762749

ENERGY TECHNOLOGY ENGINEERING CENTER

No. 020-AR-0002 Rev. _____

OPERATED FOR THE U.S. DEPARTMENT OF ENERGY
ROCKETDYNE DIVISION, BOEING NORTH AMERICAN INC.

Page 1 of 107
Orig. Date May 6, 1997
Rev. Date _____

TITLE: ROCKWELL INTERNATIONAL HOT LABORATORY DECONTAMINATION AND DISMANTLEMENT
INTERIM PROGRESS REPORT 1987-1996

- APPROVALS -

Originator

RIHL D&D Team

Final

REV.
LTR.

REVISION

APPROVAL/DATE

DE-AC03-86SF16021

PROCESSED FROM BEST AVAILABLE COPY

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONTENTS

	Page
1.0 INTRODUCTION	8
1.1 Facility Location	8
1.2 Operational History	11
1.3 Decontamination and Dismantlement	11
2.0 FACILITY DESCRIPTION PRIOR TO D&D	13
2.1 Facility Description	13
2.2 Radiological Status at the Start of D&D	19
3.0 D&D OVERVIEW	21
3.1 Overview	21
3.2 Initial Decommissioning Plan	24
3.3 Initial Characterization and Decontamination Activities	24
3.4 Project Redirection and Subsequent D&D Activities	24
3.5 Contamination Control During D&D	25
3.6 Waste Disposal	26
4.0 GOVERNING REGULATIONS, DOCUMENTS, AND PROCEDURES	27
4.1 Government Regulations	27
4.2 Rocketdyne Regulations and Procedures	28
4.3 RIHL-Specific D&D Plans and Procedures	29
4.3.1 General Plans and Procedures	29
4.3.2 Detailed Working Procedures	29
4.4 Disposal Site Requirements	31
4.4.1 Hanford	31
4.4.2 Nevada Test Site	31
5.0 PERSONNEL PROTECTION	33
5.1 ALARA	33
5.2 ALARA Implementation	33
6.0 CHRONOLOGICAL SUMMARY OF D&D HIGHLIGHTS	35
6.1 FY 1987 Activities	36
6.2 FY 1988 Activities	37

CONTENTS (Con.)

	Page
6.3 FY 1989 Activities	41
6.4 FY 1990 Activities	46
6.5 FY 1991 Activities	50
6.6 FY 1992 Activities	58
6.7 FY 1993 Activities	66
6.8 FY 1994 Activities	73
6.9 FY 1995 Activities	77
6.10 FY 1996 Activities	78
6.11 Planned Future Activities	92
7.0 COST SUMMARY	94
7.1 Overview	94
7.2 Labor Summary	94
7.3 Cost Summary	96
8.0 SUMMARY OF WASTE DISPOSAL FROM D&D OPERATIONS	97
8.1 Waste Generation Summary	97
8.2 Radioactive Waste Handling and Disposal	99
9.0 LESSONS LEARNED	101
9.1 General D&D Practices	101
9.2 Contamination Detection and Control	102
9.3 Waste Minimization and Recycling	103
9.4 Specialty Contractors	104
9.5 Specialized Equipment	105
APPENDIX A. Abbreviations and Acronyms	106

TABLES

	Page
7-1. RIHL D&D Manpower Summary	95
7-2. RIHL D&D Cost Summary	96
7-3. Major Subcontract and Service Cost Summary	96
8-1. Waste Generation Summary for the RIHL	97
8-2. Radioactive Waste Generated at the RIHL through FY 1996	99
8-3. Radioactive Waste Disposal by Volume through FY 1996	100

FIGURES

	Page
1-1. Map of Southeastern Ventura County, Showing the Location of the SSFL	8
1-2. Topographic Map for the Area Encompassing the SSFL, Showing the Location of the RIHL	9
1-3. Aerial Photograph of SSFL Area IV	9
1-4. Aerial Photograph of the RIHL Facility in 1987, Just Prior to D&D Initiation	10
1-5. Photograph of the RIHL Facility Looking North	10
 2-1. Layout View of the RIHL Facility	 14
2-2. Elevation View of Building 020, Showing the Geometry of the Hot Cells, Decon Rooms, and Basement	15
2-3. Photograph of Remote Fuel Declad Operations from the Operating Gallery	15
2-4. Plan View of the Building 020 Basement, Shown Relative to the Hot Cells and Decon Rooms, Which Overlayed It	17
2-5. Photograph of the Building 020 Basement During Construction	17
2-6. Schematic Representation of the Layout of the RIHL Radioactive Drain System	18
2-7. Schematic Representation of the Layout of the Building 020 Basement Drain System	19
 3-1. Generalized Flow Diagram for the RIHL D&D Activities	 21
3-2. Chronology of RIHL Decontamination and Demolition Activities	22
 5-1. Example Controlled Work Permit for RIHL D&D Operations	 34
 6-1. Operating Gallery Face of Cell 1 Following Removal of the Master/Slave Manipulators, Through-Tube Shield Plugs, and Small Window	 38
6-2. Cutaway of an Electropolished Drain Mockup Section, Showing the Drain Line Electropolish Electrode Assembly	39
6-3. Photograph of the Through-Port Honing Device Used for Internal Surface Scale Removal	40
6-4. Remote Survey Probe Used for Drain Line Cleaning Verification	42
6-5. Initial Stages of Drain Line Removal in the Hot Storage Area	42
6-6. Surface Paint Removal in Cell 1	43
6-7. Cell 1 Face Following Window Removal and Grit Blasting	44
6-8. Walls of Decon Room 1 After Paint Removal by Grit Blasting	44
6-9. Service Area Attic	45
6-10. Concrete Floor Scabbling Operations in the Air Lock Room	45
6-11. Electropolish Cleaning Equipment in Front of Cell 1	46
6-12. Grit Blasting Tent and HEPA Vacuum System Used for Paint Removal, Shown in Front of Cell 2	47

FIGURES (Con.)

	Page
6-13. Floor Tile and Mastic Removal in the Manipulator Maintenance Room	47
6-14. Excavation of the Unused Underground Fission Gas Tanks	48
6-15. Removal of the Underground Fission Gas Tanks	49
6-16. Hot Cell Window Palletized for Shipment to the University of Missouri for Reuse in Another DOE Program	50
6-17. Cell 3 Through-Tube Honing Operations, Performed from the Operating Gallery Side of the Cell Wall	51
6-18. Status of Operating Gallery Faces of Hot Cells 3 and 4 in January 1991	51
6-19. Status of Operating Gallery Faces of Hot Cells 3 and 4 in January 1991	52
6-20. View of the Decon Room Shielding Doors from the Service Gallery During the Initial Stages of Decontamination	53
6-21. Removal of the Decon Room 2 Shield Door from Building 020	54
6-22. Transport of the Decon Room Doors to the RMHF	54
6-23. One of the Two Glove Boxes in Room 139 Prior to Removal	55
6-24. Core Drilling Operations to Remove the Hot Cell Penetration Through-Tubes	59
6-25. Removal of Concrete-Encased Through-Tube Cores by Rocketdyne Radiation Workers	59
6-26. Cell Liner Structural Assembly Before the Concrete Cell Walls Were Poured	60
6-27. View of the Ceiling and Upper Walls of One of the Cells During Liner Removal Operations	62
6-28. View of a Cell Interior Wall Following Liner Removal	62
6-29. Diamond-Blade Sawing of the Decon Room Door Notches for Removal of the Cell Doors	63
6-30. Service Gallery and Decon Room 1 Door Openings with Notches Cut for Removal of the Cell 1 Shield Door	63
6-31. Removal of the Cell 1 Shield Door from Its Support Beam	64
6-32. Cell 1 Shield Door Rigged for Movement Outside Building 020	64
6-33. Transfer of the Cell 1 Shield Door to a Transport Trailer	65
6-34. Oxygen/Propane Cutting of the Decon Room 3 Floor Liner for Removal	66
6-35. Track-Mounted Backhoe Used for Floor Concrete Removal Inside the Hot Cells and Decon Rooms, Shown with the Hydraulic Hammer Attached	67
6-36. Wheel-Mounted Vehicle Used for Concrete Removal Inside the Hot Cells and Decon Rooms, Shown with the Hydraulic Ram in a Similar D&D Application	68
6-37. Cell 3 Exhaust Duct During Removal	69
6-38. Removed Cell Exhaust Duct Elbows	69
6-39. Radioactive Drain Line Removal in Cell 1	70
6-40. Radioactive Drain Line Removal in Cell 1 and Decon Room 1	71
6-41. Construction Photograph Showing the Placement of Lead Shielding in the Cell 4 Steel Wall Frame Before the Concrete Was Poured	72

FIGURES (Con.)

	Page
6-42. Core Drilling to Remove the Vertical Storage Tube in Cell 4	73
6-43. Vertical Storage Tube Lifting Fixture	74
6-44. Removal of a Vertical Storage Tube After Coring	74
6-45. Removal of the Radioactive Drain Tank from Building 468	75
6-46. Transport of the Wrapped Drain Tank to the RMHF	76
6-47. Status of the Service Gallery in March 1995, During Removal of Localized Contaminants from Adjacent Rooms	77
6-48. October 1958 Building 020 Construction Photograph, Showing the Distinct Structures of the Steel Building and the Hot Cell/Decon Room Assemblies	78
6-49. Removal of a Decon Room Exhaust Duct Riser (Basement View)	80
6-50. Hot Change Room Following Decontamination, Showing the Overhead Piping and the Removal of the Lower Portions of the Walls	80
6-51. View from the Battery Room Toward the Airlock with Interior Walls Removed	81
6-52. Core-Drilled Decon Room Walls for Forklift Access	82
6-53. Forklift Removal of a Concrete Decon Room Wall Block	82
6-54. Saw Cutting of the Decon Room Concrete Walls	83
6-55. Removal of a Decon Room Ceiling Block Using a Special-Purpose Fixture	83
6-56. Removal of the Building 020 Overlying Metal Roof	84
6-57. Removal of the Building 020 Underlying Asbestos-Containing Asphalt Roof	85
6-58. Core Drilling Operations to Section the Concrete Cell Roof	86
6-59. Core-Drilled Concrete Cell Roof Block Segment	86
6-60. Detachment of the Cell Roof Block Segments by Saw Cutting	87
6-61. Removal of the Concrete Cell Roof Blocks	87
6-62. Removal of the Top 55 Feet of the Building 020 Exhaust Stack to a Flatbed Truck for Transport to the RMHF	89
6-63. Cleared Building 020 floor slab and Remainder Exhaust Stack Section	90
6-64. Photograph of the RIHL Site and Its Surroundings in November 1996	91
8-1. Cumulative Activity Plot of Radioactive Waste Receipt at the RMHF	100

1.0 INTRODUCTION

The Rockwell International Hot Laboratory (RIHL) is one of a number of former nuclear facilities undergoing decontamination and decommissioning (D&D) at the Santa Susana Field Laboratory (SSFL). The RIHL facility is in the later stages of dismantlement, with the final objective of returning the site location to its original natural state. This report documents the decontamination and dismantlement activities performed at the facility over the time period 1988 through 1996. At this time, the support buildings, all equipment associated with the facility, and the entire above-ground structure of the primary facility building (Building 020) have been removed. The basement portion of this building and the outside yard areas (primarily asphalt and soil) are scheduled for D&D activities beginning in 1997.

1.1 FACILITY LOCATION

The RIHL is part of Rocketdyne's Santa Susana Field Laboratory (SSFL) 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 RIHL is 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 RIHL 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 RIHL.

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

Figure 1-4. Aerial Photograph of the RIHL Facility in 1987, Just Prior to D&D Initiation.
[6DH21-3/26/87-S1P]

Figure 1-5. Photograph of the RIHL Facility Looking North.

1.2 OPERATIONAL HISTORY

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

The RIHL 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 RIHL, 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 RIHL 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), South Eastern Fast Oxide Reactor (SEFOR), and the Fermi Reactor. These 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, when a fire occurred in the process of attempting to dispose 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 RIHL. Airborne and surface radiological contamination concentrations inside the building from the event ranged from 2% to 20% of the occupational maximum permissible concentration, 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 the RIHL 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 replanned 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 RIHL facility over the time period 1987 - 1996. 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 - 1996 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 cost and waste generation 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 020) with a floor space of about 16,000 ft². A separate support building (Building 468) housed a 3,000-gallon radioactive holdup tank that received effluents from Building 020 through a radioactive drain system. Three subsurface fission gas tanks, which were never put into service, were located at the north end of Building 020. 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 020, 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 468 holdup tank.

The configuration of the hot cells and decon rooms are shown in layout 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 decon room walls of 24-inch-thick standard reinforced concrete. All of the hot cell surfaces, plus the floors and east walls of the decon rooms, were clad with 1/4-inch-thick steel plate. The other decon 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 for the remote machining, grinding, cutting, and packaging operations.

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

Figure 2-2. Elevation View of Building 020, Showing the Geometry of the Hot Cells, Decon Rooms, and Basement.

Figure 2-3. Photograph of Remote Fuel Declud 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 includes five large concrete support columns which provide part of the structural support for the hot cells. Columns 1, 2, 3, and 5 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 020 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 ¹⁴⁷Pr 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 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

Figure 2-4. Plan View of the Building 020 Basement, Shown Relative to the Hot Cells and Decon Rooms, Which Overlayed It.

Figure 2-5 Photograph of the Building 020 Basement During Construction. [00-5788B 8/22/58]

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.

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 020 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 468 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 two sumps, one at each end of the basement, as shown in Figure 2-7. The contents of these sumps were automatically pumped into the Building 468 holdup tank.

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

Figure 2-7. Schematic Representation of the Layout of the Building 020 Basement Drain System.

2.2 RADIOLOGICAL STATUS AT THE START OF D&D

The RIHL facility was designed to control and minimize contamination. It was also standard practice during RIHL 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 RIHL 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 020 at the start of D&D. For example, removable beta and gamma contamination were present in several areas. The highest levels (> 5000 dpm/100 cm²) existed in the hot cells (Cells 1, 2, 3, 4) and in the adjoining decontamination rooms. Lower levels of contamination (1000 - 5000 dpm/100 cm²) 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 cm²) 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 cm² 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 468 radioactive water holdup tank. This contamination consisted primarily of old mixed fission products (¹³⁷Cs, ⁹⁰Sr, ¹⁴⁷Pm), plus ⁶⁰Co, 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 which 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 cm². 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 468. 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 020, 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. It was suspected that the roof was contaminated, particularly at the north end, from stack fallout. Since the building had been re-roofed several times, the roof consisted of several layers of asphalt and gravel. Core samples verified the presence of low 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 RIHL 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. Most of the facility demolition has been completed at this time. This section provides a general perspective of program directions and activities.

3.1 OVERVIEW

A generalized flow diagram for the RIHL 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 3-2 presents a chronological summary of the RIHL 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.

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

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

Activity	Fiscal Year											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Equipment Removal												
Cells and Decon Rooms												
Support Rooms												
Basement												
Outside Areas												
Hot Cells and Decontamination Rooms												
Steam clean and wash down cells												
Remove paint from cell walls & ceilings												
Decon cell steel liners (wall and ceiling)												
Remove cell steel liners												
Decontaminate cell concrete surfaces												
Decontaminate cell & decon room doors												
Remove decon room doors (contractor)												
Remove cell steel doors (contractor)												
Core-drill cell through-tubes (contractor)												
Lead Removal												
Radioactive Drain Lines												
In-situ drain & through-tube tests:												
Mockup Development Tests												
Mechanical cleaning												
Electropolish cleaning												
Remove from support areas, service gallery												
Remove from cells & decon rooms												
Remove from basement												
Remove Building 468 drain tank												
HEPA Ventilation System												
Remove and package cell system												
Remove and package support area system												
Remove and package basement system												
Install portable system for basement decon												

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

Activity	Fiscal Year											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Support Areas: Surveys & Decontamination												
Room 125 (Mockup Area)												
Room 128 (Manipulator Maintenance)												
Room 133 (Heating and Ventilation)												
Rooms 135 & 137 (Electrical & Battery)												
Room 139 (Material Testing Lab)												
Room 141 (Hot Lab)												
Room 149 (Hot Change Room)												
Room 153 (Hot Storage)												
Room 155 (Air Lock)												
Service Gallery												
Operating Gallery												
Office Area (Non-Radiological Areas)												
Engineering and HP Trailers												
Outside Areas: Surveys & Decontamination												
Fission gas tanks												
West holdup yard asphalt												
West loading dock and adjacent soil												
Site-wide asphalt removal												
Soil excavation												
Building Demolition												
Remove and dispose of interior walls												
Saw-cut decon walls and roof (contractor)												
Saw-cut and remove cell walls, roof (contr.)												
Demolish steel structure (contractor)												
Saw-cut and remove bldg. floor (contractor)												
Saw-cut & remove basement (contractor)												
Project Closure												
Final Survey (ORISE) & release												
Backfill excavated areas												
Revegetate site												

Notes:

- Completed activities
- Planned activities

3.2 INITIAL DECOMMISSIONING PLAN

At the conclusion of the Fermi Fuel declad program in FY 1986, all project-related equipment and materials were removed from the RIHL, 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 RIHL. 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 (NRC) 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 which 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.

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 RIHL 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 are now in progress to decontaminate and dispose of the sectioned concrete blocks. The concrete basement will be sectioned and removed in FY 1997, and will be followed by remediation, backfilling, and revegetation of the cleared site.

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 recontaminating 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 air flow 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 personnel protective equipment. The mastic was removed by using a non-hazardous solvent in the operating gallery and shop areas, and by

scabbling of the service gallery floor. This radioactive asbestos-containing material was packaged for disposal off-site.

3.6 WASTE DISPOSAL

Information on the generation of radioactive waste by the RIHL D&D operations is summarized in Section 8. Most of the waste disposal to date has been by shipment to the Nevada Test Site (NTS), following NTS and Department of Transportation (DOT) packaging and shipping guidelines. 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 guidelines. Those procedures were submitted extensively and approved by DOE-Nevada, and shipments resumed in 1994. The asbestos-containing floor tiles were shipped to DOE-Hanford for disposal.

Several other waste materials are currently in storage while their final disposition is being determined. This includes the steel doors and sectioned concrete blocks that comprised the hot cells and decon rooms, and several small waste streams that must be addressed individually. The doors and concrete blocks are undergoing decontamination. Radioactively contaminated soil from the site and the asbestos-containing material that comprised the Building 020 roof material have been characterized chemically and radiologically by an outside analytical laboratory, and are awaiting approvals for disposal at Envirocare of Utah; exemption requests are in process for DOE approval to use this commercial site. A request is also in process for the disposal of the solidified electropolish solution from the in-situ drain decontamination tests. The disposal of low-level radioactive and mixed-waste filters from the HEPA ventilation system, mixed-waste (lead-containing) paint chips from cell wall grit blasting, and transuranic (TRU) waste material from the drain lines and drain tank is currently under investigation.

4.0 GOVERNING REGULATIONS, DOCUMENTS, AND PROCEDURES

The RIHL 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 RIHL 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)

"Environment, Health, and Safety," *Rocketdyne System of Procedures (RSOP)*, and its predecessors, including the *Health, Safety & Environmental Procedures Manual* (572-L-1) and the *Rocketdyne Environmental Control Manual* (572-2)

Rocketdyne Radiological Control Manual, Rocketdyne Operational Safety Plan N001OSP000004 (May 1993)

Nuclear Materials Management Manual, Rocketdyne (February 1990)

"QA Inspection Requirements for the Shipment of R/A Materials," Rocketdyne Quality Assurance Acceptance Procedure 094QAP-000, Rev. P (January 1994)

"Radioactive Waste Handling & Shipping Training Plan," Rocketdyne Supporting Document N001TMP000001, Rev. D (January 1994)

"Procedure for Packaging and Off-Site Shipment of Radioactive Material." Rocketdyne Operating Procedure N001OP000048, Rev. A (May 1996)

"Procedures for Surveys of Radioactive Material Shipments," Rocketdyne Operating Procedure N001OP000030

4.3 RIHL-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 RIHL D&D operations. They include the following:

"Rockwell Hot Lab Decommissioning Project Plan," 173PMP000001, Rev. C (April 1993)

"Rockwell Hot Lab Decommissioning Quality Assurance Program Plan," 173QPP000001, Rev. A (June 1993)

"Engineering Release Plan of Action for the Decontamination and Decommissioning (D&D) of the Rockwell Hot Lab," 173RPA000001, Rev. M (December 1993)

"Sampling and Analysis Plan for RIHL D&D Waste," 173ER000010 (March 1996)

4.3.2 Detailed Working Procedures

The following Rocketdyne detailed working procedures were prepared and used for the performance and control of specific RIHL 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 and the Nevada Test Site.

4.4.1 Hanford

"Hanford Site Solid Waste Acceptance Criteria," Westinghouse Hanford Company WHC-EP-0063-4 (May 1996) and predecessors

"Packaging and Shipping of Radioactive Waste - LSA to West Hanford Disposal Site," Rocketdyne Operating Procedure N001OP160003, Rev. G

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

4.4.2 Nevada Test Site

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

"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 - Low Specific Activity (LSA) to DOE-Nevada Test Site (NTS)," Rocketdyne Operating Procedure 173OP000007 (April 1993)

"NTS Waste Stream Characterization Procedure," Rocketdyne Procedure 173OP000010
(March 1994)

"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)

5.0 PERSONNEL PROTECTION

Personnel safety is a central element of Rocketdyne's D&D practices. Rocketdyne's System of Procedures (RSOP) includes Environmental, Health, and Safety 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 RIHL 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 RSOP C-401, "Radioactive Materials and Ionizing Radiation," and its 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 RIHL 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 RSOP 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

UNIT ATTENDING ON PERFORMING WORK	JOB REQUESTED BY: <u>D.M. TRIPPEDA</u> DEPT. <u>002</u>		BEFORE STARTING WORK, NOTIFY SAFETY AND OPERATIONS																																																	
	JOB LOCATION & AREA: <u>TORO AREA SERVICE GALLERY</u>																																																			
	JOB DESCRIPTION: <u>REMOVAL OF GEN. EXHAUST SYSTEM (HEPA) & TRANSPORT TO BASEMENT FOR PACKAGING</u>																																																			
	REFERENCE PROCEDURE: <u>ACM PROJECT JOB ORDER, ETC. 1730WP000011 REV. A</u>																																																			
DATE OF PERMIT: <u>3-1-96</u>		WORK TO BEGIN: <u>3-2-96</u>		WORK TO END: <u>3-24-96</u>																																																
SUPERVISOR OF GROUP PERFORMING WORK: <u>D.M. TRIPPEDA</u>		DEPT. <u>002</u> DATE: <u>3-1-96</u>																																																		
SUPERVISOR OF AREA WHERE WORK WILL BE PERFORMED: <u>(Signature)</u> DEPT. <u>002</u> DATE: <u>3-1-96</u>																																																				
SAFETY REQUIREMENTS	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>CONVALLS</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>LEAD BOAT</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>SAFETY GLASSES</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>WOOD</td> <td>4</td> <td>OTHER</td> </tr> <tr> <td>5</td> <td>RAIN SUIT</td> <td></td> <td></td> </tr> <tr> <td>6</td> <td>ACE APRON</td> <td></td> <td></td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	CONVALLS	1	COVERING COVERING	2	LEAD BOAT	2	PLASTIC COVERS	3	SAFETY GLASSES	3	RECORD	4	WOOD	4	OTHER	5	RAIN SUIT			6	ACE APRON			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER
	NO.	REMARKS	NO.	REMARKS																																																
	1	CONVALLS	1	COVERING COVERING																																																
	2	LEAD BOAT	2	PLASTIC COVERS																																																
3	SAFETY GLASSES	3	RECORD																																																	
4	WOOD	4	OTHER																																																	
5	RAIN SUIT																																																			
6	ACE APRON																																																			
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER									
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REMARKS</th> <th>NO.</th> <th>REMARKS</th> </tr> <tr> <td>1</td> <td>COVERING COVERING</td> <td>1</td> <td>COVERING COVERING</td> </tr> <tr> <td>2</td> <td>PLASTIC COVERS</td> <td>2</td> <td>PLASTIC COVERS</td> </tr> <tr> <td>3</td> <td>RECORD</td> <td>3</td> <td>RECORD</td> </tr> <tr> <td>4</td> <td>OTHER</td> <td>4</td> <td>OTHER</td> </tr> </table>		NO.	REMARKS	NO.	REMARKS	1	COVERING COVERING	1	COVERING COVERING	2	PLASTIC COVERS	2	PLASTIC COVERS	3	RECORD	3	RECORD	4	OTHER	4	OTHER																															
NO.	REMARKS	NO.	REMARKS																																																	
1	COVERING COVERING	1	COVERING COVERING																																																	
2	PLASTIC COVERS	2	PLASTIC COVERS																																																	
3	RECORD	3	RECORD																																																	
4	OTHER	4	OTHER																																																	

6.0 CHRONOLOGICAL SUMMARY OF D&D ACTIVITIES

A chronological summary of the RIHL 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 has 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 RIHL 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 RIHL 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 RIHL. 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 RIHL. The PMP was based on the objective of decontaminating the facility in-situ, releasing it for unrestricted use, and then reusing it for nonradioactive 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, the 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.

It was recognized from the beginning of the D&D effort that the cleaning of the RIHL 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 468.

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

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]

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

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

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.

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 (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 009, was disassembled, moved to the RIHL, 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.

Several Building 020 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.

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

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

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

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.

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 (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 (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).

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]

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]

6.4 FY 1990 ACTIVITIES

The electropolish cleaning demonstration test on the Cell 1 operating gallery through-tubes was completed in FY 1990. Figure 6-11 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 6-12, 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 6-13. 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.

Figure 6-11. Electropolish Cleaning Equipment in Front of Cell 1. [6DH29-6/8/90-S1M]

Figure 6-12. Grit Blasting Tent and HEPA Vacuum System Used for Paint Removal, Shown in Front of Cell 2. [6HD29-07/06/90-S11]

Figure 6-13. Floor Tile and Mastic Removal in the Manipulator Maintenance Room. [6DH66-7/5/90-S1D]

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 (Figures 6-14 and 6-15), surveyed clean, and disposed of as scrap metal. The excavated area was back-filled with clean soil, compacted, and repaved.

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 6-14. Excavation of the Unused Underground Fission Gas Tanks.

Figure 6-15. Removal of the Underground Fission Gas Tanks.

6.5 FY 1991 ACTIVITIES

All remaining support equipment was removed from the hot cells and from Decon Rooms 3 and 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. [6DH91-111/8/90-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. [6HD29-1/24/91-S1A]

The Building 020 facility included nine large shielding doors: four decon room doors, located on the service gallery side of the 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. RIHL technicians removed and disposed of the door trolleys and support rails.

Figure 6-21. Removal of the Decon Room 2 Shield Door from Building 020. [6DH29-4/17/91-S1H]

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

The replanning 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 proper 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 RIHL technicians. The floor tile in the other rooms was asbestos-free and RIHL 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. jack hammers 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 operation) 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 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 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 operation. 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 020 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 found 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 2 feet and packaged for disposal.

The DOE Nevada Test Site, to whom several RIHL 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.

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

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-6/8/92-393171]

surrounding contaminated concrete. When the cores were removed, the holes were replugged 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.

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 6-27. 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]

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 020. [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.

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,

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

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 three interchangeable end effectors: a 200-lb. pneumatic hammer, a small bucket, and a shear. The second vehicle (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-S1005]

Figure 6-36. Wheel-Mounted Vehicle Used for Concrete Removal Inside the Hot Cells and Decon Rooms, Shown With the Hydraulic Ram in a Similar D&D Application. [6BL22-6/8/88-D1G]

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) ran through the cell floor concrete to header pipes, then via a central line to the radioactive holdup tank in Building 468. In many locations, the drain lines and the HEPA duct system intersected or were oriented in a manner that caused access interferences. 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 was 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 468 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 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. 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 (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]

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 nested 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.

Jack hammering 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 and 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 468 (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 468.

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 removed, 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 RIHL D&D activities during the 1988-1990 time frame had been set aside because of the recertification required to ship radioactive waste to DOE-NTS. The recertification process took place in 1991-1992, and required the inspection and recharacterization 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 RIHL 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 020 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 recontamination 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.

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

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.

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]

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 and are pending disposition, with a number of recycling options under investigation. The remaining four blocks contained metal door and window frames, and were size-reduced and packaged as low-level waste.

Demolition of the decon rooms was followed by the removal of the Building 020 roof. The building had been re-roofed several times, and its roof consisted of several layers of asphalt and gravel beneath a metal covering. The potential thus existed for subsurface radiological contamination. 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 either from trace building stack emissions or from 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 020 Overlying Metal Roof. [ETEC-6/13/96-394599]

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 54-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 024, 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 RIHL 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 RIHL site and all of the other blocks processed to date have been 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. Final disposition of the blocks has been stalled to date because of their origination in a radiation facility. Initial interest was high, but no non-DOE governmental agency or commercial project representative has been willing to accept ownership of the blocks because of concerns over public perception. If recycling efforts fail, the blocks will be disposed of at a commercial landfill.

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 incorporated into the cell demolition contract, and was staged with the cell removal. Rockwell personnel had at this time completed the gutting 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 building exhaust stack was also removed by the contractor. The stack was supported by a crane and severed 20 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 decontamination and release or 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.

Figure 6-62. Removal of the Top 55 Feet of the Building 020 Exhaust Stack to a Flatbed Truck for Transport to the RMHF. [ETEC-9/9/96-394817]

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 RIHL 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).

A specification was prepared for the saw cutting and removal of the building slab and the basement (roof, walls, and floor) in FY 1997. This specification was issued for bids and a contractor was selected.

Figure 6-63. *Cleared Building 020 Floor Slab and Remaining Exhaust Stack Section.* [ETEC-8/6/96-394760]

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

6.11 PLANNED FUTURE ACTIVITIES

Completion of the D&D and excavation of the facility is planned for FY 1997. Initial activities will include the continuation of radiological surveys and the removal of localized spots of contamination from the remaining concrete structure (floor slab and basement). This additional remediation will be performed to reduce contamination to a level where an outside contractor can be employed to saw-cut the basement roof, walls, and floor with minimal restrictions, and where the potential for the spread of contamination is minimal. A concrete sawing contractor will first cut the building slab (excluding the basement roof) into approximate 4-foot by 8-foot sections for later removal, and the remaining exhaust stack section will be removed. The basement will then be protected from water during the winter rainy season by a plastic sheeting over a sloped wooden frame to direct water away from, and avoid the generation of contaminated water from rain leakage through, the numerous basement penetrations. Pumps and holding drums will be used in the basement to collect and handle any water from small leaks in the cover. A surveillance program will be implemented until March 1997, when D&D operations will resume.

The facility asphalt yard and soil will be sampled in late March, and any localized contamination will be excavated and disposed of as contaminated waste. The building slab will be removed and transferred to a hold area for decontamination and release. The outside contractor selected at the end of FY 1996 for basement concrete removal will excavate the soil around the basement walls and then saw-cut and remove the basement roof, walls, and floor. Excavation of the soil will be monitored closely, and any contaminated soil will be segregated for packaging and disposal by Rocketdyne personnel. The concrete blocks will be moved to the on-site hold area and decontaminated.

The soil around Building 468 will also be sampled, and any contaminated soil will be excavated for disposal. The building's block structure will be demolished and the concrete blocks will be surveyed and disposed of as waste. Remaining structural steel from the facility will be surveyed, decontaminated and released where practical, and otherwise disposed of as radioactive waste. The facility's original leach field, which was never placed in operation, will be surveyed and sampled, and then excavated as required for the disposal of any contaminated soils.

Rocketdyne's Safety, Health, and Environmental Affairs' Radiation Protection personnel will conduct a final survey of the site, and any areas of residual soil contamination will be excavated for disposal. Documentation will be prepared for release of the site for unrestricted use, and an independent third party release survey will be requested by ORISE. A specification will be prepared for the backfill, compaction, regrading, and revegetation of the site to pre-construction conditions.

FY 1998 planned activities include the independent release survey by ORISE, the excavation of any areas for which the independent survey identifies trace contaminants, and the release of the site by ORISE for unrestricted use. Concurrence for release and the implementation of site restoration will then be obtained from the California DHS. A restoration contract will be issued and the site will be backfilled and replanted for return to its natural condition.

All concrete blocks and structural materials from the former RIHL remaining on site will be disposed of in FY 1998. Decontamination work on the concrete blocks will be completed, and the blocks will be recycled if possible and otherwise disposed of in a commercial landfill. Any other remaining contaminated material will be packaged and shipped to appropriate disposal sites. This report will then be revised to incorporate the completed FY 1997 and FY 1998 activities.

7.0 COST SUMMARY

7.1 OVERVIEW

The total cost of the RIHL D&D project at its completion is projected to be about \$23M. This is significantly higher than the original cost estimate of about \$13M. There are three main factors that contributed to this cost increase. They are: (1) changes in project direction and increases in project scope over the original plan; (2) changes in funding levels over the course of the project, which impacted D&D efficiency; and (3) an overly optimistic estimate for in-situ decontamination (drains, cells, and the HEPA system), which included an unverified original 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. 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.

Summary breakdowns of Rocketdyne labor costs and out-of-plant expenditures are presented below.

7.2 LABOR SUMMARY

A cost-accounting system was implemented at the beginning of the D&D project that tracked costs by specific elements. This provided an excellent mechanism for cost oversight and the monitoring of costs vs. projected budgets for specific tasks. Table 7-1 provides a summary of the actual man-hour expenditure through FY 1996, plus the projected manpower requirements for FY 1997. The information is provided by task account number, with the accounting series numbers assigned to the following general task areas:

10000s	Operational activities, including the physical D&D activities, RMHF waste management support operations, D&D plans and procedures, project management, and special tasks (FY 1991 DOE Tiger Team review and requirements imposed by the DOE-NTS disposal site criteria revisions)
20000s	Health physics support
30000s	Quality assurance
40000s	Program management, program administration, and procurement activities
50000s	Labor and costs associated with subcontracts
60000s	General support activities
70000s	Activities specific to ETEC Facilities
80000s	Environmental engineering and waste characterization

A review of Table 7-1 shows that the largest single expenditure, as expected, was for the D&D of the hot cells and decon rooms.

Table 7-1
RIHL D&D Manpower Summary

Account	Activity	Man Hours											Totals
		FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97*	
10001	Engineering Management	984	2484	2176	3677	3006	2734	2530	1847	1762	3566	878	25644
10002	Documentation	2959	7737	447	2427	608	1548	1623	1497	86	2498	1700	23130
10003	Crew Chiefs				2552	1722	1584	1375	244	169	1992	996	10634
10004	RMHF Operations		2228	3950	1988	1950	1817	1718	1155	1116	1440	720	18082
10006	Yard, Dock Asphalt				2235	1315	8	58	95	19	240	960	4930
10005/7/8	Attic				3419			96	7		320	480	4322
10009	Service Hall						617	22	118	383	1280		2420
10010	Support Drains				71			126	1		624	688	1510
10011	Offices and Change Room						24		4	83	672		783
10012/13	Operating Gallery and Mockup				201	580	1034	651	38	148	1920		4572
10015	Basement				39		59	860	270	248	1780	1960	5216
10016	Rooms 139, 141, Slave	601			1033	2439	54				1240		5367
10018	Cells and Decon Rooms	2742	20600	17655	17721	11047	9548	6685	2599	831	1632		91060
10019	Building Exhaust						108	2391	442	104	1712	480	5237
10020	Radioactive Drain Removal					9		4757	2509	12	560		7847
10023	Surplus Equipment				111	586	79	298	125	103	400		1702
10024	Mixed Waste Plan				268						976		1244
10025	Mixed Waste Sampling					1318	229	110	32	356	2656		4701
10026	DOE Tiger Team					3340							3340
10027	Review Team 2					1841							1841
10028/29	Indep. Cost Estimate Support						84						84
10030	Cell Steel Liner Removal						5893	536	6				6435
10031	Lead Recycle									48			48
10032	NTS Shipping Procedure						839	1685	329	231			3084
10033	Mixed Waste Operations							630			1984		2614
10034	Repackaging NTS Waste							89	583	2476			3148
10035	NTS Training							8		41			49
10036	RMHF Operations/NTS							38	322	204	992	220	1776
10038	Nevada State Questions									9			9
10039	DOE-OAK Tiger Team									10			10
20001	Health Physics (HP) Support	200	1191	1767	5049	5105	4518	3435	2672	2318	3984	1901	32140
20002	Instrument Calibration					1026	548	820	681	413	480	480	4448
20003	HP NTS Requirements							38	214	208			460
30001	Quality Assurance (QA)	162	608	360	530	489	1188	656	339	1346	317	77	6072
30002	QA Inspection						295	491	241		320	320	1667
30003	QA NTS Requirements							1033	1000	109			2142
30004	NTS Inspections							58	291				349
40000	Program Management	488	2075	1945	1338	1423	1212	761	1025	1140	1020	1020	13447
40001	Program Administration				726	427	461	345	406	247	240	240	3092
40002	Procurement Support					81	15		2				98
50000	Miscellaneous		3169	7079	52	38	39	202	41	3			10623
60001	Box Shop/Maintenance				48	13	29	105	68	53	83	83	482
60002	Photo							8	34	13	96	96	247
70003	Facilities						16	3	30				49
80001	Environmental Engineering							359	1155	179	1389	1389	4471
Totals:		8136	40092	35379	43485	38363	34580	34600	20422	14468	36413	14688	320626

* FY 1997 man hours are estimates.

7.3 COST SUMMARY

The overall costs associated with the RIHL D&D project are summarized in Table 7-2. They include the costs for labor, materials, subcontracts, equipment rental, waste disposal, and licensing fees. Approximate subcontract and outside service costs are listed in Table 7-3. They were small during the initial decontamination phases of the work, but increased significantly as the demolition of major systems and the facility structure took place in the later stages of facility dismantlement. The waste characterization and disposal cost listed in Table 7-3 is lower than the full cost of that activity, as the waste management function was transferred to other cost centers within ETEC during the later stages of work.

Table 7-2
RIHL D&D Cost Summary

Cost Element	Cost (\$000)											Totals (\$000)
	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97*	
Rocketdyne Labor	413	2,042	1,833	2,386	2,390	2,301	2,382	1,523	994	1,966		18,229
Materials & Subcontracts	0	173	346	205	262	292	509	160	121	1,127		3,196
Other	9	47	56	50	69	64	72	42	52	230		691
Totals:	422	2,262	2,235	2,642	2,720	2,656	2,964	1,725	1,167	3,323	1,048	23,164

* FY 1997 costs are estimates.

Table 7-3
Major Subcontract and Service Cost Summary

Subcontract or Service	Approximate Cost (\$000)
Decon Room Demolition	114
Hot Cells/Structure Demolition	549
Concrete Coring	113
Other Subcontracted Dismantlement Activities	118
Heavy Rigging & Trucking	54
Asbestos Abatement	48
Waste Characterization and Disposal	120
Waste Containers	323
Basement Demolition (estimate)	378

8.0 SUMMARY OF WASTE DISPOSAL FROM D&D OPERATIONS

Waste minimization was a primary objective throughout the RIHL 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 more hazardous classifications, volume compaction, and selective decontamination where cost-effective to release materials for recycle or unrestricted land burial. Examples are described in other sections of this report. Large objects in particular (concrete blocks, structural steel, etc.) were decontaminated where practical so that they could be recycled instead of costly disposal at radioactive waste disposal sites.

8.1 WASTE GENERATION SUMMARY

The total waste generated from the decontamination and demolition of the RIHL over the time period from FY 1988 through FY 1996 is summarized in Table 8-1. This encompasses the entire above-ground structure of the building and all equipment associated with its operation. It does not include the basement portion of the building or the outside yard areas (primarily asphalt and soil), for which D&D is scheduled to take place in FY 1997. Table 8-1 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.

Table 8-1
Waste Generation Summary for the RIHL

Waste Category	Distribution by Weight		Distribution by Volume	
	Weight (lb.)	Percentage	Volume (ft. ³)	Percentage
Low Level Waste (LLW)	2,030,779	23.27	41,262	44.86
Mixed Low Level Waste (MLLW)	44,700	0.51	1,460	1.59
Transuranic Waste (TRU)	458	0.01	2	0.00
Mixed Transuranic Waste	7,526	0.09	33	0.04
Contaminated Water	735,710	8.43	11,495	12.50
Hazardous Waste	10,286	0.12	124	0.13
Recycle Materials	527,876	6.05	2,195	2.39
Structural Steel	540,000	6.19	6,000	6.52
Concrete Blocks	4,260,000	48.81	20,500	22.29
Landfill Materials	570,240	6.53	8,910	9.69
Totals:	8,727,575	100.00	91,981	100.00

The waste categories associated with Table 8-1 are defined as follows:

- *Low Level Waste (LLW):* Generated LLW consisted primarily of radiologically contaminated building materials, such as concrete rubble, steel, plaster, metal slag from torch cutting, and D&D materials such as plastics and personnel protective equipment. The Building 020 roofing material is included in this category even though its asbestos content labels it as a mixed waste in California, because the planned disposal site is in state where asbestos-containing materials are not classed as hazardous.
- *Mixed Low Level Waste (MLLW):* Mixed hazardous wastes from the RIHL, defined as LLW materials that also contain materials regulated as hazardous, include lead-based paint chips, lead glass, and some of the ventilation system filter elements.
- *Transuranic (TRU) and Mixed Transuranic Wastes:* TRU-containing wastes from the RIHL consist of small amounts of nuclear material from the reprocessing of nuclear fuel elements during the active operating period of the facility. Most of the TRU waste was recovered from the glove boxes and the building's drain line system, the latter as accumulated debris from cell wash-downs over the years. The total TRU waste accumulation is about 19 Curies, which is a small fraction of the estimated 140,000 Curies of material processed at the facility.
- *Contaminated Water:* Some radiologically contaminated water was collected at the facility and transported to the RMHF for contaminant concentration by water evaporation. The source of this contaminated water was concrete sawing operations and the collection of rainwater that migrated into the building.
- *Hazardous Waste:* Hazardous wastes accumulated during the facility D&D consisted primarily of materials used during RIHL operations, including lubricating oils, acid rags, batteries, fluorescent light ballasts (containing PCBs), and some hazardous metals.
- *Recycle Materials:* The recycle materials included those materials and equipment that either have direct reusable value (manipulators, cell windows) or recyclable material value (lead, steel cell doors).
- *Structural Steel:* The structural steel building components (I-beams, roofing panels, steel plates) are listed separately and are in storage pending radiological surveys. Most of this material is expected to be recycled as scrap metal.
- *Concrete Blocks:* Approximately 180 large concrete blocks were generated by the dismantlement of the hot cells and decon rooms (plus 20 others that were size-reduced), and most have been decontaminated for free release. They are pending disposition for a recycle application or burial in a landfill.

- *Landfill Materials:* Those nonrecyclable materials from the D&D operations that were not radiologically contaminated, or were decontaminated, and did not contain hazardous materials were designated for burial in a sanitary landfill. They included such items as building materials, wall and ceiling plaster, and building fixtures.

8.2 RADIOACTIVE WASTE HANDLING AND DISPOSAL

All generated wastes that were either radioactively contaminated or suspected to contain radioactive contaminants were sent to the RMHF. Here they were analyzed, classified, and placed in storage pending final disposition. Most wastes were packaged directly into Department of Transportation-approved containers as they were generated at the RIHL site, following procedures that made them directly acceptable for burial. This minimized waste handling operations. Where necessary, repackaging for off-site transportation or burial was performed at the RMHF.

A lot follower ("Radioactive Waste Packaging Lot Follower") was prepared for each waste container (or large non-containerized 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 hazardous constituents. A "Waste Container Traveler" was used to document all container inspections and movements.

The total quantity of radioactive waste generated during the D&D activities through FY 1996 was approximately 35 Curies. The breakdown by category is summarized in Table 8-2, and represents approximately 580 storage/shipping containers of material. A best estimate of radioactive waste generation by fiscal year is provided by the records of material receipt at the RMHF. A cumulative plot is shown in Figure 8-1. The largest transfer of material, in FY 1994, was for the drain line debris collected from radioactive drain line removal in FY 1993 and 1994, and drain tank removal in FY 1994.

Table 8-2
Radioactive Waste Generated at the RIHL through FY 1996

Category	Quantity	Percentage
Low Level Waste	14.6 Ci	41.6 %
Mixed Low Level Waste	0.8 Ci	2.3 %
Transuranic Waste	0.5 Ci	1.5 %
Mixed Transuranic Waste	19.1 Ci	54.6 %
Totals:	35.0 Ci	100 %

Figure 8-1. Cumulative Activity Plot of Radioactive Waste Receipt at the RMHF.

Approximately 74% by volume of the RIHL wastes received at the RMHF was shipped off site for disposal by the end of FY 1996, with the breakdown by disposal site shown in Table 8-3. Those wastes do not include items held in storage for surveying and potential decontamination. Also, none of the TRU wastes, which represent the largest fraction of waste by activity, have been shipped off site. They remain in storage at the RIHL pending the availability of disposal options.

**Table 8-3
Radioactive Waste Disposal by Volume through FY 1996**

Disposal Site	Volume Percentage
Nevada Test Site (NTS)	61 %
Envirocare of Utah	11 %
Hanford	2 %
Pending Shipment (RMHF Storage)	26 %

9.0 LESSONS LEARNED

The decontamination and dismantlement of the RIHL 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 other organizations' planning and execution of D&D projects for hot cells and similar facilities.

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 RIHL project, a major change was implemented midway in the program that redirected the operations from facility decontamination and reuse to facility dismantlement and site revegetation. 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 FY 1996 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 RIHL 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 RIHL facility and proved to be of great value both in developing the D&D plan and performing the D&D operations themselves. 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 than 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 020 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 RIHL, the material holdup yards were repaved (two layers), surfaces were repainted, and Building 020 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 RIHL 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 RIHL 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.

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-gasketed 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 concrete blocks that resulted from the saw-cutting demolition of the hot cells and decon rooms 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. A recycle application may not be found for these blocks because of public perceptions, and the future recycling of other similar materials is expected to require a DOE complex-wide effort to overcome public concerns. However, the decontamination costs to prepare these blocks was justified by the cost savings that will be realized by their disposal in a commercial landfill instead of in a radioactive materials disposal site.

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 will be placed on the subcontractor to minimize or eliminate the generation of mixed wastes.

9.4 SPECIALTY CONTRACTORS

The RIHL 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 steel 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