6-60. Detachment of the Cell Roof Block Segments by Saw Cutting. [ETEC-6/13/96-394591]

Figure 6-61. Removal of the Concrete Cell Roof Blocks. [ETEC-6/25/96-394638]

Following removal of the cell roof, the cell walls were sectioned into blocks for removal. This required saw cutting with diamond-tipped blades from both inside and outside of the cells. The operating gallery cell face still had its steel liner in place, as localized contamination between the liner and underlying concrete had been found only around cell windows, and was previously removed. Grids were marked on this steel face to identify the locations at which the outside cuts were to be made. Those steel sections were then resurveyed and removed by torch cutting. This was done to extend the lifetimes of the saw blades, which are rapidly dulled by the continuous cutting of steel plate. The cell walls were subsequently cut using 52-inch-diameter concrete saws. Sectioned blocks ranged in weight from 10,000 to 40,000 pounds.

The sectioned wall blocks were removed by the contractor using a 75-ton capacity crane and placed on a drop-bed trailer for transfer to ETEC Building 4024, the on-site decontamination facility. Here they were off-loaded using the facility mobile crane. Approximately 80 blocks were handled in this manner. Twenty additional smaller blocks were size-reduced and decontaminated at the Hot Laboratory site. Removal of the last concrete block was completed five months after making the first cut on the decon roof.

The twenty blocks that were size-reduced at the Hot Laboratory site and all of the other blocks were subsequently decontaminated for recycling or disposal at a commercial landfill. This ability to recycle the blocks is the result of the extensive decontamination efforts conducted prior to cell dismantlement, performed under the original plan to decontaminate and release the facility in place.

Water management was a major challenge during the coring and saw-cutting activities. A significant effort was made to collect all cooling water at the point of the cutting operations. The captured water was analyzed radiologically and was typically released as clean water. However, some water drained into the basement and required radiological management. A total of about 10,000 gallons of water was collected, approximately half of which was verified to be radiologically clean and was released into the normal facility waste water system. The radiologically contaminated water was transferred to the RMHF in 500-gallon portable tanks and was subsequently processed in the facility radioactive liquid evaporation system.

The building steel structure demolition was included in the cell demolition contract, and was staged with the cell removal. Rocketdyne personnel had at this time completed the interior demolition of the building, including the removal of all interior walls, ceilings, equipment, piping, and electrical distribution systems. The contractor first removed the exterior walls and roof structure of the operating gallery, to provide access for saw cutting and for crane handling of the cut cell blocks. The remainder of the building was then razed and the steel beams and siding were moved to an adjacent hold yard for survey and release.

The top 55-foot section of the 75-foot-high building exhaust stack was also removed by the contractor. The stack was supported by a crane and severed several feet above ground level. The ends were sealed and the severed section lowered to a flatbed truck (Figure 6-62) for transport to the RMHF for size-reduction and packaging for disposal. The remaining 20-foot section was left in place pending shutdown of the basement exhaust system. Concurrent with the removal of the upper stack, the facility general HEPA exhaust system was shut down and replaced with two 4000-cfm portable HEPA systems to support basement decontamination. Openings in the floor (basement roof) were covered with plywood and sealed to control air flow within the basement. Basement decontamination control was maintained by partitioning the area into small sections that were serviced by supplemental 1000-cfm portable HEPA systems.

Following completion of the contractor work, all remaining concrete rubble was packaged for disposal, including all of the cores generated by cell roof core drilling. The building slab was then swept and washed down to eliminate any potential for contamination spread by wind-blown dust from the structure demolition. Figure 6-63 shows the cleared slab and the remaining portion of the exhaust stack, and Figure 6-64 is a photograph of the Hot Laboratory site from above in November 1996.

Removal of the remaining exhaust ducting in the basement was completed prior to the end of FY 1996. The basement concrete walls, ceiling, and floor were then surveyed and areas of localized contamination were identified and marked. Removal of this localized contamination was initiated and continued through the end of the fiscal year. Surveying and release of the metal structural materials and concrete rubble also continued through the end of FY 1996. Materials released by Rocketdyne Safety, Health, and Environmental Affairs personnel were moved to a second hold area pending review and final release by the California Department of Health Services (DHS).

Figure 6-62. Removal of the Top 55 Feet of the Building 4020 Exhaust Stack to a Flatbed Truck for Transport to the RMHF. [ETEC-9/9/96-394817]

Figure 6-63. Cleared Building 4020 Floor Slab and Remaining Exhaust Stack Section. [ETEC-8/6/96-394760]

Figure 6-64. Photograph of the Hot Laboratory Site and Its Surroundings in November 1996. The Site is in the Lower Center of the Photograph. [ETEC-10/17/96-394935]

6.11 FY 1997 ACTIVITIES

FY 1997 activities focused on the removal of the basement structure. The fiscal year goal was the complete removal of the basement and a Rocketdyne final release survey of the remaining excavated area. A parallel effort was also initiated to minimize and dispose of the bulk waste generated during the facility dismantlement activities.

6.11.1 Basement Structure Removal

The first step in removing the basement was the decontamination of the basement interior surfaces to a level that would allow the saw cutting and removal of the concrete basement roof (facility floor), walls, and floor with a minimum of radiological contamination concerns. All basement surfaces were washed down with a high-pressure water spray. The resulting waste water was collected in the three basement sumps and transferred to the RMHF in a 500-gallon portable transfer tank for evaporation. A comprehensive radiological survey was then performed for the basement interior surfaces. Radiologically contaminated ("hot") spots were identified and marked, as shown in Figure 6-65. The HEPA filtration system, including blowers, HEPA plenums, and basement ducting, presented the greatest potential for personnel exposure. That system was no longer needed, and was thus removed and packaged for disposal. Figures 6-66 and 6-67 show HEPA system ducting and blower components, respectively, during the removal operations. The three basement sumps were drained, the sludge was removed, and they were then painted to fix all loose contamination. Figure 6-68 shows a typical sump prior to cleaning, while Figure 6-69 shows the same sump after cleaning and painting. The floor drains were plugged or sealed with flanges to isolate the higher levels of contamination remaining within the underlying drain lines.

Figure 6-65. Basement Area During Survey Mapping for Hot Spots. [ETEC-11/11/96-394952]

Figure 6-66. Basement HEPA System Plenum and Ducting During Removal. [ETEC-10/2/96-394902]

Figure 6-67. Basement HEPA System Blower During Removal. [ETEC-10/2/96-394903]

Figure 6-68. Basement South Sump Prior to Cleaning. [ETEC-10/2/96-394922]

Figure 6-69. Basement South Sump Following Cleaning and Painting. [ETEC-12/20/96-394967]

Removal of the HEPA ventilation system provided access to the underlying floor area for decontamination. The decontamination was performed using a commercial pneumatic floor scabbler that incorporated four hammer heads and had a concrete floor scabbling rate of about 1 ft^2 per minute. The scabbling operations concentrated on historically known hot spots, including specific floor sections and areas around sumps and drain openings. The basement floor in the general area depicted in Figure 6-65 before scabbling is shown after scabbling in Figure 6-70.

Figure 6-70. Basement Floor Following Scabbling. [ETEC-12/20/96-394965]

The remaining 20-foot-long basement section of the facility stack, shown in Figure 6-71, was removed at this time. It was torch-cut into 4-ft-diameter by 2-ft long sections, packaged into B-boxes, and transported to the RMHF for shipment to the Nevada Test Site (NTS) for disposal. All of the torch cutting was performed using portable HEPA exhaust systems, with the basement partitioned into sections to maintain a negative airflow and ensure containment of contamination.

The removal of the HEPA ducting and other support systems left numerous openings in the basement roof. Projected El Niño storms during the 1996-97 fall and winter raised concerns of heavy rainfall and the subsequent generation of large quantities of contaminated water in the basement. A wooden structure approximately 25 feet wide by 100 feet long was constructed to cover the basement during the rainy season. The structure was sloped and covered with plastic to divert rainwater to site drainage channels. Extra waste water storage capacity was set up using portable double-wall tanks. Even with the cover, approximately 6,500 gallons of rain water were pumped from the basement in the December – February period. The external rain-protection covering is shown in Figure 6-72.

Figure 6-71. Basement Section of the Facility Exhaust Stack. [ETEC-10/2/96-394904]

Figure 6-72. Basement Covering to Minimize Water Influx During the Rainy Season. [ETEC-97/02/14-394989]

A contractor was selected at the beginning of FY 1997 to section the basement concrete structure (roof, walls, and floor) by saw-cutting and to handle and transfer the resulting concrete slabs to designated storage areas. That work was initiated in November 1996, beginning with the floor slab of the former office and support areas, which were outside of the basement area. This floor slab cutting operation is shown in Figure 6-73, where the covered basement roof is visible in the background.

Figure 6-73. Saw-Cutting of the Building 4020 Slab Adjacent to the Covered Basement. [ETEC-11/11/96-394945]

Following the rainy season, the contractor removed, numbered, and stacked the cut slab sections in the south parking lot of the facility. A large excavator was used to move the slabs to the storage area for later survey and disposition. The exposed soil (Figure 6-74) was surveyed, and any detectable contamination was removed to eliminate the potential for spread of contamination. At the same time as the slab was being removed, contractor crews inside the basement put up scaffolding to support the basement roof area. That scaffolding, for which an example is shown in Figure 6-75, was used later to support the roof sections when they were cut.

Once the concrete floor slabs that had surrounded the basement area were removed, the contractor was able to begin excavation around the support foundation walls that supported the steel frame of Building 4020. That work started at the northeast corner of the facility and worked toward the south along the eastern support foundation wall. Figure 6-76 shows the sectioning of the east foundation by saw cutting.

Figure 6-74. Soil Exposed by Concrete Pad Removal. [ETEC-4/19/97-395065]

Figure 6-75. Basement Scaffolding Used to Support the Roof During Cutting. [ETEC-5/15/97-395165]

Figure 6-76. Sectioning of the East Foundation by Saw Cutting. [ETEC-5/15/97-395150]

A major objective during basement demolition was to reuse the soil that was excavated from around the basement walls to fill in the excavation once the area was released radiologically. Detailed radiological surveys of the surrounding areas were performed prior to foundation excavation. Particular emphasis was placed on the areas that had the greatest potential for contamination, based on activities associated with the operational history of the facility. Only three areas with significant contamination were found.

The first contaminated soil area was in the vicinity of the waste-water transfer station on the west side of the Liquid Waste Facility (Building 4468). Approximately 30 cubic yards of contaminated soil were removed from this area in FY96, prior to excavation of the basement. The source of contamination was an underground 2-inch-diameter pipe used to transfer contaminated waste water from the facility 3000-gallon drain tank to the 500-gallon portable transfer tank loading station. Unlike the facility radioactive drain lines, which were welded stainless steel, this section of pipe was a mismatch of black iron and galvanized pipe which had degraded through electrolysis between the two different types of pipe material.

The second contaminated soil location was an area of expected contamination in a seam between two concrete slabs in the service gallery area, adjacent to Cells 1 and 2. Contamination in the seam area had been fixed previously to keep it from migrating. Once the foundation and facility floor slab were removed, it was discovered that the seam between the slabs was open to the underlying soil. Contaminated water from routine cleaning of the area during facility operations had migrated through this seam and into the top few inches of soil. This was similar to soil contamination found previously under seams in the floor slab in the hot slave repair shop area. Construction seams in the floors or at wall-floor joints were the major source of contamination in the soil beneath the Hot Laboratory facility slab.

The third area of radiologically contaminated soil was found in a seam between the north cell wall and the floor below the Cell 4 fuel transfer port. Fuel transfer casks had been mated to the port during normal facility operations for fuel package transfer into the cell. Contaminated water from the fuel transfer casks, and from facility decontamination activities, had leaked through the seam. Approximately 4 cubic yards of contaminated soil were excavated from this area. Contaminated soil excavation at the base of one of the concrete seams is shown in Figure 6-77, where the light-colored concrete stains are the water pathway. The contaminated soils were removed from all three areas, which were then surveyed and free-released by Radiation Safety.

Figure 6-77. Contaminated Soil Excavation at the Base of a Concrete Seam. [ETEC-7/21/97-395190]

The basement roof was sectioned by using a combination of core drilling, circular saw cutting, and wire saw cutting. Core drilling, as shown in Figure 6-78, was used first, to drill 3-inch-diameter holes through the 4-foot-thick basement roof area that had been the floor of the hot cells. Those holes were used later to feed diamond cutting wires through the roof and provided the starting point for sectioning that basement roof area by diamond wire cutting. The 2-foot-thick basement roof area, which had been the floor of the decon rooms, was then sectioned using a 48-inch diamond-tipped saw blade. The saw-cutting operation is shown in Figure 6-79. All concrete coring and cutting was preceded by surveying and decontamination of the cutting path in order to minimize the generation of contaminated dust or cooling water.

Figure 6-78. Core Drilling of the Basement Roof in Preparation for Diamond Wire Cutting. [ETEC-5/15/97-395154]

Figure 6-79. Diamond Saw Cutting of the Basement Ceiling. [ETEC-5/15/97-395147]

The 2-foot-thick basement roof area was cut into sections weighing up to 20,000 pounds. A large excavator was used to lift the sections and move them to the staging area. Fall protection was invoked for all crews working on the roof area, and personnel were prohibited from entering the basement while the roof was being cut and removed. Figure 6-80 shows the basement area during roof removal. HEPA ventilation of the basement became ineffective with the removal of the concrete roof slabs, and was terminated at the beginning of May 1997.

Figure 6-80. Basement Roof Removal in Progress. [ETEC-9/1/97-395327]

ETEC personnel performed all of the contractor-support activities, including management of the cutting waste water and concrete debris. The waste water was pumped from the basement sumps into ground-level portable holding tanks, where solids were allowed to settle out, and then transferred to the RMHF. Concrete rubble was packaged for disposal as radioactive waste. The radiological control areas were surveyed and monitored continuously to prevent the migration of radiological contamination, in the form of concrete rubble, cutting fines, waste water, and other waste, from the basement area. Access to the basement was controlled closely, and all work areas were cleaned at the end of each work shift.

The Hot Laboratory HEPA exhaust system included two underground duct sections composed of asbestos-containing Transite pipe. One Transite pipe run was a 30-inch-diameter section of duct that ran approximately 55 feet from the operating gallery floor exhaust duct to the basement plenum, and the other was a 10-inch-diameter section that ran approximately 150 feet from the service gallery main exhaust duct past the hot storage room, air lock, and hot change room. ETEC personnel excavated around those pipe runs at the same time that the concrete contractor was saw-cutting the basement roof; Figure 6-81 shows the 30-inch-diameter pipe during excavation. The two Transite pipe runs were removed by a certified asbestos-abatement contractor with the support of ETEC personnel. They were carefully sectioned to prevent generation of friable asbestos, wrapped in plastic, loaded into approved asbestos roll-off containers, and transferred to the RMHF for size reduction by the abatement contractor. The size-reduced Transite sections were double-wrapped in plastic, loaded into roll-offs with other low-level radioactive waste (LLW), and shipped to DOE-Hanford for disposal.

Figure 6-81. Excavation of a Transite HEPA Ventilation Duct. [ETEC-9/1/97-395321]

Diamond wire saw cutting was selected for sectioning the 4-foot-thick basement roof area in order to eliminate the need for personnel to work under the roof. Circular saws, used for the thinner roof areas, would have required cuts from above and below because of their maximum cut depth of 30 inches. The 3-inch-diameter core-drilled holes were used to set up the diamond cutting wires, with the wire looped through two holes and tightened as the cutting progressed. There was a significant learning curve for the contractor, with wire breakage and diamond delamination from the cutting wires occurring frequently during the first part of the work. The difficulties were caused by the high density of the concrete and the 2-inch-thick embedded steel reinforcing bars. The diamond wire sawing of the roof took about eight weeks, which was five weeks longer than originally estimated. Figure 6-82 shows a typical wire saw setup, and Figure 6-83 is a photograph of the basement area following roof removal.

Figure 6-82. Typical Setup for Diamond Wire Sawing the Basement Roof. [ETEC-7/9/97-395178]

Figure 6-83. Basement Area Following Roof Removal. [ETEC-7/21/97-395196]

The removal of the basement roof and the excavation of the soil adjacent to the exterior of the basement wall was followed by the saw cutting of the walls. The vertical and horizontal cutting lines were first laid out, and a series of 4-inch-diameter holes were cored through the walls near the top to accommodate 1-inch wire cables for lifting and handling the wall sections. The walls were cut into 15-foot-high by 30-inch-wide sections using diamond-tipped circular saws, as shown in Figure 6-84. All saw-cut surfaces were surveyed by Radiation Safety before cutting was initiated, and most cuts were made from the inside of the basement. The cut depth was set to about ¼ inch less than the thickness of the wall to eliminate the potential for the spread of radiological contamination from saw blade cooling water spray. The cutting contractors were also instructed to leave approximately 4" of wall at the base to act as a barrier to hold contaminated water inside the basement. Management of the cutting water was a critical task to prevent radioactive contamination from migrating outside of the basement area. ETEC personnel washed down the cut wall sections to remove any loose contamination and collected and packaged the concrete slurry and concrete rubble that accumulated on the basement floor from the cutting operations.

When the cutting of each wall section was complete, it was removed by a heavy excavator, as shown in Figure 6-85. Each section was snapped off by the excavator without cutting through the final ¼" of wall thickness. The individual sections were transported to a holding area for a detailed survey and decontamination by ETEC crews. Each section measured approximately 6 feet x 12 feet in area and had a thickness of 1 foot or 2 feet, depending on its basement location. Slab weights ranged from about 11,000 lb. to 22,000 lb.

Figure 6-84. Saw Cutting of the West Basement Wall. {ETEC-7/21/97-395186]

Figure 6-85. Removal of a Basement Wall Section Using the Excavator. [ETEC-8/4/97-395240]

The large high-density concrete support columns, which supported the cell floor, were sectioned using a diamond wire saw because of their large size. This also proved to be a difficult wire-saw cutting task, because of the large number and size (up to 2-inch diameter) of embedded steel reinforcing bars. Each column was cut into four sections because of its weight, with the first cut made at the base and the remaining cuts with the column lying on its side. This made it easier to cut through the steel reinforcing bars and maximized the effectiveness of the cutting water in removing cutting fines and maintaining a clear cutting surface. Figure 6-86 shows two of the basement columns after they had been cut off at the base and laid down for size reduction.

Figure 6-86. Two Basement Support Columns Cut Off and Ready for Size Reduction. [ETEC-8/25/97-395290]

The personnel entry tunnel at the southeast corner of the basement was excavated and cut into sections in the same manner as the basement wall sections. The cutting of the east basement wall was complicated by the presence of a 2-foot-diameter by 30-foot-long utility tunnel that connected the basement with the Liquid Waste Facility (Building 4468). This tunnel was used for the radioactive drain line, and thus Radiation Safety had to survey each section of the tunnel before it was demolished and the resulting waste material was placed into a roll-off container. Engineering controls were developed for each different basement section to account for differences in wall thickness, size, and radiological contamination potential to assure that no radioactive contamination migrated outside of the containment provided by the basement.

All waste water and cutting slurry generated during the cutting operations was captured in approved radiological shipping containers and sampled for contamination. Radiologically clean water was held for approximately two days to allow the solids to settle out, eliminating the problem of a high water pH due to suspended particles of concrete. The water was then pumped to a holding tank, re-sampled to verify that it was free of contamination, checked to verify that its pH met release standards, and released into the site sanitary water system. The residual concrete slurry was allowed to dry in the shipping containers and transferred to the RMHF for off-site disposal. Contaminated water was separated from the concrete fines in the same manner, transferred to the RMHF, and processed through the facility liquid waste handling system.

The final stage of basement demolition was the removal of the floor drains and the concrete floor slab. The floor drains were the largest potential source of radiological contamination and the source of the highest exposure levels in the basement. The cleaning and removal of the drain lines had been initiated before the basement demolition was started, including the flushing of the lines and sumps, the plugging and capping of drain inlets and discharge points, and the paint-sealing of the sump surfaces. With the basement walls now removed, ETEC personnel saw-cut 18-inch-wide trenches in the floor to expose the drainage system beneath the concrete slab. The work was expedited by the use of a tractor-mounted hi-ram to break up the trench-area concrete and a small backhoe tractor to perform most of the trench excavation. The use of the hi-ram is shown in Figure 6-87. Radiation Safety personnel monitored exposure levels continuously as segments of the underlying drain line system were exposed. The drain line was sectioned as it was removed, the section ends were sealed, and the sealed components were transferred to the RMHF in standard waste containers for clean out and isotopic analysis.

Figure 6-87. Removal of the Concrete Slab Above the Drain Lines. [ETEC-9/22/97-395358]

Following removal of the drain system from the basement area, the remaining floor slab was surveyed and additional areas were decontaminated. An outside contractor then saw-cut the slab into sections that were approximately 6 feet wide by 10 feet long, as shown in Figure 6-88 for the basement tunnel area (that area previously occupied by the facility HEPA ventilation duct room; see Figure 2-4). A major consideration in this cutting operation was the capture of the saw-cutting water to avoid the potential spread of contamination. Approximately 3,500 gallons of waste water was generated in a typical week of horizontal saw cutting of thick concrete.

Figure 6-88. Tunnel-Area Basement Slab Following Saw Cutting for Removal. [ETEC-9/2/97-395334]

The basement slab sections in the tunnel area, where the slab thickness was 2 feet, were removed by a large excavator, as shown in Figure 6-89. The first slabs removed were washed down in a large tub, also shown in Figure 6-89, to remove loose contamination. However, that procedure became too time consuming to meet schedule requirements, and the subsequent slab sections were set aside for later decontamination.

Figure 6-89. Removal of the Tunnel-Area Basement Slab Sections by Large Excavator. [ETEC-9/22/97-395363]

Removal of the basement slab sections in the area of the five support columns (under the facility hot cells) was significantly more difficult, as the concrete was 3 feet to 4 feet thick instead of the 2-feet-thickness specified in the as-built facility drawings. With the saw cuts only 24 inches deep, the contractor found it easier to break the thicker floor sections loose using the weight of the 70,000-lb. excavator. A layer of ½-inch-thick plywood was placed on the slab to avoid contamination of the excavator track drive, and the excavator was used directly over the slab to pull up the concrete. That operation is shown in Figure 6-90. This also proved to be difficult, because of extensive steel reinforcement bars embedded in the concrete, and the concrete broke up as it was removed. In some locations, holes were drilled in the concrete and filled with Brite-Star, an expanding chemical grout, which was allowed to cure overnight and generate fractures in the concrete. The reinforcing steel was then hand-cut using a cutting torch. This process was very slow, and was subsequently replaced with the use of an excavator with a large hi-ram to reduce the final approximately 30% of the slab area to rubble. The resulting concrete and steel debris were placed in roll-off containers and waste boxes for disposal as low-level radioactive waste.

Figure 6-90. Removal of the Thick Portion of the Basement Slab. [ETEC-10/1/97-395382]

The demolition of the facility basement was completed at the end of FY 1997. The detailed final radiological survey of the excavation, shown in Figure 6-91, and the surrounding site area by Rocketdyne Radiation Safety personnel was performed in parallel with the basement removal, and included the collection and analysis of soil samples. The excavated area was verified by Rocketdyne to be radiologically clean at the end of FY 1997.

Figure 6-91. Hot Laboratory Site Ready for Verification Surveys. [ETEC-10/20/97-395401]

6.11.2 Waste Minimization

In parallel with the demolition of the hot laboratory basement structure, a significant effort was made to minimize the quantity of material requiring disposal as low-level radioactive waste. The primary emphasis was on the concrete blocks that had been part of the hot laboratory and basement structures, and on the large shield doors from the hot cells.

Concrete Block Decontamination

Concrete block decontamination to minimize low-level radioactive waste disposal quantities had been initiated in FY 1996. That initial experience led to the development of a general rule that it was not cost-effective to decontaminate a block for which contamination was present on more than 30% of its surface area. The procedure developed was to first identify the extent and location of contamination on each block. Those blocks with less than 30% surface contamination were decontaminated, while those with greater contamination were size-reduced to manageable weights and shipped to designated DOE sites for disposal. Some of the disposed block sections were double-wrapped in plastic for shipment intact, while others were reduced to rubble and shipped in roll-off containers for disposal as bulk waste. The decontaminated blocks were surveyed and released by Radiation Safety and staged in a holding yard, as shown in Figure 6-92, pending a confirmation release survey by the California DHS. Approximately 200 blocks were released for unrestricted use during 1997 and subsequently shipped off site for use in land reclamation projects.

Figure 6-92. Holding Yard for Clean Concrete Block Sections. [ETEC-7/21/97-395192]

Hot Cell Shield Door Decontamination

The five large hot cell shield doors were removed from the facility and transferred to the RMHF for disposition in FY 1992-93 (Sections 6.6, 6.7). The doors were stored at the RMHF until 1997, when higher priority jobs were completed and funding became available to initiate decontamination activities. Decontamination was selected over radioactive waste disposal because road shipment of the radiologically contaminated doors was considered to be impractical for the extreme sizes and weights, no satisfactory and cost-effective method was initially identified for size-reducing the 24-inch-thick cast material, and because it was felt that the painted doors could be decontaminated readily with standard techniques. Decontamination also provided an opportunity to recover the scrap material value and support DOE waste minimization programs.

The shield doors became a major challenge in handling, decontamination, and final disposition. The doors weighed between 32 and 44 tons each and were made of cast Meehanite®, a dense, fine-grained cast iron. A decontamination sequence was developed that involved a series of steps, including surface paint removal, surface decontamination, decontamination of recessed features, size reduction, and recycling. Decontamination was performed in Building 4022 at the RMHF, a former dry fuel handling facility that has a 50-ton bridge crane capable of handling the doors. A special HEPA-ventilated containment enclosure was fabricated that could be moved and placed over one door at a time. Figure 6-93 shows surface decontamination in progress in the enclosure using a cart-mounted grit blast head.

Figure 6-93. Shield Door Surface Decontamination by Grit Blasting. [ETEC-4/19/97-395081]

Decontamination was initiated by paint removal using hand-held needle scalers, which was effective but extremely labor intensive. The needle scalers were replaced by the use of a large commercial steel-shot grit blast machine which incorporated an abrasive recovery/re-use system that effectively removed the paint and minimized the quantity of contaminated abrasive produced. The abrasive blasting uncovered casting irregularities along the door edges that allowed contamination to leech into the surfaces, and further aggressive abrasive blasting was ineffective in its removal. Attempts were made to remove the spot subsurface contamination using hand grinding and a magnetic-based drill press; they were successful but extremely labor intensive. A portable end mill was subsequently rented and adapted to a specially designed mounting fixture. This fixture allowed the milling machine to remove up to ¼ inch of contaminated material from the door edges without moving the door. After completion of the milling operation, shown in Figure 6-94, approximately 90% of the door surfaces had been successfully decontaminated. The remaining areas, including pockets beneath door lug pins that could not be removed, were inaccessible either for decontamination or radiological surveys.

6.12 FY 1998 ACTIVITIES

FY 1998 activities included the final verification surveys of the excavated Hot Laboratory basement area, the removal of the Liquid Waste Facility and the leach field/septic tank system, and a continuation of the effort to minimize and dispose of the bulk waste generated during the facility dismantlement activities.

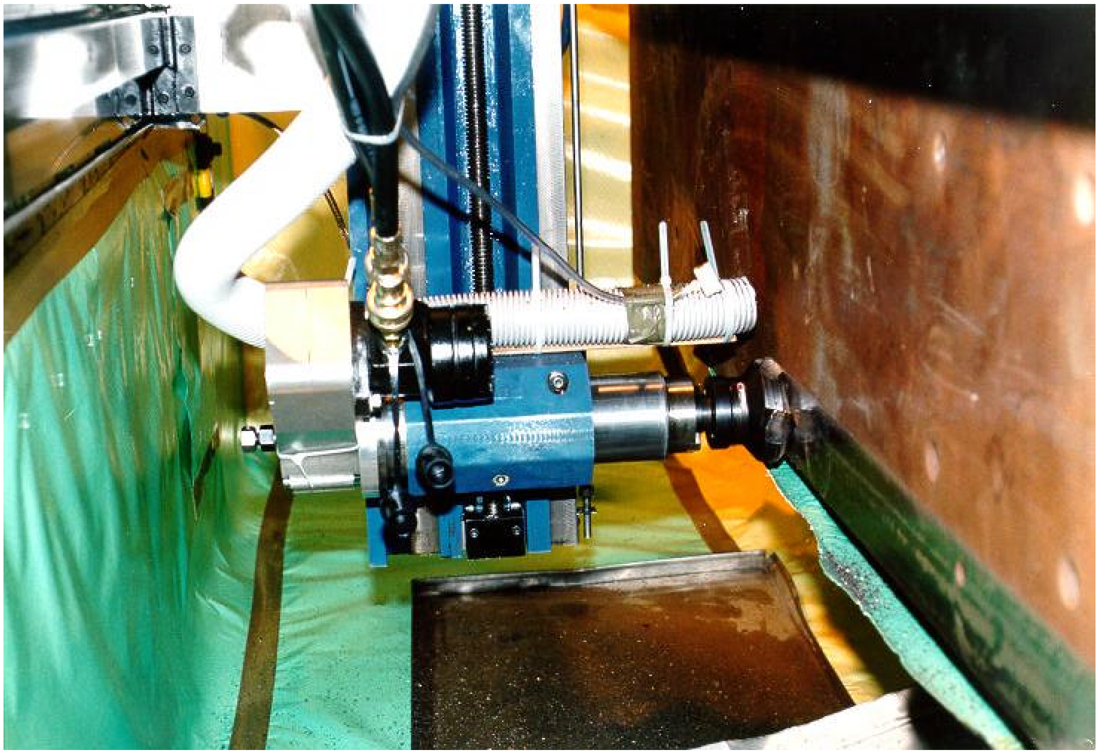


Figure 6-94. Removal of Contamination Embedded in a Shield Door Edge Using a Portable Mill. [ETEC-4/15/97-395096]

6.12.1 Hot Laboratory Site

The FY 1998 Hot Laboratory site activities were initiated with a independent on-site verification surveys by the Oak Ridge Institute for Science and Education (ORISE) and the California Department of Health Services (DHS) Radiological Branch on October 1, 1997. ORISE is an organization used by the DOE to perform independent third-party release surveys. The surveys included the collection of duplicate soil samples. ORISE issued a written report in January 1998 providing independent verification that the excavated area was radiologically clean (*Ref. 1*).

The Rocketdyne results and the initial verbal confirmation from ORISE were used to make a programmatic decision to backfill the excavation prior to the release of the official ORISE report. The purpose was to avoid having an open pit during the winter rainy season. The excavation was first lined with a 1-foot-thick layer of sand as a marker to identify the bottom of the excavation, and the area was then backfilled and compacted during the first quarter of FY 1998. Figure 6-95 shows the beginning of the backfilling operation, and Figure 6-96 shows the site at completion, including the adjacent storage of concrete block sections from the basement demolition activities. In parallel with the backfilling operation, all remaining utilities were disconnected and removed from the site, general cleanup was performed, and the site was sloped to ensure proper drainage during anticipated winter storms.

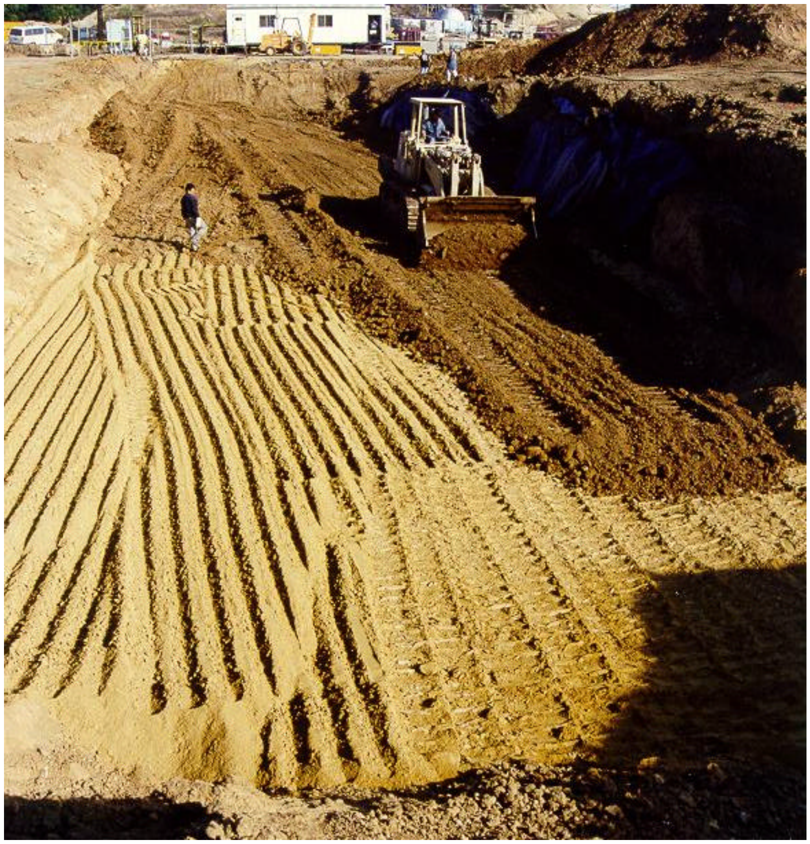


Figure 6-95. Backfilling and Compaction of the Basement Excavation. [ETEC-10/24/97-395401]

Figure 6-96. Site After Backfilling the Basement Excavation. [ETEC-11/4/97-395422]

The former Liquid Waste Facility (Building 4468) and the adjacent site leach field were removed and the areas excavated, sampled, and backfilled during the third and fourth quarters of FY 1998. Asphalt from around the site was also packaged in roll-off containers at this time for off-site disposal. The asphalt had been pulled up during the FY 1996-97 site D&D and excavation activities and stockpiled at the site perimeter for later removal.

Building 4468 had housed the 3000-gallon facility radioactive drain tank, removed in FY 1994. The remaining 10-foot by 22-foot by 20-foot building (Figure 6-97) consisted of an above-ground cinder-block structure and a below-grade structure of poured concrete. The concrete extended to a depth of about 12 feet. During facility operations, groundwater seepage would occasionally fill the facility sump and overflow onto the floor. The facility was known to have radiological contamination on the lower 6 feet of the concrete walls, on the floor, and in the sump, based on facility records and survey data.

Figure 6-97. Liquid Waste Facility Building. [ETEC-11/3/97-395411]

Decontamination and demolition of Building 4468 was initiated with the removal of the steel roof, a high-pressure spray wash-down of the interior surfaces, and removal of all loose contamination and liquid waste generated during the cleaning process. The interior surfaces were surveyed and the lower 12 feet of all wall surfaces were sealed with ALARA paint to fix the remaining surface contamination in place. A contractor was hired to excavate the soil around the building and to saw-cut and demolish the facility in the same manner as was done in FY 1997 for the Hot Laboratory basement. The above-grade portions of the walls were first saw-cut and the wall sections were placed in roll-off containers for off-site disposal. The soil surrounding the remaining structure was then excavated to a depth of 4 feet, as shown in Figure 6-98, and a series of 3-inch-diameter holes was cored through the concrete walls to act as lifting eyes during removal. The trench around the building was then excavated to the base of the structure. The soil was surveyed in 2-foot-depth increments during removal and determined to be radiologically clean.

Figure 6-98. Partial Soil Excavation Around the Building 4468 Below-Grade Structure. [ETEC-6/26/98-395613]

The excavated wall structure was saw-cut by the contractor from the outside, leaving an approximately ¼-inch thickness uncut at the interior surface to ensure that the cutting water did not become contaminated. The individual wall segments were supported using the Rocketdyne mobile crane and a sling through one of the cored holes while the bottom horizontal cut was made. The cut segment was then snapped off and moved to a staging area, where it was double-wrapped in plastic for contamination control. Figure 6-99 shows the removal of one of the wall sections. Twenty-seven wall and floor slab sections were cut and transferred to the RMHF for staging and shipment to a DOE-approved disposal site.

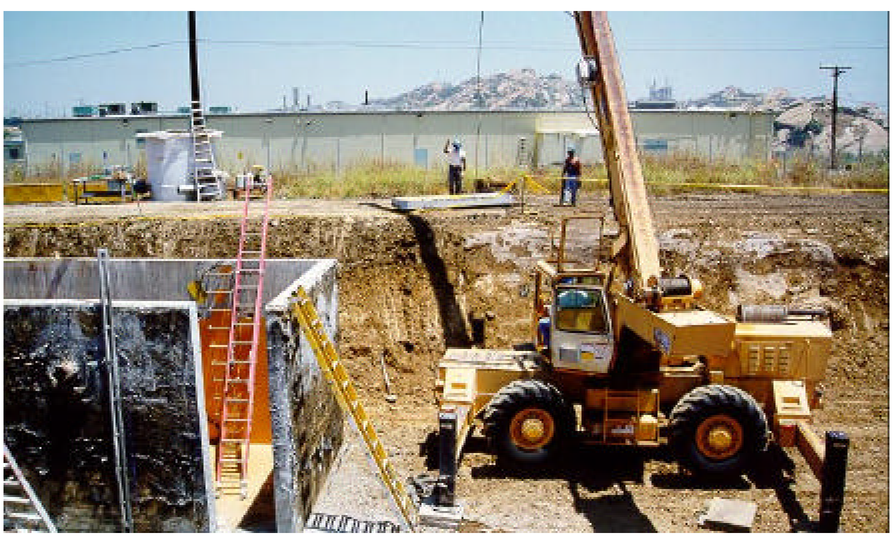


Figure 6-99. Removal of Building 4468 Below-Grade Wall Sections. [ETEC-7/20/98-395663]

The Hot Laboratory leach field pits and septic tank system, adjacent to the Liquid Waste Facility, were installed during the original construction of the facility in 1958 but never placed in service. A site-wide sanitation sewer system was installed in 1960 and was connected to the Hot Laboratory facility before the start of operations. The leach field/septic tank system, abandoned in place in the early 1960s, consisted of one septic tank and two leach pits. It was removed in FY 1998 as part of Rocketdyne's commitment to remove all former septic systems at the SSFL site. The excavation and removal of the Hot Laboratory system was included in the subcontract for the removal of the Liquid Waste Facility.

The soil above and surrounding the septic tank and leach pits were first excavated in 2-foot-depth increments, with radiological surveys and soil samples taken at each level. All of the soil from this excavation process was determined to be radiologically clean. The septic tank was found to be backfilled with soil, which probably occurred during the original facility construction phase when the septic tank system was bypassed to connect the facility directly to the site sanitation system. The tank was sampled, pulled from its location, demolished, and placed into a roll-off container for disposal. It was determined that the tank was free of radiological contamination and any hazardous biological materials.

Each of the two leach pits was a cylindrical brick structure, as shown in the Figure 6-100 construction photograph, surrounded by gravel and with a gravel layer on the inside bottom. Excavation of the pits was a slower process, because of the design coupled with concerns over the potential presence of unexpected biological hazards or radioactive contamination. Extensive surveys were made during excavation; both pits were determined to be free of radiological contamination and biological hazards. The bricks from the pits were placed in roll-off containers for disposal as clean waste. The excavation operation is shown in Figure 6-101.

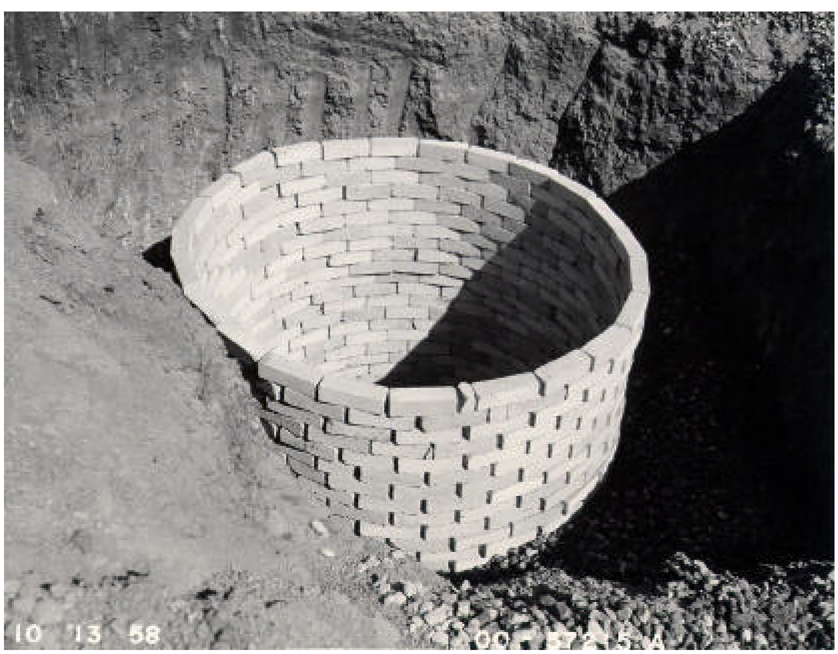


Figure 6-100. Construction Photograph of One of the Two Leach Pits. [00-57215A]

Figure 6-101. Leach Pit Excavation. [ETEC-7/17/98-395638]

Rocketdyne Radiation Safety personnel performed a final release survey of the septic tank and leach pit excavations and forwarded the survey data to ORISE for review. Independent final area and soil sample surveys were then performed by teams from ORISE and the California DHS in September 1998.

6.12.2 Waste Minimization

Concrete Block Decontamination

Approximately 600 additional concrete blocks from the former Hot Laboratory facility were surveyed and decontaminated as required during FY 1998, and over 250 of those blocks were released for unrestricted use by the California DHS and shipped off site by the end of the year. An additional 60 blocks were double-wrapped in plastic or reduced to rubble and placed in roll-off containers for radiological waste disposal. By the end of FY 1998, 75% of all concrete blocks generated during the Hot Laboratory demolition activities had been processed by on-site personnel.

Hot Cell Shield Doors

Most of the hot cell shield door surfaces were successfully decontaminated in FY 1997, but some door areas were identified during that work that could not be accessed for decontamination. Activities were redirected in FY 1998 toward finding a method to remove those portions of the doors that contained residual contamination. That would still allow over 80% of the 180 tons of cast Meehanite® to be released as non-contaminated scrap iron. Several size-reduction approaches had previously been investigated and ruled out when segmenting the doors was originally considered as an alternative to decontamination. Those approaches included saw cutting, diamond wire cutting, abrasive water jet cutting, and traditional oxygen-acetylene and oxygen-propane torches. For example, conventional torches do not maintain sufficient heat in the cutting zone to cut thick cast iron. Further investigation identified the use of a powder torch as a viable option. The powder torch injects iron powder into the flame of an oxygen-propane torch to cut non-ferrous metals and cast iron. The powder is preheated as it passes through the flames, and bursts into flame in the stream of cutting oxygen. The extreme heat created by the burning of the powder makes it possible to cut the metal without preheating.

Preparations for using the powder torch included the installation of a steel-sided penthouse structure inside the RMHF high bay (Figure 6-102). A high-volume exhaust system was set up and directed through a water spray to reduce the smoke particulate. The cutting torch was track-mounted inside the containment structure, with the gas valves, powder flow, and motor drive controls located outside of the structure.

The sections of the doors that could not be decontaminated were first cut from each door (Figure 6-103), and the door was then cut into quarters. No cuts were made across contaminated metal, to avoid the generation of contaminated smoke and dross. The torch-cut contaminated sections were surveyed and packaged for disposal as low-level radioactive waste. The remaining door segments were re-surveyed to assure complete decontamination and then released as non-radioactive scrap. Over 600 ft^3 of previously contaminated material, weighing over 140 tons, was released as scrap metal for recycling. Figure 6-104 shows some of the size-reduced shield door sections that were released. The cutting and removal of the shield door sections was completed in October 1998 (the beginning of FY 1999).

Figure 6-102. Door Cutting Operation in the Steel Penthouse Structure. [ETEC-10/26/98-395696]

Figure 6-103. Size-Reduction of the Hot Cell Shield Doors Using a Powder Torch. [ETEC-10/26/98-395715]

Figure 6-104. Decontaminated and Size-Reduced Sections from One Hot Cell Shield Door Released for Recycling. [ETEC-10/26/98-395710]

6.13 FY 1999 ACTIVITIES

6.13.1 Hot Laboratory Site

ORISE provided verbal confirmation during the first quarter of FY 1999 that the Liquid Waste Facility and septic tank/leach pit area excavation was acceptable for unrestricted release. The excavation contractor placed a layer of sand at the base of the excavation as a marker, similar to that done in FY 1998 for the Hot Laboratory basement excavation, and backfilled and compacted the area with soil. The backfilling was completed on 11/5/98, and marked the completion of the Hot Laboratory decontamination and dismantlement project. Figure 6-105 shows the graded site in its final state, pending the final release surveys.

Figue 6-105. Graded Hot Laboratory Site at Completion of D&D Activities. [ETEC-12/7/98-395756]

The formal ORISE report for the release of the Liquid Waste Facility area was received during the second quarter of FY 1999 (*Ref. 2*). Rocketdyne Radiation Safety prepared a final site release survey plan for the entire facility site that incorporated the newly implemented Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) survey protocol, and completed the final site release survey in September 1999 (*Ref. 3*).

6.13.2 Waste Minimization

Decontamination or size reduction and disposal, as required, of the remaining 290 concrete blocks was completed during FY 1999. Using the 30% surface contamination guideline for decisions on decontamination versus radioactive waste disposal (Section 6.11.2), approximately 250 blocks were decontaminated and released as clean material, and about 40 blocks were reduced to rubble and containerized for off-site shipment to DOE-approved disposal sites.

Approximately 600 clean blocks stored on site were released and shipped off site during FY 1999. Over the three-year period that the concrete blocks were processed, approximately 90% of the blocks (over 1000 blocks) were surveyed cleaned and released. The California DHS performed verification surveys on the clean concrete blocks and debris prior to off-site shipment. The remaining 10% of the blocks, representing about 7,000 ft^3, were shipped for disposal as radioactive waste. The radioactive waste component included about 30% (2000 ft^3) in the form of large double-wrapped slabs and blocks with significant contamination. Examples include the sections that contained the basement drain sumps, which were filled with clean concrete to seal in contaminated surfaces. The remaining disposal volume consisted of concrete that had been reduced to rubble for disposal in 30-yard roll-off containers as bulk waste.

6.14 FY 2000 ACTIVITIES

ORISE and California DHS teams returned during the first quarter of FY 2000 and performed their independent third-party final release surveys of the entire backfilled and graded site.

6.15 FY 2001 ACTIVITIES

Rocketdyne completed its Final Status Survey Report in October 2000 (*Ref. 3*), and forwarded it to ORISE, DOE, and the California DHS. The formal ORISE final verification report was released and forwarded to Rocketdyne and DOE-Oakland in December 2000 (*Ref. 4*). Rocketdyne subsequently forwarded the ORISE report to the California DHS in February 2001 (*Ref. 5*), with a request that the DHS concur with the release of the land formerly occupied by the Hot Laboratory. The Hot Laboratory D&D project will be closed out officially when the following actions have been completed: (1) Submittal of a final docket report by Rocketdyne to DOE-Oakland. That report will include the Rocketdyne final release survey report, the ORISE final verification report, and this Hot Laboratory D&D Final Report, and will be placed in the document repositories of three local libraries. (2) Publication in the Federal Register by DOE-Oakland of a notice of intent to release the facility area, based on the Rocketdyne final docket. (3) Issuance of a formal letter of concurrence on site release by the California DHS.

7.0 D&D WASTE MANAGEMENT AND DISPOSAL

Waste disposal was an important component of the Hot Laboratory D&D operations. Most radioactive waste generated at the site was packaged and transferred to the Radioactive Materials Handling Facility (RMHF), located about 1 mile from the Hot Laboratory facility on the SSFL site. Two major waste disposal support activities were on-site waste management and waste minimization. The RMHF (Figure 7-1) is responsible for the management of radioactive and mixed (hazardous plus radioactive) waste generated as the result of DOE-funded programs at the SSFL, and was used for preparing and staging the Hot Laboratory wastes for off-site shipment to DOE-approved disposal sites. Waste minimization included the implementation of procedures to minimize contamination spread and to decontaminate waste materials where practical, and thus reduce waste disposal volumes.

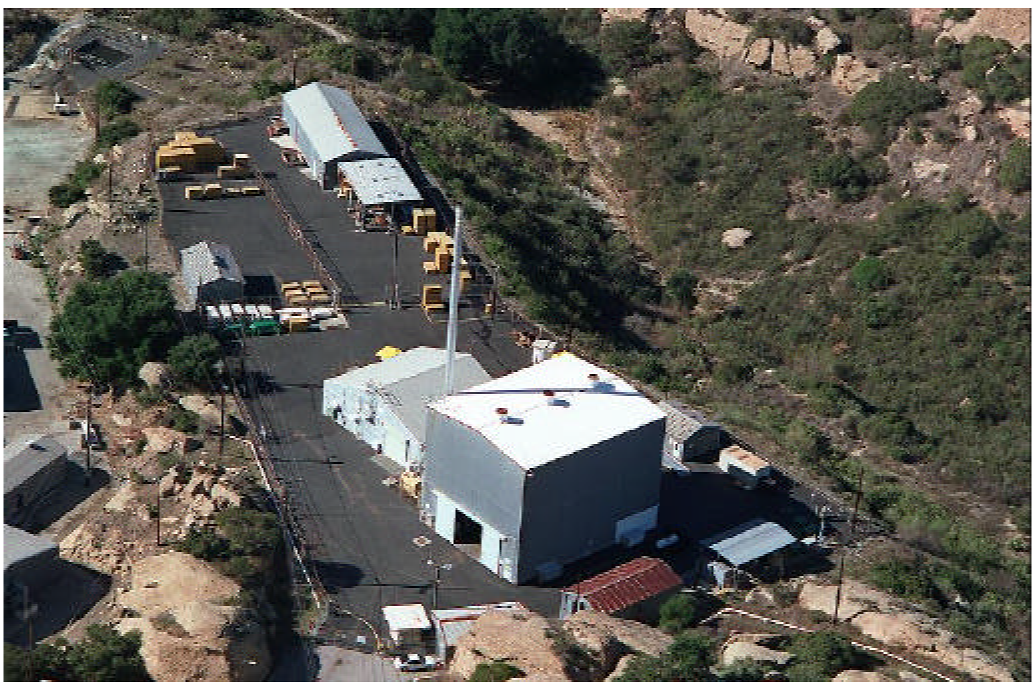


Figure 7-1. Aerial View of the Radioactive Materials Handling Facility.

7.1 RADIOACTIVE WASTE MANAGEMENT

Waste sent to the RMHF included waste that was both known and suspected to contain radioactive contaminants. At the RMHF it was analyzed, classified, and placed in storage pending final disposition. Most waste was packaged directly into Department of Transportation-approved containers as it was generated at the Hot Laboratory site, following procedures that ensured that the packaged waste met the Waste Acceptance Criteria (WAC) of the planned final disposal site. This minimized waste handling operations. Where necessary, repackaging for off-site transportation and burial was performed at the RMHF. The D&D waste was classified as defense waste because the Hot Laboratory spent fuel decladding operations that led to the facility contamination were funded under DOE defense budgets. The radioactive waste generated by the D&D operations was thus managed for conformance to the Waste Acceptance Criteria of the DOE Nevada Test Site (NTS), which was the primary waste disposal site.

The waste was tracked from its time of generation until its off-site disposition. A lot follower ("Radioactive Material Lot Follower and Procedure Verification," Rocketdyne Form 652-A) was prepared for each waste container, or large non-containerized waste object, as the waste was generated. This lot follower was used to identify the contents of the container and document the waste characterization information, including the presence of any known or suspected hazardous constituents. The waste was evaluated by a Rocketdyne environmental specialist to identify potential mixed wastes, and packaging was performed under the surveillance of Rocketdyne Quality Assurance (QA) inspectors. A "Waste Container Traveler" was used to document all container inspections and movements, and thus provided a history of each waste container that included the verification signatures (or stamp, as appropriate) of the environmental specialist and QA inspector. Each waste container or large object was further tracked using an electronic data base tracking system. The information included in the data base was used to generate required shipping and disposal-site documentation.

Most of the radioactive waste was packaged in sealed metal containers that were manufactured to DOE-NTS criteria by approved suppliers. The containers had nominal sizes of 2 ft x 4 ft x 7 ft (44 ft^3, 5,000-lb capacity) and 4½ ft x 4 ft x 7 ft (100 ft^3, 9,000-lb capacity) and were shipped to NTS in 48-ft-long enclosed trailers. The concrete waste generated during the final stages of D&D was shipped out as concrete blocks double-wrapped in plastic on flat-bed trailers, and as concrete rubble in plastic-lined 30-yard roll-off containers.

Some of the major facility components were size-reduced and packaged for disposal in the RMHF decontamination facility. That facility includes specific work areas for size-reduction and packaging, hot and cold change rooms, and support areas for decontamination activities. Components processed in this facility included the HEPA ducting and the 55-ft-long Hot Laboratory facility upper exhaust stack section.

Mixed Waste Management

Small quantities of mixed waste were generated or accumulated during the Hot Laboratory D&D operations. Those mixed wastes were managed at the RMHF under an Interim Status Part A Permit for the Treatment, Storage, and Disposal (TSD) of mixed wastes. The primary waste streams included a corrosive liquid (electropolish solution) from in-situ drain line cleaning development tests (Figure 6-2, 6-4; Sections 6.2, 6.3, 6.4), contaminated lead that had been used for shielding near penetrations in the hot cells (Figure 6-41; Sections 6.7, 6.8) and other applications, and heavy metal contamination (cadmium, chromium, and mercury) in the debris generated by the grit blasting of painted surfaces (Figures 6-6, 6-7, 6-8; Section 6.3) and in the debris collected from the facility radioactive drain lines (Figures 6-39, 6-40; Sections 6.7, 6.8).

The contaminated lead represented the largest volume of mixed waste. It included bulk shot, sheet, and brick, plus shield plugs, shield doors, and shielded containers. The lead was consolidated at the RMHF and shipped to a lead recycling facility in Tennessee. The commercial facility used a combination of ice blasting and chelation baths to decontaminate approximately 90% of the lead. The chelation process was particularly effective on lead shot, whose small size makes it extremely difficult to decontaminate. However, the chelation process produced about 700 gallons of lead-containing hazardous waste from the decontamination of about 240,000 lb. of lead. That waste was stabilized and shipped to Envirocare of Utah for treatment and disposal following DOE approvals. Lead bricks and sheets with crushed corners and other indentations, which could trap radioactive contamination beneath the lead surfaces, were removed physically and sent to Envirocare separately for treatment and disposal.

The electropolish process that was developed during the early part of the D&D program for the in-situ cleaning of the contaminated radioactive drain lines generated approximately 30 gallons of corrosive radioactive liquid waste. That waste was neutralized and stabilized at the RMHF, and shipped to Envirocare for disposal. Grit blasting to remove lead-based paint from the hot cell steel liner surfaces and the concrete surfaces generated mixed waste streams of grit-blast material and concrete dust and particulate. Both waste streams were stabilized and also shipped to Envirocare for disposal.

Transuranic and Mixed Transuranic Waste Management

The removal of the facility radioactive drain line system generated an approximate unpackaged volume of about 0.3 m^3 (80 gallons) of mixed transuranic waste. That drain line system had supported the hot cells, decontamination rooms, and contaminated support rooms, which drained to the 3000-gallon drain tank in Building 4468. The debris from the drain lines was collected in 1-gallon and 5-gallon paint cans during drain line removal, and those cans were overpacked in 28 concrete-shielded 55-gallon storage drums. Additional drain line debris had collected in two remaining weir boxes (Section 6.7) and as residual sludge at the bottom of the drain tank (Figure 6-45). The 55-gallon storage drums (about 6 m^3 volume), weir boxes, and drain tank, plus seven additional 55-gallon drums of transuranic debris waste from the dismantlement of the glove box system used at the Hot Laboratory for SEFOR fuel decladding, were all moved to the RMHF for storage. They are presently stored in RMHF below-grade, HEPA-ventilated vaults that were originally designed for the dry storage of spent nuclear fuel. They will remain there until a path forward is established for their off-site disposition, either by intersite transfer or direct shipment to the Waste Isolation Pilot Plant (WIPP) for disposal.

7.2 WASTE MINIMIZATION

Waste minimization was a primary objective throughout the Hot Laboratory D&D project. Procedures were implemented to minimize the extent of contamination spread during demolition, and to decontaminate the waste materials where practical. Waste minimization practices included waste segregation to reduce the quantities of materials in the hazardous classifications, volume compaction, and selective decontamination where cost-effective to release materials for recycle or unrestricted land burial. Large objects in particular, such as concrete blocks and structural steel, were decontaminated where practical for recycle instead of costly disposal at radioactive waste disposal sites.

Three major waste minimization activities were the decontamination of the sectioned Hot Laboratory concrete structures, the decontamination and sectioning of the cast iron hot cell shield doors, and the decontamination of the lead (described in Section 7.1). The concrete structures (walls and floors of the hot cells, decontamination rooms, and basement) had been sectioned into blocks as part of the dismantlement process, and were surveyed and decontaminated to the extent practical during the FY 1997-99 time period (see Sections 6.11.2, 6.12.2, and 6.13.2). Over 1000 blocks, typically weighing between 10,000 and 40,000 lb., were processed. About 90% of the blocks were successfully decontaminated and released. The hot cell shield doors were decontaminated to the extent practical in FY 1997 (Section 6.11.2), and size-reduced in FY 1998 (Section 6.12.2) to separate the inaccessible contaminated sections for disposal. The doors were then successfully size-reduced into manageable sections of 10,000 lb. or less, and 80% of the shield door cast iron was released as clean material for recycling.

7.3 WASTE GENERATION SUMMARY

The total waste generated from the decontamination and demolition of the Hot Laboratory over the time period from FY 1988 through FY 1999 is summarized in Table 7-1. This encompasses the entire above-ground structure of the building, the basement, the outside yard areas (primarily asphalt and soil), and all equipment associated with the facility operation. Table 7-1 itemizes the waste by the categories used for handling and disposition purposes. The information in this table was compiled from the waste generation records for D&D operations that were recorded and maintained throughout the project. A cumulative plot of the Hot Laboratory radioactive waste volume generated (LLW and MLLW) during D&D operations is presented in Figure 7-2.

Table 7-1
Waste Generation Summary for the Hot Laboratory Facility

	Distribution by Volume		Distribution by Weight	
Waste Category	**Volume (ft^3)**	**Percentage**	**Weight (lb.)**	**Percentage**
Low Level Waste (LLW)	125,592	55.24	8,325,652	31.88
Mixed Low Level Waste (MLLW)	1,903	0.84	61,758	0.24
Transuranic Waste (TRU, MTRU)	386	0.17	8,256	0.03
Contaminated Water	18,383	8.08	1,147,619	4.40
Hazardous Waste	100	0.04	10,000	0.04
Recycle Materials	1,595	0.70	567,100	2.17
Released Structural Steel	450	0.20	72,500	0.28
Released Concrete Blocks	66,000	29.03	14,300,000	54.76
Landfill Materials	12,960	5.70	1,620,000	6.20
Totals:	227,369	100.00	26,112,885	100.00

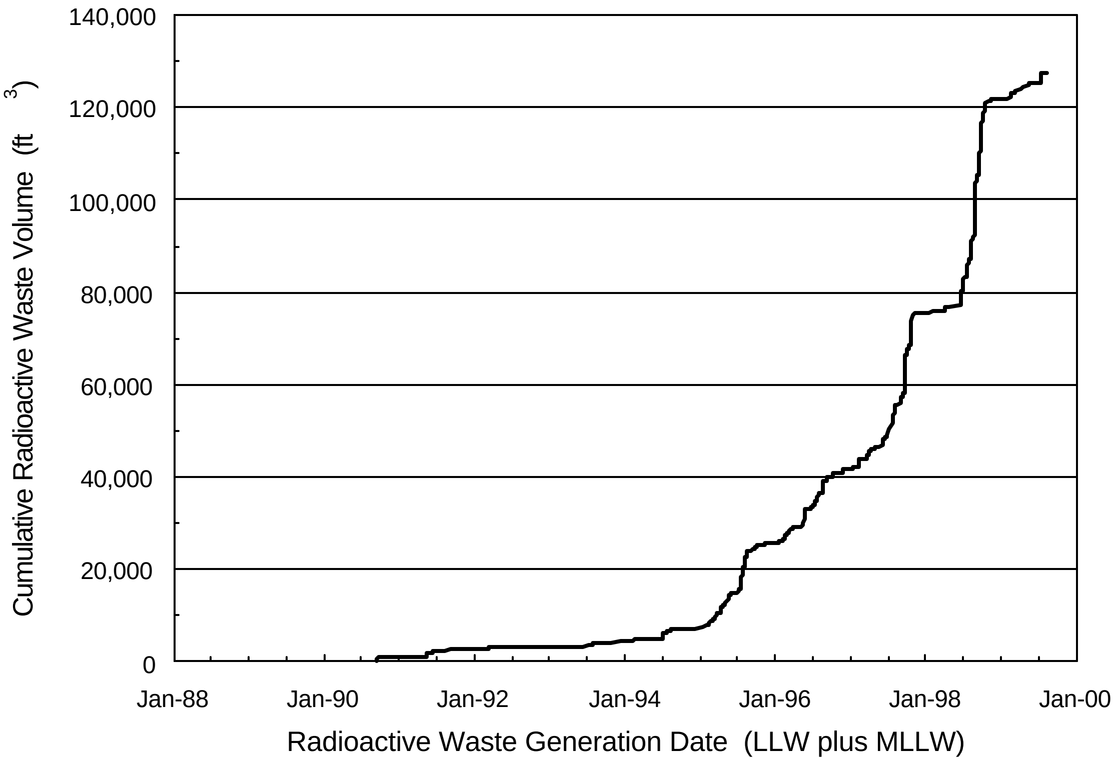


Figure 7-2. Cumulative Plot of LLW and MLLW Generation by Volume During D&D Operations.

The waste categories associated with Table 7-1 are defined as follows:

Low Level Waste (LLW): Low level waste consisted primarily of radiologically contaminated building materials, such as concrete rubble, steel, plaster, and metal slag from torch cutting, plus D&D materials such as plastics and personal protective equipment. The Building 4020 roofing material is included in this category. Its asbestos content classified it as a mixed waste in California, but not at the final disposal site (Envirocare of Utah).

Mixed Low Level Waste (MLLW): Mixed wastes are LLW materials that also contain constituents regulated as hazardous. As summarized in Section 7.1, the Hot Laboratory MLLW included contaminated lead, electropolish solution, and lead-based paint chips and other grit-blast debris.

Transuranic and Mixed Transuranic Waste (TRU, MTRU): TRU-containing wastes from the Hot Laboratory consist of drain line debris, glove box components, and D&D materials that were contaminated with reactor fuel fines from the decladding of spent nuclear reactor fuel assemblies. The Table 7-1 TRU weight value omits the contribution of the concrete-shielded storage containers.

Contaminated Water: Concrete saw cutting operations and the collection of rainwater that migrated into the facility during D&D generated some radiologically contaminated water. It was collected at the facility and transported to the RMHF for processing and disposal of the residual contaminants.

Hazardous Waste: Hazardous wastes accumulated during the facility D&D consisted primarily of materials that were used during Hot Laboratory operations, including lubricating oils, acid rags, batteries, fluorescent light ballasts (containing polychlorinated biphenyls), and some hazardous metals. They were not radiologically contaminated.

Recycle Materials: The recycle materials included those materials and equipment that either have direct reusable value (manipulators, cell windows) or were disposed of as recycled materials (lead, hot cell shield door sections). Those material components that could not be decontaminated for recycle are included in the LLW category.

Released Structural Steel: The structural steel building components (I-beams, roofing panels, steel plates) that were surveyed clean and recycled as scrap metal are listed in this category. The remainder are included in the LLW category.

Released Concrete Blocks: This category includes over 1000 large concrete block sections that were generated by the dismantlement of the hot cells and decon rooms, decontaminated (as necessary), and free-released. The remaining concrete block sections that could not be readily decontaminated were disposed of as low level radioactive waste; they are included in the LLW category.

Landfill Materials: Those non-recyclable and non-hazardous materials from the D&D operations that were not radiologically contaminated, or were decontaminated and released, were disposed of in a sanitary landfill. They included such items as building materials (excluding the concrete blocks), wall and ceiling plaster, and building fixtures.

7.4 WASTE RADIOLOGICAL CONTENT

The total quantity of radioactive waste generated during the Hot Laboratory D&D activities was approximately 17.5 Curies. The breakdown by category is summarized in Table 7-2, and includes approximately 1000 containers of material. A cumulative plot of waste generation by radiological activity is shown in Figure 7-3. It includes the LLW and MLLW waste categories, for which the material has been shipped to disposal sites, but omits the TRU, which remains in on-site storage at the RMHF.

Table 7-2
Radiological Content of the Hot Laboratory D&D Waste

Category	Quantity (Ci)	Percentage
Low Level Waste	13.4	76.6
Mixed Low Level Waste	0.1	0.5
Transuranic Waste (TRU plus MTRU)	4.0	22.9
Totals:	17.5	100.0

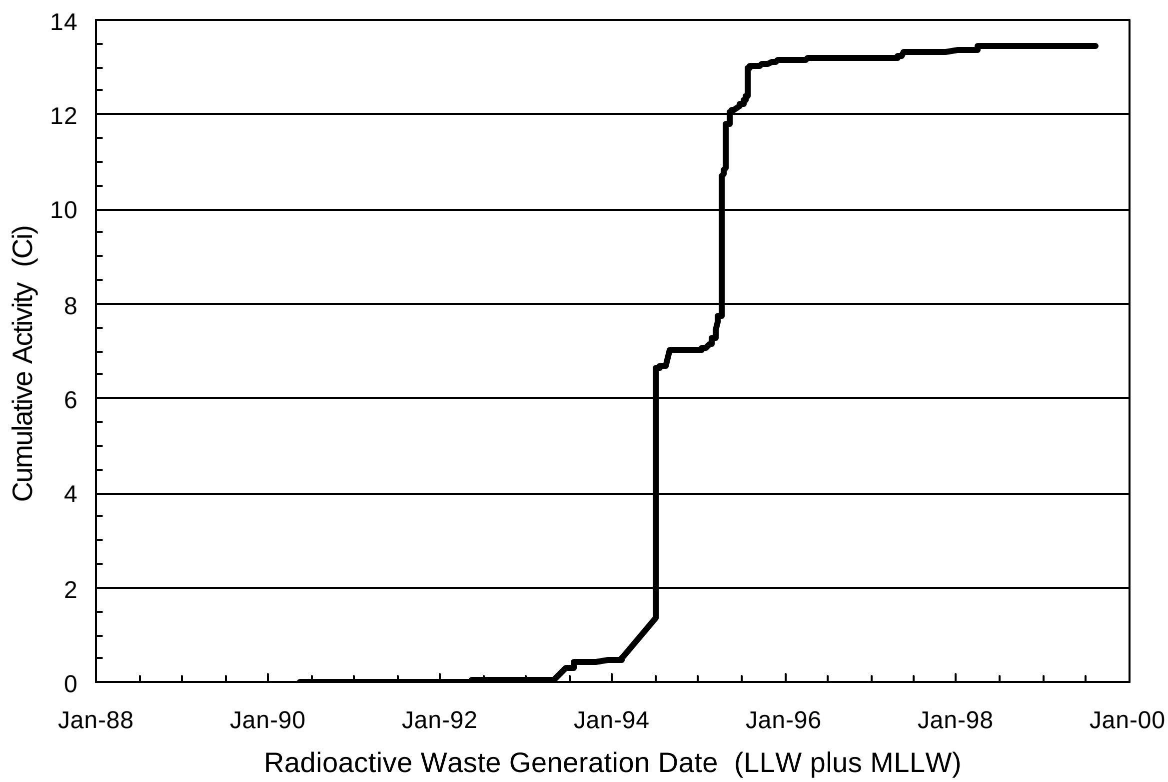


Figure 7-3. Cumulative Plot of LLW and MLLW Generation by Activity During D&D Operations.

7.5 WASTE DISPOSAL

Table 7-3 summarizes the disposition of the Hot Laboratory wastes by disposal site. Those wastes do not include the TRU wastes, which remain in storage at the RMHF pending the availability of a waste disposition path.

Table 7-3
Radioactive Waste Disposal Site by Relative Volume

Disposal Site	Volume Percentage
Nevada Test Site (NTS)	72
Hanford	22
Envirocare of Utah	6

8.0 PROGRAM COST SUMMARY

8.1 COST OVERVIEW

The total cost of the Hot Laboratory D&D project was $26.6M. This is significantly higher than the original 1986 cost estimate, which was about $13M. There are three primary factors that contributed to this cost increase. They are: (1) major customer-initiated changes in project direction and increases in project scope over the original plan; (2) an overly optimistic estimate for in-situ decontamination (drains, cells, and the HEPA system), and (3) an assumption that no significant contamination existed behind the hot cell liners. Several DOE contract modifications were made as the project progressed and the scope and direction were altered from decontamination to demolition, as summarized in Section 1.3. This included the submittal of a baseline plan to the DOE in FY 1990, a significant redirection in scope in FY 1992, and the submittal of final cost revisions in FY 1996. The latter was based both on the transfer of ownership of the facility from Rocketdyne to the DOE and the accelerated demolition of the facility.

8.2 COST SUMMARY

The project costs by major category are summarized in Table 8-1. They are presented in a format that is intended to assist in estimating costs in similar projects. A more detailed breakdown of engineering and D&D operations costs is presented in Appendix B. The task descriptions associated with the categories listed in Table 8-1 are given below.

Program Management: The Program Management task included Program Office oversight, interaction with the DOE customer, cost management, development of technical approaches, and evaluation of work strategies. Also included in this category is a one-time cost of approximately $45K for contract re-negotiations in FY97.

Engineering: Engineering included the preparation of engineering designs and D&D methodology studies, technical progress reports, plans and procedures for D&D-specific tasks, and technical specifications for subcontractor work.

D&D Operations: D&D Operations included all of the Rocketdyne physical hands-on D&D activities. Costs include labor, direct supervision of Rocketdyne personnel, and direct contractor oversight and support. They also include other activities related to day-to-day D&D operations, such the management of supplies and materials.

D&D Subcontracts: D&D Subcontracts summarizes the costs associated with the major D&D subcontractors, including such activities as concrete sawing and coring, structure demolition, soil analysis, and heavy rigging.

D&D Consumables and Rentals: This category includes the costs of consumable materials, contaminated equipment and tools, and specialized equipment rentals.

Table 8-1
Hot Laboratory D&D Project Costs by Major Category

Category	Cost ($000)	Percent of Total Cost
Program Management (including cost management)	1,010	3.8
Engineering (plans, procedures, design, etc.)	3,174	11.9
D&D Operations (including contractor oversight)	10,747	40.3
D&D Subcontracts	1,401	5.3
D&D Consumables and Rentals	2,849	10.7
Health Physics	2,686	10.1
Waste Management [1]	1,267	4.8
Waste Management Subcontracts and Disposal Fees	1,296	4.9
Waste Management Consumables	333	1.3
Quality Assurance	761	2.8
Environmental Compliance	594	2.2
General Support	189	0.7
Special Projects	335	1.2
Total Program Cost	26,642	100

[1] Waste Management costs do not include RMHF costs associated with general mixed waste (TSD) operations, or costs associated with the ultimate disposition of the TRU waste generated during the project, including management, storage, characterization, repackaging, and certification costs. See Section 8.3.

Health Physics: Health Physics included the Radiation Safety staff that directed the ALARA program, performed radiological surveys and instrument calibrations, prepared radiological procedures and control documentation, and ensured regulatory compliance. This task also included analytical support and documentation for LLW shipments, the release of non-radioactive waste materials, and in-house support of the independent ORISE third-party radiological verification surveys.

Waste Management: Waste Management included waste management-related labor activities that supported the D&D operations, such as initial waste container packaging and content documentation, plus waste transport to the RMHF for storage and disposal preparation. The costs do not include RMHF costs associated with general facility low-level waste or mixed waste operations or the costs associated with the management, storage, and disposal preparation of the TRU waste accumulated during the Hot Laboratory D&D operations.

Waste Management Subcontracts and Disposal Fees: This category includes the costs associated with outside subcontractors that performed waste management-related activities or services, such as asbestos abatement, analytical waste characterization, and waste disposal. It includes fees paid directly to the disposal sites by the DOE for Hot Laboratory waste disposal. The largest costs in this category were the $1.13M in fees for waste disposal at NTS, Hanford, and Envirocare in FY 1997 – FY 2000.

Waste Management Consumables: The Waste Management Consumables category includes the costs of waste management-related materials, for which waste containers represented the dominant component.

Quality Assurance: Quality Assurance (QA) included the staffing to perform oversight, surveillance, inspections, and audits to assure compliance with established program requirements. It also included the NTS Waste Certification Official and other activities associated with the oversight of LLW shipments.

Environmental Compliance: Environmental Compliance included all reviews by environmental compliance specialists to support regulatory compliance and site operations in the identification, characterization, certification, and management of hazardous and mixed wastes. Costs incurred for analytical laboratory waste characterization are included under Waste Management Subcontracts and Disposal Fees.

General Support: The General Support category includes all other non-specific project support, including general maintenance of equipment by Plant Services, photographic and document reproduction services, logistics, material handling, and deliveries.

Special Projects: The major activity included under Special Projects was the FY 1991 DOE Tiger Team review. Minor activities included were the DOE Independent Cost Estimations and other activities not directly related to normal D&D project support. The Tiger Team review, including subsequent actions implemented by Rocketdyne, was 1.6% of the total project labor cost.

8.3 UNACCOUNTED PROGRAM COSTS

There are additional costs associated with the Hot Laboratory decontamination and dismantlement program that have not been included in the cost summary. Two major project-related activities not accounted for above are the management of the TRU waste accumulated during Hot Laboratory D&D, and the maintenance of the RMHF as a Resource Conservation and Recovery Act (RCRA)-permitted facility. Other unaccounted costs, covered directly by the DOE-Oakland Operations Office, include DOE oversight of the Hot Laboratory D&D program and the third-party radiological verification surveys conducted independently by the Oak Ridge Institute for Science & Education (ORISE).

8.3.1 Transuranic Waste Management

A small quantity of TRU waste (including MTRU) was accumulated during the Hot Laboratory D&D operations. That waste is currently stored at the RMHF in below-grade vaults, and the storage volume will be about 10 m^3 when repackaging activities are complete. It will ultimately be shipped to the Waste Isolation Pilot Plant (WIPP) for final disposal. However, part of the TRU is defined as remote-handled (container contact dose rates > 200 mrem/h, with no credit allowed for shielding), whose disposal is currently prohibited by the WIPP Hazardous Waste Permit. Further, on-site capabilities are not available to certify the small quantity of contact-handled TRU (about 1.2 m^3; container contact dose rates < 200 mrem/h). Current efforts are focused on characterizing and repackaging the TRU for enhanced safe storage and future shipment, in parallel with extensive interactions with the DOE to establish a path forward. The latter includes participation in DOE's national TRU waste management planning. Options include modifications to the WIPP Hazardous Waste Permit (ultimately required for WIPP disposal), the use of mobile vendor services for waste certification, and shipment to a large TRU generator site for interim storage and eventual certification. The current costs of on-site TRU waste storage, characterization, and repackaging activities, plus Rocketdyne's extensive interactions with the DOE, are significant but not included in this cost summary. Further, the costs for TRU waste disposal cannot be estimated until a final path forward is identified.

8.3.2 RMHF Permitted Facility Compliance

The RMHF currently operates under a Part A RCRA permit from the State of California's Department of Toxic Substances Control (DTSC) for the storage and treatment of MLLW and MTRU wastes. An RMHF Part B Permit has also been submitted to the DTSC at their request. Most of the MLLW and MTRU originated at the Hot Laboratory and is associated with the D&D operations. However, costs associated with the management of those mixed wastes, the maintenance of the Part A permit, and the implementation of a Part B permit are funded under a separate DOE Waste Management account and are not included in this cost summary.

9.0 LESSONS LEARNED

The decontamination and dismantlement of the Hot Laboratory included the application of several innovative approaches to D&D, a number of changes in program direction, and some post-task insight on task performance. This section provides a compilation of lessons learned from the program, which may contribute to planning and execution of D&D projects for hot cells and similar facilities at other sites.

A general observation is that an effective D&D project is based on a well-conceived, unchanged plan, the availability of an experienced D&D staff, a good knowledge of the facility and its history (including areas of potential concern), and an optimum combination of proven technology, innovative techniques, and specialized experts for unique or high-risk tasks. Personnel safety, ALARA conformance, contamination control, and waste minimization are primary considerations in the planning and execution of all D&D projects.

For the Hot Laboratory project, a major change was implemented midway in the program that redirected the operations from facility decontamination and reuse to facility dismantlement and site re-vegetation. This had a significant cost impact, as a considerable effort had already been expended on the decontamination of the hot cell and decon room interiors. It did, however, work to the project's advantage during the later-stage activities to dismantle the facility, as the majority of the concrete structure was radiologically clean. This optimized the use of specialty contractors and minimized the generation of radioactively contaminated debris.

9.1 GENERAL D&D PRACTICES

Several general D&D practices that have been used routinely in other Rocketdyne hardware development, system test, and facility D&D projects were applied to the Hot Laboratory project with great success. Examples include the use of historical information, mockups for pre-application hardware and process testing, and strategies to maximize personnel safety.

Original construction photographs were available for the Hot Laboratory facility and proved to be of great value both in developing the D&D plan and performing the D&D operations. They complemented the construction drawings, identifying differences between the drawings and final facility "as built" conditions. In addition, they showed specific locations of features not detailed on the drawings, such as buried electrical conduits. They also provided workers with a better visualization of construction details, such as the hot cell liner support structure and the HEPA ventilation ducting within the concrete mass.

Mockups were used to great advantage to optimize and validate processes and procedures prior to performing the actual tasks in contaminated environments. The use of mockups and "dry runs" was one of the most cost effective aids used for the hot cells in their operational days, and proved to be of equal value in this and other D&D projects at Rocketdyne. The added costs of the mockup tests were consistently less that the costs in time and personnel exposure associated with starting a new task directly in a contaminated area.

Personnel safety was enhanced by following a general plan of working from areas of greatest to lowest contamination. This lowered the radiation levels as quickly as possible and satisfied ALARA requirements. Within a specific area, the process of decontamination, surveying, and further decontamination was repeated in an iterative manner. Each decontamination step lowered the general radiation background in the work area to a level that allowed the detection of lower-level contaminants. Work procedures did deviate from this general plan in some special cases, including the decontamination of the four similar hot cells. In that case, decontamination was initiated in the cell with the lowest exposure levels in order to gain experience, optimize procedures, and solve routine problems. Work then progressed to the areas of greatest exposure with improved efficiency and shorter task times in conformance with ALARA principles.

Equipment removal began with the dismantlement of non-essential equipment and systems. Essential support systems, such as HEPA ventilation, fire protection, and air monitoring systems, were maintained in operation as long as practical to ensure worker safety and reduce the costs of employing supplemental portable systems. Portable HEPA systems and air monitors were used extensively throughout the project, however, to maximize localized ventilation and air-flow control in work areas.

9.2 CONTAMINATION DETECTION AND CONTROL

Four contaminant issues that had to be dealt with continually during the D&D effort were the control of contaminants during dismantlement operations, the tracing of contaminants through all possible migration pathways, the identification and removal of trapped subsurface contaminants, and the ability to verify complete decontamination following D&D procedures. All were important issues that affected D&D planning and work activities.

The verification issue had a significant impact on program direction. During drain line cleaning, the absence of alpha and beta contamination on the outside of the drain lines (where a possible contaminant pathway was drain line joint cracks) could not be verified in-situ, because the pipe walls shielded the drain line probe from detecting such contamination. This inability to fully validate the effectiveness of the in-situ cleaning process was a significant factor in eliminating in-situ cleaning. Decisions on D&D approaches that trade off the costs of in-situ cleaning of limited-access surfaces with more conventional dismantlement options (e.g., complete removal) must address the requirement of accessibility to verify adherence to release criteria, both by operations personnel and by an independent party.

Seams and cracks were major sources of subsurface contamination that had to be “chased” and remediated. For example, contamination was found to extend into the soil beneath the Building 4020 floor through a seam that ran the length of the manipulator maintenance room. This seam was the cold joint between the vertical edge of the basement roof slab at the west wall and the support area floor slab running west of the basement. Similarly, widespread contamination was found in the hot cells on the back sides of the liners, on the underlying concrete faces, and in cracks in the concrete. Contamination pathways included cracks in the liner weld seams and penetrations through the liners for hardware wall attachments during facility operation.

Contamination was frequently found in cracks along reinforcing rods within the concrete structure. The source of this contamination was the routine high pressure water wash-down of the cells during the facility's operational life. Facility drawings and historical operations records can be significant aids in evaluating potential areas of hidden contamination.

Other examples of potential subsurface contamination include areas that have received routine upkeep and maintenance during a facility's lifetime. At the Hot Laboratory, the material holdup yards were repaved (two layers), surfaces were repainted, and Building 4020 was re-roofed (overlays) a number of times. These multiple layers of material trapped known and suspected contamination. The early identification of possible subsurface contaminants can result in significant cost savings by an early decision to remove and dispose of entire sections (of asphalt or wall, for example) instead of proceeding with a program of decontamination and waste minimization for multiple-layered surfaces.

Contamination control during dismantlement of the facility was aided by sealing off area duct and door openings to ensure that the HEPA ventilation system continued to operate at maximum efficiency. As the air filtration system was shut down and the ducting was removed, portable units were installed to maintain proper air control in work areas.

The Hot Laboratory cell dismantlement demonstrated that operations can be designed to allow working from the clean side of a wall common to a contaminated area to contain contamination during wall remediation. An example is the core drilling operation performed to remove the contaminated hot cell through-tubes. The core drilling was performed from the clean operating-gallery side and was stopped about an inch short of penetrating into the cell, leaving an intact barrier. This allowed the use of commercial contractors to perform the specialized drilling in a clean, non-radioactive environment without costly radiation worker training. A minimum number of trained Rocketdyne radiation workers broke loose and removed the cores from inside the walls. The combination of specialty contractors supported by trained radiation workers was used effectively here and throughout the Hot Laboratory D&D project.

9.3 WASTE MINIMIZATION AND RECYCLING

All known hazardous materials were removed from the facility early in the project and extra efforts were taken in procedure preparation, operations, and the use of subcontractors to preclude bringing any potentially hazardous materials into the facility. Particular attention was given to the use of nonhazardous materials to minimize the generation of mixed wastes. This included the replacement of hydraulic fluids with nonhazardous fluids and the use of nonhazardous cleaning solutions.

The cooling/lubricating water from the sawing and core drilling processes was collected at the process locations and recycled whenever possible. This prevented the flow of cooling water into contaminated areas, where there would have been a potential for the spread of contamination and the generation of additional radioactive waste. Procedures and operations should address process effluent control for waste minimization and contamination containment as standard practice. Prior to the disposal of clean cooling water from saw cutting operations, the concrete fines in the water were allowed to settle and the water was separated from the fines. This process ensured that the pH level of the water met site release criteria and that the water could thus be disposed of in the site sanitary water system. The fines were then dried and handled separately.

Extensive efforts were made to recycle construction materials, particularly metals, where practical. The dismantlement and decontamination of auxiliary systems were performed in a manner that segregated non-recyclable materials, such as the asbestos-gasket interfaces of HEPA ventilation ducts, to minimize waste. Even with this segregation, the release of materials requires a defensible basis for claiming that they are free of all possible hazardous constituents. Establishing this basis in turn requires keeping records of the materials' source and processing, and may require extensive characterization analyses. Time and resources must be allotted for the characterization and documentation of all materials, and for review by all applicable state and federal agencies.

The majority of the concrete blocks that resulted from the saw-cutting demolition of the hot cells, decon rooms, and basement were decontaminated for recycling. They were initially planned to be used as components of artificial reefs, breakwaters, erosion control barriers, or similar structures. Initial outside interest was high, but the origin of the cleaned and released blocks in a radiological facility became a stumbling block for acceptance in commercial or non-DOE governmental uses. Recycling options for these blocks became limited because of negative public perceptions. However, the block decontamination costs were ultimately justified by the cost savings realized when recycle solutions were found. Most of the blocks were used to construct a rock/concrete rubble levee on property adjacent to a dry river bed to protect the property from spring flooding. The remainder of the blocks were crushed by a milling company for use as road base material. This experience suggests that the future recycling of significant quantities of similar materials from other DOE facilities will require a complex-wide effort to overcome public concerns.

The overall decontamination and size-reduction of the five large hot cell shield doors for disposal was successful, resulting in the minimization of radioactive waste and the release of over 140 tons of cast Meehanite® as non-contaminated scrap iron. However, a much greater effort was required than was originally planned. A cost-effective means of sectioning the large doors was not identified initially, and the option of one-piece radioactive disposal for each door was originally rejected. The latter was based in part on the assumption that decontamination would be relatively easy, and in part on the intangible costs associated with an unfavorable political climate and public perceptions associated with the site's nuclear D&D projects. The transportation of large escorted loads of radiologically contaminated material on the neighboring public roads would have generated concerns, and a transportation mishap of any kind with these large loads would have had a large negative impact on decommissioning work. In hind sight, it would have been much more cost-effective to dispose of the doors with no attempts at decontamination. An alternative option for future consideration would be to perform minimal decontamination to minimize handling and contamination issues during size reduction, and then to section the massive components for simplified transportation and radioactive waste disposal using the powder torch cutting technology that was identified during the later stages of the work.

Some of the radioactively contaminated lead from the facility dismantlement was included in a project to recycle a larger ETEC inventory of contaminated lead. The decontamination was performed by an outside contractor using a proprietary chelating process. This project was successful, resulting in the free release of a large percentage of the lead, but the process generated some mixed waste which required stabilization and subsequent disposal at an off-site facility (Envirocare of Utah). If this approach is used for future lead recycling, tighter controls should be placed on the outside contractor to minimize or eliminate the generation of mixed wastes.

9.4 SPECIALTY CONTRACTORS

The Hot Laboratory project utilized a variety of task-specific outside contractors to supplement an experienced crew of in-house D&D radiation workers. The contractors were selected in many cases to perform tasks which required specialized and expensive equipment (such as large-diameter concrete saws, heavy rigging equipment, and large mobile cranes), or which required specialized training. In other cases, specialty contractors were hired to perform tasks which had a potential for unacceptable safety risks to on-site operations personnel because of their limited experience. Examples included the handling of 40-ton shield doors and the saw-cutting and movement of 20-ton concrete blocks. In all cases, facility personnel worked with the contractors to perform support operations involving the proper handling of radioactive materials and the packaging of contaminated wastes. This also allowed the radiation workers to concentrate their efforts on tasks requiring their particular training and expertise.

Tasks for which specialty contractors were utilized included the following:

- *Concrete coring and concrete sawing*. Contractors were used initially to core the through-tubes in the operating gallery and in the hot cell walls and floors, and to cut notches above the decon room door openings for clearance to remove the cell doors. Based on those successes, similar expertise was used to dismantle the decon room and hot cell walls and roofs, plus the basement structure. The coring operations in particular introduced innovative dismantlement approaches that both minimized the spread of contaminants and enhanced personnel safety. The concrete sawing included both diamond-blade circular saws and diamond wire saws.

- *Oxygen/propane torch cutting.* This higher temperature cutting method was used to segment the hot cell steel floor plates for removal, with an increased cutting efficiency.

- *Heavy-rigging.* Heavy-rigging contractors were used to take down and move the concrete decon room doors and the steel hot cell doors, the latter weighing up to 44 tons. Contractor access to, and experience with, rollers, rigging, and large cranes ensured that these tasks were performed quickly and safely.

- *Asbestos abatement.* The use of asbestos abatement specialists eliminated the need for costly training and documentation to meet state certification requirements to use in-house personnel.

The wire sawing of the large concrete sections required a substantially greater learning curve than anticipated by the specialty contractor. The process was ultimately successful, but the process development difficulties illustrated the need to ensure that bidding contractors are experts in the specialty areas required, and that job scheduling includes adequate time for site-specific process development. One suggestion for future work is the use of a field trial to demonstrate capability and experience prior to awarding a subcontract for specialty work.

In conjunction with the use of specialized contractors, separate specifications were prepared for the dismantlement of the primary building structures by subcontractors. This was part of a strategy to perform the dismantlement in stages. For example, the lessons-learned from the demolition of the smaller, standard-density concrete decon rooms were used to prepare the specification for the demolition of the high-density concrete hot cell roof and walls.

9.5 SPECIALIZED EQUIPMENT

The initial decontamination of the hot cells was performed using the existing master/slave and in-cell remote manipulators. Additional specialized equipment was then added to optimize the hot cell decontamination operations. A significant fraction of the in-cell work was performed using mobile personnel lifts to access ceilings and upper walls. The lifts provided a much safer, more stable, and roomier platform than using scaffolding or ladders. A small battery-powered forklift was also used within the cells. In the latter stages of the project, two additional small vehicles were used effectively in the cells to break up and remove the concrete overlaying the HEPA ventilation ducts and drain lines. These commercially available vehicles, which have also been used successfully in other D&D projects, were a track-mounted Takeuchi backhoe with the capability of using a power ram and a small bucket, and a Bobcat skip loader which used a power ram and a large bucket. These vehicles significantly reduced schedule and worker fatigue in breaking up and handling large quantities of concrete within the confines of the cells.

The final disposition of the hot cell shield doors was aided by the use of other specialized equipment. High-powered abrasive blasting with an abrasive recovery/re-use system was effective in paint removal while minimizing the quantity of contaminated waste produced. The portable milling machine successfully decontaminated the door edges by removing material to a 7-mm depth without moving the massive doors. The powder torch made it possible to size-reduce the thick cast iron doors and release over 80% of the material for recycle.

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REFERENCES

1. T. J. Vitkus, "Interim Letter Report for the Verification Survey of the Land Area Formerly Supporting the Hot Laboratory, Santa Susana Field Laboratory, Canoga Park, California," Oak Ridge Institute for Science and Education Letter Report to D. Williams, U.S. Department of Energy, dated 29 January 1998

2. T. J. Vitkus, "Interim Letter Report for the Phase 2 Verification Survey of the Land Area Formerly Supporting the Hot Laboratory, Santa Susana Field Laboratory, Canoga Park, California," Oak Ridge Institute for Science and Education Letter Report to A. Gupta, U. S. Department of Energy, dated 25 January 1999

3. P. Liddy, "Area 4020, MARSSIM Final Status Survey Report," Rocketdyne Engineering Product Document RS-00010 (October 2000)

4. J. R. Morton, "Verification Survey for the Land Area Formerly Supporting the Hot Laboratory (4020), Santa Susana Field Laboratory, The Boeing Company, Ventura County, California," Oak Ridge Institute for Science and Education Report ORISE 2000-1524 (December 2000)

5. P. Rutherford, "Area 4020, Santa Susana Field Laboratory. Release for Unrestricted Use," Rocketdyne Letter 2001RC-504 to S. Hsu dated 8 February 2001

APPENDIX A
ABBREVIATIONS AND ACRONYMS

10FS3	SNAP-10 Flight System ground test reactor
ALARA	As Low As Reasonably Achievable
CWP	Controlled Work Permit
D&D	Decontamination and decommissioning
DHS	Department of Health Services
DOE	Department of Energy
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
DWP	Detailed Working Procedure
EBR-I	Experimental Breeder Reactor I
EBR-II	Experimental Breeder Reactor II
EPA	Environmental Protection Agency
FFTF	Fast Flux Test Facility
FY	Fiscal year
HEPA	High efficiency particulate air
HPGe	High-purity germanium
LLW	Low level (radioactive) waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MLLW	Mixed low level waste
MTRU	Mixed transuranic
NaK	Sodium-potassium eutectic
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OMR	Organic Moderated Reactor Critical Facility
ORISE	Oak Ridge Institute for Science and Education
OSHA	Occupational Safety and Health Administration
PMP	Program Management Plan
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RIHL	Rockwell International Hot Laboratory
RMHF	Radioactive Materials Handling Facility
S2DR	SNAP-2 Developmental Reactor
S8DR	SNAP-8 Developmental Reactor
S8ER	SNAP-8 Experimental Reactor
SER	SNAP-2 Experimental Reactor
SEFOR	Southwest Experimental Fast Oxide Reactor
SGR	Sodium Graphite Reactor Critical Facility
SHEA	Safety, Health, and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SNM	Special Nuclear Material
SOP	System of Procedures (Boeing Canoga Park and Rocketdyne)
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
TLD	Thermoluminescent dosimeter
TRU	Transuranic
TSD	Treatment, Storage, and Disposal
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant

APPENDIX B
PROJECT COST DETAILS

A more detailed breakdown of total Hot Laboratory D&D project costs is provided in this Appendix.

Table B-1 provides a more detailed breakdown of labor costs by task for the Hot Laboratory D&D project. This project used a very detailed cost breakdown structure during its first ten years (FY 1987-96), when it was funded by the DOE through the Rocketdyne Advanced Programs Office. The program was transferred to the ETEC DOE contract in FY 1997. The new cost structure was less detailed, since the program was entering its final phases and the D&D activities were concentrated in a few major areas. The change in cost structure detail is reflected in the table.

Table B-2 is a summary of the major subcontract and service costs, which are divided between the Table 8-1 categories “D&D Subcontracts,” “Waste Management Subcontracts and Disposal Fees,” and “Waste Management Consumables.” No cost adjustments have been made to account for inflation.

Table B-3 summarizes the D&D project costs by year, divided between the categories of Labor, Materials and Subcontracts, and Other Costs.

Table B-1 (page 1 of 2)
Hot Laboratory D&D Labor Summary by Activity and Fiscal Year

General Order	Account	Activity	Labor Hours							
			FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94
95744	10001	Engineering Management	984	2,484	2,176	3,677	3,006	2,734	2,530	1,847
	10002	Documentation	2,959	7,737	447	2,427	608	1,548	1,623	1,497
	10003	Crew Chiefs				2,552	1,722	1,584	1,375	244
	10004	RMHF Operations		2,228	3,950	1,988	1,950	1,817	1,718	1,155
	10006	Yard, Dock, Asphalt				2,235	1,315	8	58	95
	10005/7/8	Attic				3,419			96	7
	10009	Service Gallery						617	22	118
	10010	Support Drains				71			126	1
	10011	Office & Change Rooms						24		4
	10012/13	Operating Gallery & Mockup				201	580	1,034	651	38
	10015	Basement				39		59	860	270
	10016	Rooms 139, 141, Slave Shop	601			1,033	2,439	54		
	10018	Cells & Decon Rooms	2,742	20,600	17,655	17,721	11,047	9,548	6,685	2,599
	10019	Building Exhaust						108	2,391	442
	10020	Radioactive Drain Removal					9		4,757	2,509
	10023	Surplus Equipment				111	586	79	298	125
	10024	Mixed Waste Plan				268				
	10025	Mixed Waste Sampling					1,318	229	110	32
	10026	DOE Tiger Team					3,340			
	10027	Review Team 2					1,841			
	10028/29	ICE Cost Review						84		
	10030	Cell Steel Liner Removal						5,893	536	6
	10031	Lead Recycling								
	10032	NTS Shipping Procedures						839	1,685	329
	10033	Mixed Waste Operations							630	
	10034	Repackaging NTS Waste							89	583
	10035	NTS Training							8	
	10036	RMHF Operations/NTS							38	322
	10038	Nevada State Questions								
	10039	DOE-OAK Tiger Team								
	20001	Health Physics (HP) Support	200	1,191	1,767	5,049	5,105	4,518	3,435	2,672
	20002	Instrument Calibration					1,026	548	820	681
	20003	HP NTS Requirements							38	214
	30001	Quality Assurance (QA)	162	608	360	530	489	1,188	656	339
	30002	QA Inspection						295	491	241
	30003	QA NTS Requirements							1,033	1,000
	30004	NTS Inspections							58	291
	40000	Program Management	488	2,075	1,945	1,338	1,423	1,212	761	1,025
	40001	Program Administration				726	427	461	345	406
	40002	Procurement Support					81	15		2
	41000	Contract Re-Negotiations								
	50000	Miscellaneous		3,169	7,079	52	38	39	202	41
	60001	Box Shop/Plant Services				48	13	29	105	68
	60002	Photographic							8	34
	70003	Facilities						16	3	30
	80001	Environmental Engineer							359	1,155
96672	72200	Project Mgmt. & Planning								
	72300	Engineering Support & Doc.								
	72410	D&D of Hot Cells								
	72420	D&D of Basement								
	72430	Other Activities								
96944	10000	Project Mgmt. & Documentation								
	20000	Operations								
	20100	Concrete Block Decontam.								
	30000	Waste Management at 4020								
	50000	Health Physics								
	60000	General Support								
97055	31000	Subs, Leases, Expendables								
	31010	Subcontractor Shipments								
	31100/50	Concrete Block Decontam.								
	31120/70	Final Report								
	31200/50	QA for Blocks, Roll-Offs								
	31300	Environmental Support								
	31600/10	HP Support (Concrete Decon.)								
	31620	HP (ORISE & General)								
	31800	Photographic								
	31900	Coord. Grading Contract								
		Total Labor Hours:	8,136	40,092	35,379	43,485	38,363	34,580	34,600	20,422

Table B-1 (page 2 of 2)
Hot Laboratory D&D Labor Summary by Activity and Fiscal Year

General Order	Account	Activity	Labor Hours FY95	FY96	FY97	FY98	FY99	FY00	Total
95744	10001	Engineering Management	1,762	3,566					24,766
	10002	Documentation	86	2,498					21,430
	10003	Crew Chiefs	169	1,992					9,638
	10004	RMHF Operations	1,116	1,440					17,362
	10006	Yard, Dock, Asphalt	19	240					3,970
	10005/7/8	Attic		320					3,842
	10009	Service Gallery	383	1,280					2,420
	10010	Support Drains		624					822
	10011	Office & Change Rooms	83	672					783
	10012/13	Operating Gallery & Mockup	148	1,920					4,572
	10015	Basement	248	1,780					3,256
	10016	Rooms 139, 141, Slave Shop		1,240					5,367
	10018	Cells & Decon Rooms	831	1,632					91,060
	10019	Building Exhaust	104	1,712					4,757
	10020	Radioactive Drain Removal	12	560					7,847
	10023	Surplus Equipment	103	400					1,702
	10024	Mixed Waste Plan		976					1,244
	10025	Mixed Waste Sampling	356	2,656					4,701
	10026	DOE Tiger Team							3,340
	10027	Review Team 2							1,841
	10028/29	ICE Cost Review							84
	10030	Cell Steel Liner Removal							6,435
	10031	Lead Recycling	48						48
	10032	NTS Shipping Procedures	231						3,084
	10033	Mixed Waste Operations		1,984					2,614
	10034	Repackaging NTS Waste	2,476						3,148
	10035	NTS Training	41						49
	10036	RMHF Operations/NTS	204	992					1,556
	10038	Nevada State Questions	9						9
	10039	DOE-OAK Tiger Team	10						10
	20001	Health Physics (HP) Support	2,318	3,984					30,239
	20002	Instrument Calibration	413	480					3,968
	20003	HP NTS Requirements	208						460
	30001	Quality Assurance (QA)	1,346	317					5,995
	30002	QA Inspection		320					1,347
	30003	QA NTS Requirements	109						2,142
	30004	NTS Inspections							349
	40000	Program Management	1,140	1,020					12,427
	40001	Program Administration	247	240					2,852
	40002	Procurement Support							98
	41000	Contract Re-Negotiations			425	71			496
	50000	Miscellaneous	3						10,623
	60001	Box Shop/Plant Services	53	83					399
	60002	Photographic	13	96					151
	70003	Facilities							49
	80001	Environmental Engineer	179	1,389					3,082
96672	72200	Project Mgmt. & Planning			128				128
	72300	Engineering Support & Doc.			1,247	335			1,582
	72410	D&D of Hot Cells			45				45
	72420	D&D of Basement			2,166				2,166
	72430	Other Activities			2,309	2,505	285		5,099
96944	10000	Project Mgmt. & Documentation				316	141		457
	20000	Operations				640	62		702
	20100	Concrete Block Decontam.				2,886	1,487		4,372
	30000	Waste Management at 4020				114	35		149
	50000	Health Physics				1,508	64		1,571
	60000	General Support				631	70		701
97055	31000	Subs, Leases, Expendables						8	8
	31010	Subcontractor Shipments							0
	31100/50	Concrete Block Decontam.					3,267	161	3,428
	31120/70	Final Report					206	310	516
	31200/50	QA for Blocks, Roll-Offs					145		145
	31300	Environmental Support							0
	31600/10	HP Support (Concrete Decon.)					2,104	21	2,125
	31620	HP (ORISE & General)					348	921	1,269
	31800	Photographic							0
	31900	Coord. Grading Contract						3	3
		Total Labor Hours:	14,468	36,413	6,328	8,997	8,212	1,423	330,898

Table B-2
Major Subcontract and Service Cost Summary

Category	Subcontract or Service	Approximate Cost ($000)
D&D	Decon Room Demolition	114
	Hot Cell/Structure Demolition	549
	Concrete Coring	113
	Other Subcontracted Dismantlement Activities	118
	Heavy Rigging and Trucking	54
	Basement Demolition	378
	Building 4020 Excavation and Backfill	50
	Building 4468 Excavation and Backfill	25
Waste Management	Asbestos Abatement	48
	Waste Characterization and Disposal	1,248
	Waste Containers	323

Table B-3
Hot Laboratory D&D Project Costs by Year

Fiscal Year	Labor ($000)	Material & Subcontracts ($000)	Other Costs ($000)	Total ($000)
1987	413	0	9	422
1988	2,042	173	47	2,262
1989	1,833	346	56	2,235
1990	2,386	205	50	2,641
1991	2,390	262	69	2,721
1992	2,301	292	64	2,657
1993	2,382	509	72	2,963
1994	1,523	160	42	1,725
1995	994	121	52	1,167
1996	1,966	1,127	230	3,323
1997	328	756	190	1,274
1998	502	994	272	1,768
1999	399	490	239	1,128
2000	73	201	82	356
Totals:	19,532	5,636	1,474	26,642