LOCKHEED MARTIN

ORNL/ER-400

**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Final Deactivation Project Report
on the Source Development
Laboratory, Building 3029,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

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DEPARTMENT OF ENERGY

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Energy Systems Environmental Restoration Program

**Final Deactivation Project Report
on the Source Development
Laboratory, Building 3029,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

Date Issued—May 1997

Prepared for the
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Environmental Management Activities at the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
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PREFACE

This *Final Deactivation Project Report on the Source Development Laboratory, Building 3029, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (ORNL/ER-400) provides the Environmental Management and Enrichment Facilities program with the final report on the deactivation of the Source Development Laboratory, Building 3029. Although this element of work is not part of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), it was accomplished in accordance with the substantive requirements of the act. This work was performed under Work Breakdown Structure 1.6.6.2.10.02, Activity Data Sheet 6504IS, "Isotopes Facilities Deactivation Project."

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ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EM	DOE Office of Environmental Restoration and Waste Management
EM-40	DOE Office of Environmental Restoration
EM-60	DOE Nuclear Materials and Facility Stabilization Program
Energy Systems	Lockheed Martin Energy Systems, Inc.
ER	Environmental Restoration
FDPR	final deactivation project report
HEPA	high efficiency particulate air
HVAC	heating, ventilating and air-conditioning
IFDP	Isotopes Facilities Deactivation Project
LLLW	liquid low-level waste
MOA	Memorandum of Agreement
ORNL	Oak Ridge National Laboratory
S&M	surveillance and maintenance

DEFINITIONS

Term	Definition
Commitments	Tasks required to be accomplished to meet non-regulatory requirements. (site, stakeholders, etc.)
Deactivation	The process of placing a facility in a safe and stable condition to minimize the long-term cost of a surveillance and maintenance (S&M) program that is protective of workers, the public, and the environment until decommissioning is completed.
Decommissioning	Refers to the ultimate disposition of a facility. Also substitutes for previously used "D&D" (decontamination and decommissioning).
Decontamination	The removal or reduction of radioactive or hazardous contamination from facilities, equipment, or soils by washing, heating, chemical or electro-chemical action, mechanical cleaning, or other techniques to achieve a stated objective or end condition.
End Point	A detailed specification for the final deactivation condition of areas and hardware within a facility and related documentation. An individual milestone towards the deactivation and/or the decommissioning of a facility.
Stakeholder	Individuals and organizations (e.g., regulators, local municipalities, the public, etc.) who may be directly or indirectly impacted by activities associated with the Isotopes Facilities Deactivation Project (IFDP).
Turnover Package	A compilation of project related documents to be given to a post-deactivation organization.

EXECUTIVE SUMMARY

This report documents the condition of Building 3029 after completion of deactivation activities as outlined by the U.S. Department of Energy (DOE) Nuclear Materials and Facility Stabilization Program (EM-60) guidance documentation. The report outlines the activities conducted to place the facility in a safe and environmentally sound condition for transfer to the DOE Office of Environmental Restoration (EM-40).

A history and profile of Building 3029 prior to commencing deactivation activities and a profile of the building after completion of deactivation activities is provided. Turnover items, such as the Post-Deactivation Surveillance & Maintenance Plan, remaining hazardous materials, radiological controls, Safeguards and Security, quality assurance, facility operations, and supporting documentation provided in the EM-60 turnover package are discussed.

Building 3029 will require access to facilitate required surveillance and maintenance (S&M) activities to maintain the building safety envelope. Building 3029 was stabilized during deactivation so that when transferred to the EM-40 program, only a minimal S&M effort would be required to maintain the building safety envelope. Other than the minimal S&M activities, the building will be unoccupied and the exterior doors locked to prevent unauthorized access. The building will be entered only to perform the required S&M.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this report is to document the condition of Building 3029 after completion of deactivation activities as outlined by the DOE Nuclear Materials and Facility Stabilization Program (EM-60) guidance documentation. This report outlines the activities conducted to place the facility in a safe and environmentally sound condition for transfer to the DOE Office of Environmental Restoration (EM-40).

This report provides a history and profile of the facility prior to commencing deactivation activities and a profile of the building after completion of deactivation activities. Turnover items, such as the post-deactivation S&M plan, remaining hazardous materials, radiological controls, safeguards and security, quality assurance, facility operations, and supporting documentation provided in the EM-60 turnover package are discussed.

1.2 SCOPE

This report addresses the activities performed during deactivation associated with Building 3029 to place the facility in a safe and environmentally sound condition to await decommissioning, the status of the facility, and the activities required to maintain the facility following deactivation. Attachment 1, "Building 3029 Floor Plan," provides a floor plan of Building 3029 which illustrates the physical boundaries and scope of this final deactivation project report (FDPR). The scope of this FDPR is limited to Building 3029.

2. BACKGROUND

2.1 FACILITY DESCRIPTION

Building 3029 is located in the west-central area of Isotope Circle in the Oak Ridge National Laboratory (ORNL) Isotopes Area adjacent to the Stack 3039 area. The facility is a single story steel frame structure covered by corrugated aluminum siding containing a cell operating area and east and west wings. The building covers 3,000 ft² with a total volume of 33,000 ft³ of free space.

The operating area contains four manipulator-type cells and two laboratory hoods. The two laboratory hoods are equipped for use as gloveboxes and are used for preparing elemental $^{131}\text{I}_2$ and $\text{CH}_3^{131}\text{I}$. In addition to providing access to the rear of Cells 1, 2, and 3; the east wing contains a ^{60}Co storage and irradiation area known as the ^{60}Co garden and two small gloveboxes. The west wing provides access to the rear of Cell 4.

2.2 FACILITY HISTORY

Building 3029 was constructed in 1952 and originally contained a system of remotely operated barricades and a small manipulator cell (Cell 4). The facility was built as part of the isotopes program. Isotopes originally handled in the facility were ^{192}Ir processing and small ^{60}Co sources. Cell 1 was built in 1955–1956 to handle large quantities of ^{60}Co . Very little ^{60}Co source fabrication has been done since the late 1950s. Cell 3 was built in 1960–1962 for ^{137}Cs source fabrication. Cell 2 was built by enclosing the space between Cell 1 and Cell 3 and is used for waste handling and pass through between Cell 1 and Cell 3. Major operations in Building 3029 included ^{60}Co , ^{137}Cs , and ^{90}Sr source fabrication and ^{192}Ir processing.

3. FACILITY STATUS

3.1 PRE-DEACTIVATION FACILITY STATUS

Chapter 9, "Photographs," contains photographs of the building conditions prior to deactivation activities.

3.1.1 Hazards Analysis

Based on Hazard Screening, HS/3029/F/RT-06 Rev. 1, this facility was classified as "INDUSTRIAL," with no unacceptable, non-standard industrial hazards/actions/situations present in the facility.

3.1.2 Internal Spaces

3.1.2.1 Operating area

Two laboratory type hoods are located in the southwest corner of the operating area. These hoods were converted to operate as gloveboxes in the early 1980s and were used to process elemental iodine (^{131}I) and methyl iodine ($\text{CH}_3^{131}\text{I}$). Hot drains were provided in both laboratory hoods and were connected to the liquid low-level waste (LLLW) system. The drain to hood "B" leaked and allowed the spread of alpha contamination to the area below the hood. The laboratory hoods were continuously exhausted through a high-efficiency particulate air (HEPA) filter to the local building ventilation system. The effluent air was piped to the roof of the building where it was pulled by a roof fan through two roof mounted HEPA filters and then discharged from a short stack above the Building 3029 roof.

Pre-deactivation hazardous materials and waste located in these areas are listed in Table 1, "Building 3029 Pre-Deactivation Hazardous Materials and Waste."

3.1.2.2 East wing

Two gloveboxes are located in the northeast corner of the east wing. These gloveboxes were used to process ^{14}C and ^{99}Tc . The ^{14}C glovebox was highly contaminated due to process related activities. The ^{99}Tc glovebox is moderately contaminated due to process activities. The gloveboxes were continuously exhausted through a HEPA filter to the local building ventilation system. The effluent air was piped to the roof of the building where it was pulled by a roof fan through two roof mounted HEPA filters and then discharged from a short stack above the Building 3029 roof.

Pre-deactivation hazardous materials and waste located in these areas are listed in Table 1, "Building 3029 Pre-Deactivation Hazardous Materials and Waste."

3.1.2.3 West wing

The west wing provided access to the rear of Cell 4 and to the storage well in the floor of the west wing. No process activities occurred in the west wing.

Pre-deactivation hazardous materials and waste located in these areas are listed in Table 1, "Building 3029 Pre-Deactivation Hazardous Materials and Waste."

3.1.2.4 Cell 1

Prior to deactivation, Cell 1 contained various process items (e. g., cell tools and equipment) abandoned when the facility was no longer in use. Cell 1 was used as a clean cell during facility operations and was therefore not highly contaminated. Cell 1 hot drains were connected to the LLLW system. Cell 1 was equipped with exhaust ports covered by gasketed in-cell HEPA filters and roughing filters. The cell effluent air was piped to the roof of the building where it was pulled through a roof mounted HEPA filter and delivered into the isotopes area cell ventilation system and to the Stack 3039. Prior to deactivation, Cell 1 provided primary containment for radioactive material and was shielded by a mineral-oil-filled glass viewing window and 3 ft. thick barytes concrete walls lined with stainless steel.

Pre-deactivation hazardous materials and waste are listed in Table 1, "Building 3029 Pre-Deactivation Hazardous Materials and Waste."

3.1.2.5 Cell 2

Prior to deactivation, Cell 2 contained various process items (e.g., cell tools, bottles, beakers, and trash) abandoned when the facility was no longer in use. Cell 2 was used as a pass through cell during facility operations and is highly contaminated with radioactive material. Cell 2 hot drains were connected to the LLLW system. Cell 2 was equipped with exhaust ports covered by gasketed in-cell HEPA filters and roughing filters. The cell effluent air was piped to the roof of the building where it was pulled through a roof mounted HEPA filter and delivered into the isotopes area - ventilation system and to the Stack 3039.

Prior to deactivation, Cell 2 provided primary containment for radioactive material and was shielded by a mineral-oil-filled glass viewing window, a 3 ft. thick barytes concrete wall on the operator side, 1 ft. of steel on the cell access side, a stainless steel pan, and walls coated with a radiation resistant sealant. Cell 2 lighting and electrical services are in poor condition due to radiation damage.

Pre-deactivation hazardous materials and waste are listed in Table 1, "Building 3029 Pre Deactivation Hazardous Materials and Waste."

3.1.2.6 Cell 3

Prior to deactivation, Cell 3 contained various process items (e.g., cell tools and equipment) abandoned when the facility was no longer in use. Cell 3 was constructed primarily for ^{137}Cs source fabrication. In 1987-1988, during a cell clean-up project contaminated water in Cell 3 overflowed out the door and resulted in high contamination near the cell shield doors. Lead shielding and duct tape were applied to the exterior area of Cell 3 and Cell 2. Cell 3 was not used following the ^{137}Cs spill Cell 3 hot drains were connected to the LLLW system. Hot Cell 3 was equipped with exhaust ports covered by gasketed in-cell HEPA filters and roughing filters. The cell effluent air was piped to the roof of the building where it was pulled through a roof mounted HEPA filter and delivered into the isotopes area cell ventilation and to the Stack 3039. Prior to deactivation, Cell 3 provided primary containment for radioactive material and was shielded by a mineral-oil-filled glass viewing window and 3 ft. thick barytes concrete walls lined with stainless steel. Cell 3 lighting and electrical services are in poor condition due to radiation damage.

Pre-deactivation hazardous materials and waste are listed in Table 1, "Building 3029 Pre Deactivation Hazardous Materials and Waste."

3.1.2.7 Cell 4

Prior to deactivation, Cell 4 contained various process items (e.g., cell tools and equipment) abandoned when the facility was no longer in use. In addition, Cell 4 also contained approximately 300 cesium sources. Cell 4 was used as a transfer cell during facility operations and was therefore not highly contaminated. The Cell 4 hot drain was connected to the LLLW system.

Cell 4 was equipped with exhaust ports covered by a gasketed in-cell roughing filter. The cell effluent air was piped to the roof of the building where it was pulled through a roof mounted HEPA filter and then delivered into the isotopes area cell ventilation system and discharged from the Stack 3039. In addition Cell 4 was equipped with a low volume Process Off-Gas connection to mitigate potential hazards related to corrosive vapors and high concentrations of radioactive particles released during process operations. The process off-gas was filtered by a HEPA filter and then delivered into the isotopes area cell ventilation system. The effluent air from the cell was then scrubbed and HEPA filtered at the Stack 3039 prior to discharge. Prior to deactivation, Cell 4 provided primary containment for radioactive material and was shielded by a mineral-oil-filled glass viewing window and 2 ft. thick barytes concrete walls lined with stainless steel.

Pre-deactivation hazardous materials and waste are listed in Table 1, "Building 3029 Pre Deactivation Hazardous Materials and Waste."

3.1.2.8 Cobalt garden

The cobalt garden is located in the east wing of Building 3029 and was used for storage and irradiation. The facility is subterranean and is 6 ft square and 8.5 ft deep. The facility was capable of irradiation doses up to 1.5×10^6 rem/hr. The facility consisted of 92 stationary stainless steel tubes surrounding a 1 ft square 7 ft long irradiation plug. All of the tubes were covered with 22 inches of lead shot at the top. The cobalt garden plenum, into which the tubes project, was cooled by a stream of air which is discharged to the Process Off-Gas system. The effluent air from the cobalt garden was then scrubbed and HEPA filtered at the Stack 3039 prior to discharge.

Pre-deactivation hazardous materials and waste are listed in Table 1, "Building 3029 Pre Deactivation Hazardous Materials and Waste."

3.1.3 Building Structure and External Spaces

3.1.3.1 Building 3029 structure

The exterior of Building 3029 was inspected and found to be in generally good structural condition. The structure and exterior of Building 3029 provide secondary containment in conjunction with the roof.

3.1.3.2 Building 3029 roof

The roof of Building 3029 was inspected and found to be in generally good structural condition, with the exception of various small roof leaks. The roof of Building 3029 provides secondary containment in conjunction with structure and exterior of Building 3029.

3.1.4 Process, Utility, and Support Systems

3.1.4.1 Cell ventilation system

Prior to deactivation, the cell ventilation system provided exhaust ventilation services to the cells in Building 3029. The cell ventilation system for Building 3029 is filtered by both "in-cell" and external HEPA filters. Cell 2 was equipped with in-cell filters for filtering Cell 2 and Cell 3 prior to exiting the cells. Each cell exhaust stream is filtered by HEPA filters located on the roof of Building 3029 prior to being delivered to Stack 3039 for release to the atmosphere. The cell ventilation system was determined to be highly contaminated from the process activities performed prior to deactivation.

3.1.4.2 Process off-gas system

Prior to deactivation, the process off-gas system provided exhaust ventilation services to Cell 4 and the Cobalt Garden in Building 3029. The Building 3029 process off-gas effluent is delivered to Stack 3039 for release to the atmosphere. The process off-gas system is highly contaminated from the process activities performed prior to deactivation.

3.1.4.3 Local building ventilation system

Prior to deactivation, the local building ventilation system provided exhaust ventilation services to the laboratory hoods, gloveboxes, and general areas in Building 3029. The local building ventilation system for Building 3029 is filtered by external HEPA filters mounted on the roof of Building 3029 and discharged through a short stack located on the roof of Building 3029.

The local building ventilation system also provided for emergency containment during contamination conditions within the building. Exhaust ducts located at the southeast corner of the operating area and the southwest corner of the east wing were opened automatically by valves during containment. These two exhaust ducts lead to the local building ventilation system on the roof and removed contaminated air from the interior of the building. The local building ventilation system is highly contaminated from the process activities performed prior to deactivation.

3.1.4.4 Liquid low-level waste system

The LLLW provides a liquid drainage system to the cells and the laboratory hoods for wastes generated inside the cells. The LLLW system drains to Tank WC-10 in the ORNL Tank Farm. The LLLW system is highly contaminated from the process activities performed prior to deactivation.

3.1.4.5 Process drain system

Prior to deactivation, the process drain system provided a means of removing liquids from the operating area floors to ORNL Tank Farm. The process drain system was a gravity drain system. The process drain system is highly contaminated from the process and cleaning activities performed prior to deactivation.

3.1.4.6 Process water system

Prior to deactivation, the process water system provided make-up water and process water to the cells and laboratory hoods. The process water system is not believed to be contaminated.

3.1.4.7 Cell manipulators

Prior to deactivation, the cell manipulators provided a means of remote process operation within the cells. Model 8 and Model E manipulators are in use in the building cells. Cell 1 and Cell 4 are equipped with Model E manipulators, while Cell 2 and Cell 3 are equipped with Model 8 manipulators. Prior to deactivation, the cell manipulator boots and seals were determined to be in poor condition and a potential for the spread of contamination from the cells.

3.1.4.8 Electrical power system

Prior to deactivation, the electrical power system provide power and distribution for the 480 VAC electrical service to Building 3029. Typical electrical loads were lighting, pumps, compressors, welders, heaters, and exhaust fans. The electrical components in Cell 2 and Cell 3 are severely deteriorated from extended exposure to radiation fields.

3.1.4.9 Fire protection system

Prior to deactivation, the fire protection system provided a wet pipe fire suppression system for Building 3029. The operating area, east wing, and west wing were equipped with sprinkler heads and alarms as required by the local fire code. In addition, fire extinguishers were placed strategically in and around Building 3029. No fire protection was provided inside the cells or hoods. The fire protection system is not believed to be contaminated.

3.1.4.10 Building steam system

Prior to deactivation, the building steam system provided steam for use in heating the operating areas. Heat exchangers were located throughout Building 3029 to provide space heating for operating personnel. The building steam system is not believed to be contaminated. However, the majority of the steam piping within Building 3029 is lagged with asbestos insulation materials.

3.1.4.11 Building HVAC system

Prior to deactivation, the building heating, ventilating and air-conditioning (HVAC) system provided cooling and ventilation to the operating areas within Building 3029. Two HVAC units were located in the operating area and the east wing to provide cooling for operating personnel.

3.1.4.12 Potable water system

Prior to deactivation, the Potable Water System provided water to the Building 3029 safety showers and eye wash stations. The potable water system is not believed to be contaminated.

3.1.4.13 Natural gas system

The natural gas system to Building 3029 was never used. The system remained capped at the building from the time of its installation. The natural gas system is not believed to be contaminated.

3.1.4.14 Plant air system

Prior to deactivation, the plant air system provided 110 psig air to Building 3029. The plant air system was regulated and used for process activities and instrumentation throughout the facility. The plant air system is not believed to be contaminated.

3.1.5 Hazardous Materials and Waste

Table 1, "Building 3029 Pre-Deactivation Hazardous Materials and Waste," lists the hazardous materials and waste identified during facility walkdowns prior to deactivation:

Table 1. Building 3029 pre-deactivation hazardous materials and waste

Identification	Description	Quantity
Lead based paint	Used as wall covering throughout building.	indeterminate
Asbestos Floor Tiles	Used as floor covering throughout building.	approx. 8000 ft ²
Asbestos Lagging	Used as pipe lagging throughout building	indeterminate
PCBs	Electrical devices and transformers	indeterminate
Lead Shielding	Used in cell walls, doors and windows	indeterminate
Mineral Oil	Used in cell windows	indeterminate

3.2 POST-DEACTIVATION FACILITY STATUS

Chapter 9, "Photographs," contains photographs of the building conditions both before and following deactivation activities.

3.2.1 Deactivation End Point Completion

End point criteria for deactivation activities and end point completion documentation are not applicable for Building 3029. The requirement and guidance for these program elements were not developed prior to Building 3029 deactivation.

3.2.2 Hazards Analysis

A post-deactivation hazard screening has not been performed for this facility. However a hazard screening, reported in "Building 3029 Hazard Screening," (HS/3029/F/RT-06, Rev. 1), was performed during deactivation, at which time, the facility was assigned a hazard level classification of "INDUSTRIAL."

3.2.3 Internal Spaces

3.2.3.1 Operating area

The miscellaneous items abandoned when the facility was no longer in use have been removed from the operating area. No significant combustibles remain in the operating area. The operating area

of Building 3028 was decontaminated to remove transferable contamination from access-required spaces.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.2 East wing

Two gloveboxes are located in the northeast corner of the east wing. These gloveboxes were used to process ^{14}C and ^{99}Tc . The ^{14}C glovebox was highly contaminated due to process related activities. The ^{99}Tc glovebox is moderately contaminated due to process activities. The miscellaneous items abandoned when the facility was no longer in use have been removed from this area. No significant combustibles remain.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.3 West wing

The miscellaneous items abandoned when the facility was no longer in use have been removed from this area. No significant combustibles remain.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.4 Cell 1

The miscellaneous items abandoned when the facility was no longer in use have been removed from this cell. No significant combustibles remain.

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. The manipulator control arms are bagged as an added precaution. All service lines and systems have been deactivated and abandoned in place. Drains have been plugged.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.5 Cell 2

The miscellaneous items abandoned when the facility was no longer in use have been removed from this cell. No significant combustibles remain. The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. The manipulator control arms are bagged as an added precaution. All service lines and systems have been deactivated and abandoned in place. Drains have been plugged.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.6 Cell 3

The miscellaneous items abandoned when the facility was no longer in use have been removed from this cell. No significant combustibles remain. The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. The manipulator control arms are bagged as an added precaution. All service lines and systems have been deactivated and abandoned in place. Drains have been plugged.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.7 Cell 4

The miscellaneous items abandoned when the facility was no longer in use have been removed from this cell. No significant combustibles remain. The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. The manipulator control arms are bagged as an added precaution. All service lines and systems have been deactivated and abandoned in place. Drains have been plugged.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.3.8 Cobalt garden

All of the cobalt sources, with the exception of two, have been removed from the cobalt garden. The remaining sources could not be removed and have been abandoned in place. The tubes associated with the remaining sources have been capped at the top. The total curie content of the sources is less than 10 curies.

Post-deactivation radioactive contamination levels and radiation levels for this area are listed in Appendix D, "Post-Deactivation Radiological Surveys."

3.2.4 Building Structure and External Spaces

3.2.4.1 Building 3029 structure

The exterior of Building 3029 was inspected and found to be in generally good structural condition. The building exterior has been cocooned to eliminate air in-leakage and to provide an effective containment for the building.

3.2.4.2 Building 3029 roof

The roof of Building 3029 was inspected and found to be in generally good structural condition. The building exterior has been cocooned to eliminate air in-leakage and to provide an effective containment for the building.

3.2.5 Process, Utility, and Support Systems

3.2.5.1 Cell ventilation system

The cell ventilation system remains in operation to provide negative pressure contamination control for Cells 1 through 4. All controls and negative pressure relief valves associated with the cell ventilation system remain in operation as well.

3.2.5.2 Process Off-Gas System

The process off-gas system is valved off and has been taken out of service.

3.2.5.3 Local building ventilation system

The HVAC and building exhaust system has been isolated, de-energized, and abandoned in place.

3.2.5.4 Liquid low-level waste system

The LLLW system has been drained and abandoned in place. However, the system remains connected to the ORNL Tank Farm. Drains in individual cells have been plugged. The LLLW system remains highly contaminated from the process activities performed prior to deactivation.

3.2.5.5 Process drain system

The process drain system has been abandoned in place. However, the process drain system remains connected to the ORNL process waste system. The process drain system remains contaminated from the process and cleaning activities performed prior to deactivation.

3.2.5.6 Process water system

The process water system has been isolated, drained, and abandoned in place.

3.2.5.7 Cell manipulators

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. The manipulator control arms are bagged as an added precaution.

3.2.5.8 Electrical power system

All electrical services, with the exception of lighting, have been disconnected or de-energized at the main breaker box.

3.2.5.9 Fire protection system

The fire protection system will be drained and isolated from the fire main header. The fire protection system was converted from a wet pipe protection system to a dry pipe delivery system available for use if there is a fire in the building. Heat sensors have been installed throughout the building.

3.2.5.10 Building steam system

The building steam system has been isolated, drained, and abandoned in place.

3.2.5.11 Building HVAC system

The building HVAC system has been de-energized and abandoned in place.

3.2.5.12 Potable water system

The potable water system has been isolated, drained, and abandoned in place.

3.2.5.13 Natural gas system

The natural gas system has been isolated, vented, and abandoned in place.

3.2.5.14 Plant air system

The plant air system has been isolated, vented, and abandoned in place.

3.2.6 Hazardous Materials and Waste

Table 2, "Building 3029 Post-Deactivation Hazardous Materials and Waste," lists the hazardous materials and waste identified during facility walkdowns following deactivation:

Table 2. Building 3029 post-deactivation hazardous materials and waste

Identification	Description	Quantity
Lead based paint	Used as wall covering throughout building.	indeterminate
Asbestos Floor Tiles	Used as floor covering throughout building.	approx. 8000 ft ²
Asbestos Lagging	Used as pipe lagging throughout the building	indeterminate
PCBs	Electrical devices and transformers	indeterminate
Lead Shielding	Used in cell walls, doors and windows	indeterminate
Mineral Oil	Used in cell windows	indeterminate

4. BUILDING 3029 DEACTIVATION ACTIVITIES

The following section addresses the major activities performed during the deactivation of Building 3029. The objectives of the deactivation process were to place the facility in a passively safe and environmentally stable configuration which can be efficiently and cost effectively maintained for an indefinite period of time. The major deactivation issues, with regard to Building 3029, are listed below:

4.1 INTERNAL SPACES—ACCESS REQUIRED

4.1.1 Operating Area

All storage cabinets, desks, file cabinets and miscellaneous office materials were removed from the building. Some were green-tagged for reuse. The remaining items were size reduced as applicable and disposed. Asbestos was removed in accordance with safety work permits and plant and equipment asbestos removal procedures. The asbestos floor tiles were not removed and are not intended to be removed until facility decontamination and decommissioning (D&D).

Lead based paint exists throughout the building as wall covering. The areas which were peeling and flaking have been repaired, the remainder of the paint will remain as is. Paint condition is an inspection item in the S&M plan for Building 3029.

4.1.2 East Wing

All storage cabinets, desks, file cabinets and miscellaneous materials were removed from this area. All combustibles were removed from the area. The space was decontaminated to remove transferable contamination from the access required area. All systems and services to the area were de-energized, drained, vented, and isolated.

4.1.3 West Wing

All storage cabinets, desks, file cabinets and miscellaneous materials were removed from this area. All combustibles were removed from the area. The space was decontaminated to remove transferable contamination from the access required area. All systems and services to the area were de-energized, drained, vented, and isolated.

4.2 INTERNAL SPACES—NO ACCESS REQUIRED

4.2.1 Cell 1

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the master slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. All waste and loose equipment was removed, cut up, and downsized. The cell was wiped down to reduce airborne contamination. All cell service lines were identified, labeled, and plugged. All cell drains were plugged. Access to the cell was secured.

4.2.2 Cell 2

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the master slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. All waste and loose equipment was removed, cut up, and downsized. The cell was wiped down to reduce airborne contamination. All cell service lines were identified, labeled, and plugged. All cell drains were plugged. Access to the cell was secured.

4.2.3 Cell 3

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the master slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. All waste and loose equipment was removed, cut up, and downsized. The cell was wiped down to reduce airborne contamination. All cell service lines were identified, labeled, and plugged. All cell drains were plugged. Access to the cell was secured.

4.2.4 Cell 4

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the master slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. All waste and loose equipment was removed, cut up, and downsized. The cell was wiped down to reduce airborne contamination. All cell service lines were identified, labeled, and plugged. All cell drains were plugged. Access to the cell was secured.

4.2.5 Cobalt Garden

All of the cobalt sources, with the exception of two, have been removed from the Cobalt Garden. The remaining sources could not be removed and have been abandoned in place. The tubes associated with the remaining sources have been capped at the top.

4.3 EXTERNAL SPACES

4.3.1 Building 3029 Structure

The building structure was inspected and repaired, as necessary, to provide structural stability for the next 5 years. The building was sealed to provide an effective secondary containment boundary and to prevent animal intrusion to the interior during the post-deactivation S&M period.

4.3.2 Building 3029 Roof

The building roof was repaired and sealed, as necessary, to provide an effective secondary containment boundary and to minimize the amount of water in leakage during the post-deactivation S&M period.

4.4 OPERATIONAL SYSTEMS

4.4.1 Cell Ventilation System

The cell ventilation system remains in operation to provide negative pressure contamination control for the cells. All controls and negative pressure relief valves associated with the process off-gas system remain in operation as well. No decontamination of the cell ventilation system has been performed.

4.4.2 Electrical Power System

All electrical services that were not essential to the basic S&M operations were disconnected at the main breaker box.

4.4.3 Fire Protection System

The fire protection system has been drained and isolated from the fire main header. The fire protection system has been converted from a wet pipe protection system to a dry pipe delivery system available for use if there is a fire in the building. Heat sensors have been installed throughout the building.

4.5 MOTHBALLED SYSTEMS

No mothballed systems are associated with Building 3029.

4.6 ABANDONED SYSTEMS

4.6.1 Process Drain System

The process drain system has been plugged and isolated.

4.6.2 Process Off-Gas System

The process off-gas system has been valved off and abandoned.

4.6.3 Plant Air System

The plant air system has been drained and valved off.

4.6.4 Liquid Low-Level Waste System

No specific deactivation activities were performed for the LLLW System. No decontamination of the LLLW system has been performed.

4.6.5 Process Water System

The process water system has been drained and valved off.

4.6.6 Cell Manipulators

The cell manipulator boots and isolation bags were removed and replaced. New boots were placed on the slaves of the manipulators. The plastic boot and wiper which seals around the manipulator were removed. Decontamination was performed, as required, during manipulator boot replacement.

4.6.7 Building Steam System

The building steam system has been drained and valved off.

4.6.8 Local Building Ventilation System

The local building ventilation system has been de-energized and abandoned in place.

4.6.9 Potable Water System

The potable water system has been drained and valved off.

4.6.10 Natural Gas System

The natural gas system has been valved off and capped.

5. TRANSITION ACTIVITIES

Building 3029 will be officially transferred from the DOE Nuclear Materials and Facility Stabilization Program (EM-60) to the Office of Environmental Restoration (EM-40) by a Memorandum of Agreement (MOA). The building will be accepted "as is" by EM-40 at the time of transfer.

5.1 MEMORANDUM OF AGREEMENT

The MOA documents the requirements agreed upon between EM-40 and EM-60. The signed MOA indicates acceptance by EM-40 that the criteria outlined in the MOA have been completed satisfactorily, with the exception of post-transition punchlist items, and that the level of deactivation of the facility is acceptable for transition to the EM-40 program. Post-transition punchlist items will be finished after deactivation is complete using EM-60 funding. The details of how the punchlist items will be completed and documented are addressed in the MOA.

5.2 REQUIREMENTS AND COMMITMENTS

5.2.1 Regulatory Requirements

No regulatory requirements are associated with Building 3029.

5.2.2 Stakeholder Commitments

No stakeholder commitments are associated with Building 3029.

5.3 POST-TRANSITION ACTIVITIES

No post-transition punchlist items have been identified for Building 3029. All deactivation activities have been completed prior to transfer to EM-40.

6. POST-DEACTIVATION SURVEILLANCE AND MAINTENANCE

The "Post-Deactivation S&M Plan for Building 3029" covers S&M activities associated with the interior spaces, operational and mothballed systems, and external areas related to Building 3029. The specific objectives of the S&M program for Building 3029 are as follows:

Ensure adequate containment of contamination,

Provide physical safety and security control,

Maintain the facility in a manner that will minimize potential hazards to the public, and

Provide a mechanism for the identification and compliance with applicable environmental, safety, and health requirements.

The "Post-Deactivation S&M Plan for Building 3029" details the specific S&M items to be performed. The S&M activities associated with Building 3029 include the following types of activities:

Walkdowns and inspections for structural integrity, safety, radioactive contamination, and hazardous material conditions;

General housekeeping of the interior and exterior of the building as needed; and

Maintenance activities required to maintain the security and safety envelop of the facility.

7. ABNORMAL ACTIVITIES/CONDITIONS

No abnormal activities/conditions have been identified for Building 3029.

8. TURNOVER PACKAGE DOCUMENTATION

8.1 ADMINISTRATIVE TURNOVER PACKAGE

Administrative turnover consists of a collection of administrative documents. This includes procedures, agreements, permits, and other documents not directly related to the physical facility. The level of detail depends on the conditions, requirements, and agreements specific to the facility.

The Administrative Turnover Package Checklist in Appendix B, "Turnover Package Checklists" reflects the documents required for this facility with respect to administrative turnover. The following sections detail the contents of the applicable sections required for the facility.

8.1.1 Final Deactivation Project Report

A management summary of the facility deactivation completion, general status and conditions, demonstrating conformance with DOE's specification of the overall end point. It identifies management actions needed that are not routine. Unresolved issues are also described.

8.1.2 Deactivation Locks and Keys Log

The deactivation locks and keys log is a formal "deactivation lock system" for facility access, isolation of electrical components, chaining of valves, and other situations where physical access is to be controlled. The primary purpose of this system is to ensure control as the work force "backs out" of the facility as specified end points are achieved.

8.2 TECHNICAL TURNOVER PACKAGE

Technical turnover consists of a collection of technical documents that describe the facility, its equipment, and the conditions at the completion of all deactivation activities. The level of detail depends on the conditions, requirements, and agreements specific to the facility. The "Technical Turnover Package Checklist" in Appendix B, "Turnover Package Checklists," reflects the documents required for this facility with respect to technical turnover. The following sections detail the contents of the applicable sections required for the facility.

8.2.1 Facility Drawings

The facility drawing list is provided in Appendix C.

8.2.2 Radioactive Materials Inventory and Survey

The radioactive materials surveys provide an inventory with characterization information of radioactive and fissile materials remaining as contamination. The technical turnover package includes final radiological/hazardous materials survey records, final configuration and S&M requirements, available drawings, specifications, procedures, manuals, and unplanned occurrences records applicable to the facility.

8.3 SURVEILLANCE AND MAINTENANCE TURNOVER PACKAGE

S&M turnover consists of a collection of documents required to support post-deactivation S&M activities. The level of detail depends on the S&M specific to the facility. The "Surveillance and Maintenance Turnover Package Checklist" in Appendix B, "Turnover Package Checklists" reflects the documents required for this facility with respect to S&M turnover. The following sections detail the contents of the applicable sections required for the facility.

8.3.1 Post-Deactivation S&M Plan

This document describes the S&M plan for the facility after deactivation is complete, up to the initiation of decommissioning. The S&M activities will be integrated into the decommissioning work and phased out as decommissioning is completed.

8.3.2 Post-Deactivation S&M Procedures

Table 3, "Building 3029 S&M Procedures" contains a list of procedures required during the post-deactivation S&M period. These procedures outline the maintenance activities and special surveillances required to ensure that the facility conditions and safety envelop remain consistent until decommissioning can take place.

Table 3. Building 3029 S&M procedures

Number	Procedure title
IP-1108	Manipulator Removal, Repair, and Replacement
IP-1312, Rev. 2	Process Off-Gas System HEPA Filter Replacement
IP-1313, Rev. 2	Local and Central Ventilation System HEPA Filter Replacement

9. PHOTOGRAPHS

The following photographs show the pre-deactivation and post-deactivation condition of various areas of the Source Development Laboratory, Building 3029.

Fig. 1. Building 3029 Cells 2 and 3 in the operating gallery: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 2. Building 3029 Cell 4 and glovebox area in the operating gallery: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 3. Building 3029 ^{131}I gloveboxes: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 4. Area behind Cell 3 doors in the east wing: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 5. Building 3029 west wing access area: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 6. Building 3029 hot sink in west wing: (A) Pre-deactivation view; (B) Post-deactivation view.

Fig. 7. Building 3029 east wing access corridor: (A) Pre-deactivation view; (B) Post-deactivation view.

10. REFERENCES

- DOE (U.S. Department of Energy) 1995. *Decommissioning Resource Manual*, (DOE/EM-0246). August.
- Energy Systems (Lockheed Martin Energy Systems, Inc.) Draft. *Facility Deactivation End Points Handbook; Volume 1. Method and Examples*.
- Energy Systems (Lockheed Martin Energy Systems, Inc.) Draft. *Facility Deactivation End Points Handbook; Volume 2. Deactivation Practices*.
- Energy Systems (Lockheed Martin Energy Systems, Inc.) 1995. *Work Plan for the Isotopes Facilities Deactivation Project at Oak Ridge National Laboratory*, (ORNL/ER-249/R2). Environmental Restoration Program. August.
- Energy Systems (Martin Marietta Energy Systems, Inc.) 1994. *Local Emergency Manual, Isotope Area*, (Revision 94-1). Oak Ridge Natl. Lab. January.

APPENDIX A
BUILDING 3029 FLOOR PLAN

BUILDING 3029 FLOOR PLAN

FL3029

APPENDIX B

TURNOVER PACKAGE CHECKLISTS

**ADMINISTRATIVE
TURNOVER PACKAGE CHECKLIST**

Item Number	Document	Applicable ?
1	Final Deactivation Project Report	Yes
2	Emergency Response Plan	No
3	Safety Documentation (Category III or greater)	No
4	Regulatory Compliance Documentation	No
5	Interagency Agreements Documentation	No
6	Existing Permit Documentation	No
7	Corrective Action Documentation	No
8	Post-Deactivation Punchlist	No
9	Deactivation Locks and Keys Log	Yes

**TECHNICAL
TURNOVER PACKAGE CHECKLIST**

Item Number	Document	Applicable ?
1	End Point Determination Report	No
2	End Points Completion Report	No
3	End Point Technical Information	No
4	Deactivation Work Plans	No
5	Updated Facility Drawings (arrangement, PID, Loop, etc.)	Yes
6	"As Left" Photos of Spaces and Major Equipment	Yes
7	Hazardous Material Inventory and Survey	No
8	Safeguards and Security Documentation	No
9	Chemical Substance Inventory and Survey	No
10	Radioactive Materials Inventory and Survey	Yes
11	Facility Soil, Surface Water, & Groundwater Condition Report	No

SURVEILLANCE AND MAINTENANCE TURNOVER PACKAGE CHECKLIST

Item Number	Document	Applicable ?
1	Post-Deactivation Surveillance and Maintenance (S&M) Plan	Yes
2	Post-Deactivation S&M Updated Effluent Monitoring Plan	No
3	Post-Deactivation S&M Updated Safety Equipment List	No
4	Post-Deactivation S&M Procedures	Yes
5	Post-Deactivation S&M Recommendations	No
6	Mothballed Systems Lay-up and Restart Documentation	No

APPENDIX C

BUILDING 3029 DRAWING LIST

BUILDING 3029 DRAWING LIST

Document	Revision	Title
D-25428		Det. of Lead Glass Viewing Window
D-25429	001	Manipulator Sleeve Stainless Steel Liners
D-25430	001	Storage Safe Liner Plug Hoist Track Dets.
D-25431		Cell Access Doors Sect. Elevs. & Dets.
D-25432		Title Sht. & Dwg. Index
D-27124		Temporary Shielding Wall
D-27144	003	Plot Plan Det. Plan Elevation Sect. Det.
D-28150		Locality Map
D-28151	003	Site Topography Dets.
D-28152		Plot Plan Det. Plan Elevations Sect. Det
D-28153		Det. plan Elevations Sect. Det.
D-28192		Drainage Piping Plan, Det. & Sect.
D-28193		Air Piping For Hoist Plan, Det. & Sect.
D-28194		Serv. & Washdown Pipe, Plan, Sect. & Det.
D-28195		Exhaust Duct System Dets. & Sect.
D-28196		Exhaust System Dets.
D-28197		Hot Off-Gas Piping Plan & Sect.
D-28198	001	Power Plan Dets.
D-28199	002	Lighting Plan Profile
D-28265		Location Plan & Col Dets.
D-28266		Shelter at MKC & C060 Strg. Garden—Roof Framing Plan & Dets.
D-28955		Wheel Drive for Manip. Cell Assy.
D-28956		Wheel Drive F- Manip. Cell Det. Sht. 1
D-28957		Wheel Drive for Manip. Cell Det. Sht. 2
D-29059		Exh Duct Sys below Grade Plan & Sect.
D-29060		Drainage Piping below Grade Plan & Sect. & Det.
D-29061		Hot off Gas piping below Grade Plan & Sect.
D-29132		Manip. Cell Site Prep
D-29194		Air Hoist Plan & Det.
D-29244		Shelter Plan, Dets. & Elevs
D-29354		Lighting Plan & Sects.
D-29369	001	New 110V. Electrical System at Stack Area
D-29488		Manip Hoist Det. Sht 1
D-29489		Manip. Hoist Det. Sht. 2

Building 3029 Drawing List (continued)

Document	Revision	Title
D-29700		Manip. Hoist Trolley Det. Sht. 1
D-30607		Wrench Assy. Hrt. Fuel & BLKT Samp. Holders
D-30608		Wrench Assy. Hrt. Fuel & BLKT Samp. Holders
D-30752		HRT Fuel & BLKT Samp Hold Rush Rod Assy.
D-30755		Dets. for Hrt Fuel & BLKT Samp Hold Access Hole
D-30757		Hrt. Fuel & BLKT Samp Holder Carrier Support
D-30758		Hrt. Fuel & BLKT Samp Holder remote Assy. Fac. Arrgmt.
D-30971		Cell Piping in Attic plan Sect. & Det.
D-30972		Cell Hoist Piping
D-31185		Transfer Container Assy.
D-31186		Transfer Container Dets.
D-31472	001	Layout & Instl. for Bridge Crane
D-31829		LITR P32 can Carrier Bail
D-32480	002	Extended Shelter Plan Sect. Dets.
D-32642	001	Extended Shelter Electrical Plan Dets.
D-33588		Locality Map
D-34929		Uranium Carrier enclosed in Water Pot
D-34930		Cooling Wtr. Instl. & Dets.
D-34935		Wtr. Jacketed Carrier Dets. Sht. 1
D-34936		Final Purificatn. Equip. F3P Wtr. Jacketed Carrier Dets. Sht. 2
D-35320		Reactor Bldg. Pictorial Elevation
D-35322		Reactor Bldg. Plan & Sections Scheme II
D-35339		Dual Purpose Cell for Bldg. 3029 Plan & Det.
D-35787		Equip & Facilities FSP—Nitrogen Station Details
D-37903		Process Piping Plan, Sects. & Dets.
D-37905		Vent Hood over Sinks Plan, Elev. & Sect.
D-37920		Decontam. Cubicle Cell Vent
D-37983		Contam. for Explosive Release Plan
D-38000		Horiz. & Vert. Sects.
D-38001		SST Floor Pan Plan & Dets.
D-38002		Workbench & Shelves Plan & Dets.
D-38376		Decontam. Cubicle Elec Plan & Sect.
D-39260		Cooling Air Piping Plan & Sect.
D-39261	001	Cooling Air Piping Details Section General Notes
D-39763		Wiring Diag. & Dets.

Building 3029 Drawing List (continued)

Document	Revision	Title
D-44587		Conduct Plan & Sect.
D-50340		Encl. Assy.
D-50341		Encl. Dets. Sht. 1
D-50342		Encl. Dets. Sht. 2
D-50343		Encl. Dets. Sht. 2
D-54348		Bag Inserter Assy.
D-54349		Bag Inserter Assy.
D-54369		Bag Expander Det. & Assy.
D-5540		Misc Alt of Hot Lathe Sht. 3
D-5590		Misc Alt of Hot Lathe Sht. 2
D-5620		Machining Barricade Serv. Piping
D-5621		Machining Barricade Proc. Drainage
D-6625	A	Power, Comm. & Fire Alarm Plan
D-6625	004	Process Bldgs. E, F, Power, Comm. & Fire Alarm Plan
D-6627	A	Isotope Proc. Area Processing Bldg. 3 Htg. & Exh. Sys.
D-6627		Heating & Exhaust System
D-6636	A	Service Bldg. Power Layout
D-6636	001	Service Bldg. Power Layout
D-6644		E Bldg. Serv. Piping Plan, Sect. & Dets.
D-8415		Movable Manip. Assy. & Det.
D-9406		Cell Plans, Sects. & Elevs.
D-9407		2 Ft 6 in x 4 Ft Lead Door Dets.
D-9408		12 x 12 Lead Door & Sliding Pan
D-9409		ZN BR Window Dets.
D-9410		Top Cover & SS Flr. Dets.
D-9864		Strontium 90 Tong Assy. Dets.
E-16660		Proposed Hoist Equip. & Manip
E-29449		Manip. Hoist Trolley Assy.
E-31887		Manip. Hoist Assy.
E-31828		P32 Can Carrier Assy. & Dets.
E-39433	002	HVAC Control Dia.
E-39434	002	Elec. Plans, Sects., Det. Wiring Diagrams

 

APPENDIX D

POST-DEACTIVATION RADIOLOGICAL SURVEYS

ORNL Radiological Survey Data

Survey Number: 3047-97-0100

3047 Field Office

Date: 01/29/97

Time: 10:39

Surveyor Badge Number: 34657

☐ Routine Survey

RWP Number: 3047-97-0005A

Building: 3029

Specific Location: East Wing

Description:

Along with T. W. Davis completed the monthly transferable contamination survey of the east wing of building 3029. Used standing RWP # 3047-97-0005A to enter contamination area and complete the contamination survey.

Instruments Used and Calibration Due Date:

CTA-032 03/11/97

CTB-001 03/11/97

3047-01P 03/05/97

General Description of Radiological Conditions:

Twenty -Two smears were taken during this survey. Transferable contamination from 300 dpm beta-gamma to 35,000 dpm beta-gamma. (Please see survey map for smear locations).

Division or Group Needing the Survey: CT

Person-hours spent on the survey: 2

of Pages: 2

Completed By: *Chaim*Reviewed by: *J. Slota*

Date: 2-7-97

Smear Results (dpm/100 cm² unless noted)

Smear Number	α	β	Location	Smear Number	α	β	Location	Smear Number	α	β	Location
1	NC	<200	see map	2	NC	12,000	see map	3	NC	1500	see map
4	NC	25,000	see map	5	NC	12,000	see map	6	NC	8,000	see map
7	NC	4,000	see map	8	NC	3,500	see map	9	NC	500	see map
10	NC	370	see map	11	NC	<200	see map	12	NC	30,000	see map
13	NC	2,000	see map	14	NC	1,000	see map	15	NC	8,000	see map
16	NC	500	see map	17	NC	400	see map	18	NC	10,000	see map
19	NC	5,000	see map	20	NC	35,000	see map	21	NC	300	see map
22	NC	5,000	see map								

ORNL Radiological Survey Data

Survey Number: 3047-97-0100

3047 Field Office

Date: 01/29/97

Time: 10:39

Transferable Contamination Survey Completed on 01/29/97

#	- Smear Location	Boundary Designations	
#-#	- Large Area Smear	RA - Radiation Area	BA - Radiological Buffer Area
#	- Contact Dose Rate	HR - High Radiation Area	CA - Contamination Area
#	- 30 cm Dose Rate	VR - Very High Radiation Area	HC - High Contamination Area
#	- General Area Dose Rate	AR - Airborne Radioactivity Area	FC - Fixed Contamination Area
SOP	- Step-off Pad	RM - Radioactive Materials Area	SC - Soil Contamination Area
AS	- Air Sample Location	UM - Underground Radioactive Materials Area	

Default units are in mR/hr and are for open window beta/gamma readings. Letter suffixes with the number indicate specific radiations: B - Beta (mRad/hr), G - Gamma (mR/hr), N - Neutron (mRem/hr). Boundary designations are looking from the designations into the zoned area.

ORNL Radiological Survey Data

Survey Number: 3047-97-0095

3047 Field Office

Date: 1/29/97

Time: 9:00

Surveyor Badge Number: 626444

☐ Routine Survey

RWP Number: N/A

Building: 3029

Specific Location: Operating Area

Description:

Along with C. Grainger, conducted weekly transferable contamination and monthly radiation survey of the Operating Area in Building 3029.

Instruments Used and Calibration Due Date:

3047-01B	5/18/97	3047-15P	3/5/97	CTA-032	3/11/97	CTB-001	3/11/97
3047-02I	3/27/97						

General Description of Radiological Conditions:

No transferable contamination detected. Please see map for exact smear locations and dose rate information.

Division or Group Needing the Survey: CHEM TECH

Person-hours spent on the survey: 2.2

of Pages: 2 Completed By: Ferry Davis Reviewed by: O. Slats Date: 2-10-97**Smear Results (dpm/100 cm² unless noted)**

Smear Number	α	β	Location	Smear Number	α	β	Location	Smear Number	α	β	Location
1-7	ND/ASC	ND/GMT	See map	8-16	<20	<200	See map				

Time: 9:00

- Smear Location
- Large Area Smear
#	- Contact Dose Rate
#	- 30 cm Dose Rate
#	- General Area Dose Rate
SOP	- Step-off Pad
AS	- Air Sample Location

RA - Radiation Area	BA - Biological Area
HR - High Radiation Area	CA - Chemical Area
VR - Very High Radiation Area	HO - Home Office
AR - Airborne Radioactivity Area	FC - Food Chain
RM - Radioactive Materials Area	SC - Safety Committee
UM - Underground Radioactive Materials Area	

Boundary Designations

BA - Radiological Buffer Area
CA - Contamination Area
HC - High Contamination Area
FC - Fixed Contamination Area
SC - Soil Contamination Area

Default units are in mR/hr and are for open window beta/gamma readings. Letter suffixes with the number indicate specific radiations: B - Beta (mRad/hr), G - Gamma (mR/hr), N - Neutron (mRem/hr). Boundary designations are looking from the designations into the zoned area.

D-7

ORNL Radiological Survey Data

Survey Number: 3047-97-0094

3047 Field Office

Date: 1/29/97

Time: 7:30

Surveyor Badge Number: 626444

☐ Routine Survey

RWP Number: N/A

Building: 3047

Specific Location: West Air Lock

Description:

Conducted weekly transferable and monthly radiation surveys of the West Air Lock in Building 3029.

Instruments Used and Calibration Due Date:

3047-01B

5/18/97

3047-15P

3/5/97

CTA-032

3/11/97

CTB-001

3/11/97

General Description of Radiological Conditions:

No transferable contamination detected. Please see map for exact smear locations and dose rate information.

Division or Group Needing the Survey: CHEM TECH

Person-hours spent on the survey:

2

of Pages: 2

Completed By: *[Signature]*Reviewed by: *[Signature]*

Date: 2-10-97

Smear Results (dpm/100 cm² unless noted)

Smear Number	α	β	Location	Smear Number	α	β	Location	Smear Number	α	β	Location
1-5	ND/ASC	ND/GMT	See map	6-10	<20	<200	See map				

ORNL Radiological Survey Data

Survey Number: 3047-97-0094

3047 Field Office

Date: 1/29/97

Time: 7:30

- ① - Smear Location
- ①-① - Large Area Smear
- # - Contact Dose Rate
- # - 30 cm Dose Rate
- # - General Area Dose Rate
- SOP - Step-off Pad
- AS - Air Sample Location

- RA - Radiation Area
- HR - High Radiation Area
- VR - Very High Radiation Area
- AR - Airborne Radioactivity Area
- RM - Radioactive Materials Area
- UM - Underground Radioactive Materials Area

Boundary Designations

- BA - Radiological Buffer Area
- CA - Contamination Area
- HC - High Contamination Area
- FC - Fixed Contamination Area
- SC - Soil Contamination Area

Default units are in mR/hr and are for open window beta/gamma readings. Letter suffixes with the number indicate specific radiations: B - Beta (mRad/hr), G - Gamma (mR/hr), N - Neutron (mRem/hr). Boundary designations are looking from the designations into the zoned area.

ORNL Radiological Survey Data

Survey Number: 3047-96-0920

3047 Field Office

Date: 11/13/96

Time: 19:30

Surveyor Badge Number: 626444

☐ Routine Survey

RWP Number: 3047-96-0124A

Building: 3029

Specific Location: East Wing Area

Description:

Together with D. A. Craft, we performed a radiation and a contamination survey of the East Wing Area of building 3029.

Instruments Used and Calibration Due Date:

3047-061 01/11/97

3047-06P 11/19/96

CTA-032 03/11/97

CTB-001 03/11/97

General Description of Radiological Conditions:

The maximum transferable contamination detected was 45,000 dpm/100 cm² Beta-gamma. The first count factor was normal for the area.

Division or Group Needing the Survey: CHEM TECH

Person-hours spent on the survey:

4

of Pages: 3

Completed By: *Tom Davis*Reviewed by: *John Slatt*

Date: 12-3-96

Smear Results (dpm/100 cm² unless noted)

Smear Number	α	β	Location	Smear Number	α	β	Location	Smear Number	α	β	Location
1	<20	<200	See map	2	<20	1000	See map	3	<20	1500	See map
4	<20	8000	See map	5	<20	6000	See map	6	<20	7000	See map
7	<20	550	See map	8	<20	11000	See map	9	<20	4000	See map
10	<20	3000	See map	11	<20	300	See map	12	<20	1000	See map
13	<20	4500	See map	14	<20	1500	See map	15	<20	3000	See map
16	<20	8000	See map	17	<20	1000	See map	18	<20	6000	See map
19	<20	3000	See map	20	<20	240	See map	21	<20	680	See map
22	<20	1500	See map	23	<20	990	See map	24	<20	470	See map
25	<20	380	See map	26	<20	3000	See map	27	<20	1500	See map
28	<20	1500	See map	29	<20	1500	See map	30	<20	1500	See map
31	<20	1500	See map	32	<20	3000	See map	33	<20	15000	See map
34	<20	2000	See map	35	<20	3500	See map	36	<20	2500	See map
37	<20	2500	See map	38	<20	3000	See map	39	<20	4000	See map
40	<20	2500	See map	41	<20	16000	See map	42	<20	12000	See map
43	<20	6000	See map	44	<20	8000	See map	45	<20	6000	See map
46	<20	5000	See map	47	<20	3000	See map	48	<20	8000	See map
49	<20	4000	See map	50	<20	475	See map	51	<20	10000	See map
52	<20	560	See map	53	<20	520	See map	54	<20	1000	See map
55	<20	250	See map	56	<20	1000	See map	57	<20	400	See map
58	<20	<200	See map	59	<20	<200	See map	60	<20	18000	See map
61	<20	11000	See map	62	<20	4000	See map	63	<20	27000	See map
64	<20	14000	See map	65	<20	17000	See map	66	<20	5000	See map
67	<20	4000	See map	68	<20	38000	See map	69	<20	20000	See map
70	<20	7000	See map	71	<20	15000	See map	72	<20	6000	See map
73	<20	45000	See map	74	<20	8000	See map	75	<20	10000	See map
76	<20	3000	See map	77	<20	8000	See map	78	<20	1000	See map
79	<20	290	See map	80	<20	8000	See map				

Description 3029 East Wing Area

Sampler Number

Flow Rate (cfm)

1

Date/Time Start

11/13/96 16:30

Filter Efficiency

100.0%

Date/Time End

11/13/96 18:30

Date/Time Counted 11/14/96

Sample Time (min)

120.0

Alpha

Beta

Counter ID

CTA-032

CTB-001

Counter Efficiency

43.5%

11.3%

Background Counts

0

13

Bkgd Count Time (min)

5

5

Gross Sample Counts

427

352

AIR

SAMPLE

D-10

ORNL Radiological Survey Data

Survey Number: 3047-96-0920

3047 Field Office

Date: 11/13/96

Time: 19:30

Gross Sample Counts	427	352	
Sample Count Time (min)	1	1	
Sample DPM	981.6	3092.0	
Air Concentration (uCi/ml)	1.30E-10	4.10E-10	First Count Factor
Min. Det. Conc. (uCi/ml)	8.26E-13	1.00E-11	3.15

- ① - Smear Location
- ①-② - Large Area Smear
- # - Contact Dose Rate
- # - 30 cm Dose Rate
- # - General Area Dose Rate
- SOP - Step-off Pad

- RA - Radiation Area
- HR - High Radiation Area
- VR - Very High Radiation Area
- AR - Airborne Radioactivity Area
- RM - Radioactive Materials Area

Boundary Designations

- BA - Radiological Buffer Area
- CA - Contamination Area
- HC - High Contamination Area
- FC - Fixed Contamination Area
- SC - Soil Contamination Area

ORNL Radiological Survey Data

Survey Number: 3047-96-0920

3047 Field Office

Date: 11/13/96

Time: 19:30

AS - Air Sample Location

UM - Underground Radioactive Materials Area

Default units are in mR/hr and are for open window beta/gamma readings. Letter suffixes with the number indicate specific radiations: B - Beta (mRad/hr), G - Gamma (mR/hr), N - Neutron (mRem/hr). Boundary designations are looking from the designations into the zoned area.

ORNL Radiological Survey Data

Survey Number: 3047-96-0791

3047 Field Office

Date: 9/26/96

Time: 10:00

Surveyor Badge Number: 33947

☒ Routine Survey

RWP Number: 3047-96-0124 A

Building: 3029

Specific Location: Roof

Description:

Completed the routine semi-annual radiation survey of the 3029 Roof.

Instruments Used and Calibration Due Date:

3047-061 1/11/97

General Description of Radiological Conditions:

Average whole body dose rate 2.45 mR/hr.

Division or Group Needing the Survey:

CHEM TECH

Person-hours spent on the survey:

2

of Pages: 3

Completed By:

Reviewed by:

Date: 10-3-96

ORNL Radiological Survey Data

Survey Number: 3047-96-0791

3047 Field Office

Date: 9/26/96

Time: 10:00

North

#	- Smear Location
#—#	- Large Area Smear
#	- Contact Dose Rate
#	- 30 cm Dose Rate
#	- General Area Dose Rate
SOP	- Step-off Pad
AS	- Air Sample Location

Boundary Designations

RA - Radiation Area	BA - Radiological Buffer Area
HR - High Radiation Area	CA - Contamination Area
VR - Very High Radiation Area	HC - High Contamination Area
AR - Airborne Radioactivity Area	FC - Fixed Contamination Area
RM - Radioactive Materials Area	SC - Soil Contamination Area
UM - Underground Radioactive Materials Area	

Default units are in mR/hr and are for open window beta/gamma readings. Letter suffixes with the number indicate specific radiations: B - Beta (mRad/hr), G - Gamma (mR/hr), N - Neutron (mRem/hr). Boundary designations are looking from the designations into the zoned area.

RADIOLOGICAL WORK PERMIT SIGN-IN SHEET - EXPOSURE TRACKING

By my signature below I state that I have read, understand, and will comply with all requirements specified in the RWP indicated.

DATE
9-26-86

DRD
TOTAL

NAME <i>DAVID ALAN CRAFT</i>	BADGE NUMBER 33947	TIME IN 0937	TIME OUT 1000	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE <i>David Alan Craft</i>	RWP NUMBER 3047-96-0124A	DRD IN 0	DRD OUT 0	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME <i>T W DAVIS</i>	BADGE NUMBER 626444	TIME IN 0937	TIME OUT 1000	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE <i>T W Davis</i>	RWP NUMBER 3047-96-0124A	DRD IN 70	DRD OUT 72	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	
NAME	BADGE NUMBER	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	TIME IN	TIME OUT	DRD
SIGNATURE	RWP NUMBER	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT	DRD IN	DRD OUT

APPENDIX E

EXCERPTS FROM BUILDING 3029 HAZARD SCREENING

PHASE I SAFETY DOCUMENTATION
THE SOURCE DEVELOPMENT LABORATORY
BUILDING 3029

HAZARD SCREENING

APPROVAL

PHASE I SAFETY DOCUMENTATION

THE SOURCE DEVELOPMENT LABORATORY

BUILDING 3029

HAZARD SCREENING

Prepared by:

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 K. W. Haff date
 FSET Leader

R. S. Owens 1/11/95
 R. S. Owens date
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 R. E. Eversole date
 ORNL ER Program

Reviewed by:

David B. Renfro 1/19/95
 D. G. Renfro date
 ORNL Site Coordinator

M. W. Kohring 1/24/95
 M. W. Kohring date
 Installation Facility Safety Manager

Approved by:

D. E. Reichle 1.24.95
 D. E. Reichle date
 PSET Chairman

M. W. Kohring *date*
Installation Facility Safety Manager

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¹The pages in this appendix have been numbered according to appendix format. Please look for materials listed on this table of contents or in other appendix front matter by heading or section number.

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ACRONYMS AND ABBREVIATIONS

CFR	-	Code of Federal Regulations: specifically, the reference to 40 CFR 302, Appendix B; this reference cited by DOE-EM-STD-5502-94 (see below).
Ci	-	Curie(s)
CSET	-	Central Safety Evaluation Team
CSET-1,2	-	<u>The Safety Analysis Report Update Program: Overview and Phase I Implementation (Revision 2)</u> , Report No. ES/CSET-1/R2, August 1991; <u>The Safety Analysis Report Update Program: Hazard Screening Application Guide</u> , Report No. CSET-2, December 1990.
DOE-1027	-	DOE Standard, DOE-STD-1027-92, <u>Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports</u> , December 1992, US Department of Energy, Washington, D. C., 20585
FSET	-	Facility Safety Evaluation Team
HAZOP	-	hazard and operability
HP	-	Health Physics/Health Physicist
ORNL	-	The Oak Ridge National Laboratory
Rem	-	Roentgen-equivalent-man, a radiation dose measurement as applied to human beings
RP	-	radiation protection
S&M	-	surveillance and maintenance
SDL	-	Source Development Laboratory
SIH	-	standard industrial hazards
5480.11	-	DOE Order 5480.11, <u>Radiation Protection for Occupational Workers</u> , December 1988.
5502-94	-	DOE Limited Standard, DOE-EM-STD-5502-94, <u>Hazard Baseline Documentation</u> , August 1994.

3.3 HAZARD SOURCE INFORMATION

A legacy of the many programs and processes previously conducted in this facility since its construction remains primarily as residual surface contamination of cells and process equipment (vessels, piping, vent ducts, etc.). A list of substances and hazardous materials that may be located within the facility (Table 1) was developed from historical information based on facility inventory records for all isotopes facilities and from operational information for this specific facility. Quantities of the residual materials present have been estimated from the recent Health Physics (HP) surveys of the facility. (See Appendix A.) An inventory of the contamination, based on these estimates, is attached in Appendix B. [Table 1 was developed from the data presented in Appendices A and B.]

A review of Table 1 resulted in the determination that the only unusual hazard present in the facility is due to the small quantities of residual surface radioactive contamination currently present in the facility and in the ^{60}Co garden. The residue is not considered significant due to the small amount of material involved, the immobility of the fixed contaminants, the identification and isolation of the small amounts of transferable contamination remaining, and the normal lack of personnel access to and activity (i.e., operations) in these areas.

Table 1. Characteristics of residual contamination in SDL

Radioisotope(s)	Quantity (percent of Category 3 threshold)	Quantity (percent of 'Radiological' threshold)
^{60}Co	< 1; limited to the ^{60}Co Garden	~ 20; limited to the ^{60}Co Garden
^{90}Sr	< < 0.1 (equivalent); limited to four cells and describes all beta/gamma [No significant alpha present in SDL]	< 1.0 (equivalent); limited to four cells and describes all beta/gamma [No significant alpha present in SDL]

The amount of radioactive material remaining within the facility (as stated in the inventory) has been estimated based on the HP average smearable levels of alpha and beta-gamma in the facility (see the summary in Appendix A) over the entire free surface of the facility. Estimates of in-cell and ^{60}Co -garden activity are included with those outside of the cell areas to obtain an overall inventory value.

No significant hazards are attributed to the small quantities (less than the 29 CFR 1910.1000 laboratory quantities) of chemicals currently used in the facility.

Facility utilities include plant air (less than the screening criterion of 3,000 psig), steam for heating (less than the screening criteria of 3,000 psig and 250°C), and electrical power (less than the screening criterion of 600 V); thus, these are equivalent to any utilities found on any industrial site. No fans or pumps are unique; these are equivalent to those found in any industrial area. All utility and equipment hazards have been classified as SIHs; and, therefore, no significant hazards are attributed to these items.

4. HAZARD SCREENING

All hazard screening has been developed using two reports for guidance. Those references are: The Safety Analysis Report Update Program: Overview and Phase I Implementation (Revision 2), Report No. ES/CSET-1/R2, August 1991; and The Safety Analysis Report Update Program: Hazard Screening Application Guide, Report No. CSET-2, December 1990 [hereafter referred to as CSET-1,2]. All information and data utilized for this screening have come from facility operators and management and the existing documentation for the facility.

In addition, DOE-1027, 5502-94, and 5480.11 have been utilized for inventory estimation and facility categorization. Since the inventory estimation is the basis for categorization, no accident analysis has been made for this facility.

4.1 HAZARD IDENTIFICATION

4.1.1 Preliminary Hazard Identification Matrix

The completed Preliminary Hazard Identification Matrix can be found in Appendix C. Residual surface radioactive contamination is the only non-industrial hazard identified; all other (non-radioactive) materials/hazards were evaluated and can be classified as Standard Industrial Hazards (SIHs). Examples of these SIHs are small quantities of acids, hydraulic fluids, and other chemicals; vacuum pumps; utilities; and instrumentation.

4.1.2 Preliminary Hazards Analysis Worksheet

The completed Preliminary Hazards Analysis Worksheet will be found in Appendix D. The major hazard is radioactive contamination and can lead to only one significant consequence, which is local exposure of facility personnel to radiation.

4.2 INITIATING EVENT IDENTIFICATION AND SELECTION

No HAZOP (Hazard and Operability) Worksheet was completed for SDL. Functionally, the hazards and consequences can be developed from the past documentation. Only natural phenomena are considered credible as an accident source. Fire is not considered credible due to the lack of combustible materials. Chemical and mechanical initiation of an accident is not credible since all operations are shut down. No accident analysis has been made for SDL.

4.3 SCENARIO DEVELOPMENT

The Hazard Classification Input Form was not developed for SDL. No accident analysis has been made for SDL.

4.4 CONSEQUENCE DETERMINATION

No evaluations were made for the Phase I report since categorization has been completed utilizing DOE-1027, 5502-94, and 5480.11. No significant release of radioactive material from the facility is possible.

4.5 INITIAL HAZARD CLASSIFICATION

Using the DOE-1027, 5502-94, and 5480.11 guidelines, the SDL Complex should be considered INDUSTRIAL. There is no potential for other than negligible impact to any individual on-site or off-site.

No radiological or industrial regulatory limits, as defined in DOE-1027 and 5480.11, are exceeded within this facility. No release fractions or release quantities, as referenced to 40 CFR 302, Appendix B by 5502-94, are exceeded. This is the determining basis for facility classification.

5. SAFETY DOCUMENTATION REQUIREMENTS

No further hazards evaluation is planned for this facility. All source and past operational information for the building is currently well documented. No radioactive material storage will be permitted within the facility complex in the future. No operations, other than S&M and decontamination activities, will be permitted.

6. MATERIALS AND HAZARDS THAT COULD AFFECT OTHER FACILITIES

There are no accident consequences that could affect adjacent facilities. No adjacent facilities would be expected to impact SDL.

APPENDIX A

SUPPORTING HEALTH PHYSICS SURVEY INFORMATION

Supporting Health Physics Survey Data*September, October, and November 1994 (and some earlier) Reports*A.1. REMAINING INVENTORY

No inventory as 'discrete' or 'individual' items remains within SDL (Building 3029). No single sources of radioactive material, including waste, are left in the facility. The only 'inventory' remaining is fixed and transferable surface contamination (radioactive material).

A.2. CONTAMINATION LEVELS

Overall contamination levels within SDL have been determined and are updated with new surveys at least once a quarter except for the hot cells. Smears give the levels of transferable surface radioactive material, and radiation surveys give the levels of transferable plus fixed surface radioactive material as a total. Smears generally are reported as disintegration count rates that are easily converted into Curies (Ci) of radioactive material. Radiation surveys are normally reported as dose rates that are easily converted into Roentgen-equivalent-man (Rem) of radiation dose to humans. No quantitative identification by isotope of either type of surface material contamination (fixed or transferable) is feasible. [See Fig. A-1 for those areas considered to be contaminated.]

The hot-cell interiors have very high radiation levels and pose a great potential hazard for exposure and contamination of individuals if they enter the hot cells or stand before the opened entries. As a result, attempts to obtain quantitative and representative information on contamination levels and resulting inventories in the hot cells is difficult even with the utilization of manipulators since the smears must be transferred out of the hot cells to personnel. Smears from the same area could differ by a factor of five to seven (or more), and the resulting inventory calculations could differ by an order of magnitude or more. Smears from a hot cell can be so contaminated with radioactive material that only a dose rate can be determined from them: they cannot be counted if too hot.

Total Radiation Levels. Fixed and transferable contamination, as a total, give radiation survey levels that remain relatively constant over time if no decontamination work is done within the facility. There is little variance in the results for the overall facility or in any specific area with time although some areas may be more contaminated with radioactive material than others. The 5480.11 limit of radiation level for a 'radiologically acceptable' facility is ≤ 5 mRem (milli-Roentgen-equivalent-man, a radiation dose equivalent defined for determination of radiation effect on human beings) per hour at a distance of 30 cm from the surface (referred to as mRem/hr @ 30 cm) (and if transferable and fixed contamination levels are below 5480.11 limits and inventory levels are below the Category 3 limits); otherwise, the facility is defined as 'radiologically contaminated'.

The results by area in SDL for radiation levels (fixed plus transferable contamination) are as follows:

Main floor; west air lock --	all < 1.0 mRem/hr @ 30 cm
Cell charging area (including ^{60}Co Garden) --	up to 20 (excluding the exterior face of the hot cells) mRem/hr @ 30 cm
Cell operating area --	≤ 1.0 mRem/hr @ 30 cm
Exterior face of Cell # 3 --	up to 120 mRem/hr @ 30 cm
Roof --	up to 25 mRem/hr @ 30 cm
Cell # 1 --	≤ 180 mRem/hr @ 30 cm
Cell # 2 --	unknown; assumed to be about the same as the other cells
Cell # 3 --	≤ 400 mRem/hr @ 30 cm
Cell # 4 --	unknown; assumed to be about the same as the other cells [a lower reading would be expected due to significantly lower smear results]

CRNL DWG 90-801

Contaminated areas (defined on figure as):

- Cell 1
- Cell 2
- Cell 3
- Cell 4

West air lock (designated WAL on diagram), cell charging area (CCA, including ⁶⁰Co Garden); and cell operating area (COA)

Fig. A-1. Contaminated Areas of SDL

Table A-1. Summary of facility contamination estimate for SDL

Estimated background	Comments
Smear Results (transferable, dpm/100 cm ²)	
< 20 alpha	Everywhere except the hot cells (high levels of beta/gamma mask the alpha, which must be very low)
< 200 to 230 beta/gamma	West air lock
< 200 to 2,600 beta/gamma	Cell charging area (including the ⁶⁰ Co Garden)
< 200 beta/gamma	Cell operating area
< 200 to 1,150 beta/gamma	Face of Cell # 3
< 200 beta/gamma	Roof
average of ~ 50,000 beta/gamma	Cell # 1 (smears are from inside the hot cell)
unknown	Cell # 2
unknown	Cell # 3
average of ~ 7,500 beta/gamma	Cell # 4 (smears are from inside the hot cell)
Radiation Levels (all contamination present)	
< 1.0 mRem/hr @ 30 cm	West air lock
~ 120 mRem/hr @ 30 cm (maximum)	Cell charging area (including the ⁶⁰ Co Garden and external face of hot cells)
<= 1.0 mRem/hr @ 30 cm	Cell operating area
~ 25 mRem/hr @ 30 cm (maximum)	Roof
<= 180 (average of ~ 75) mRem/hr @ 30 cm	Cell # 1
unknown	Cell # 2
<= 400 (average of ~ 50) mRem/hr @ 30 cm	Cell # 3
unknown	Cell # 4

[This information has been reviewed by another professional who is competent to perform the verification and was not directly involved in preparing any portion of this document including the specific calculations found within this subsection (4.4).]

Smear Results. Transferable contamination results, although relatively stable while no decontamination work is done in the facility, do tend to vary 'up and down', especially small, isolated, individual hot spots (a hot spot is defined as a small area that shows much greater contamination than the surrounding areas). The variances are due to such uncontrollable variables as how 'hard' a person presses when obtaining a smear, the adherence of the contamination to the surface, how closely the smeared area corresponds to exactly 100 cm² (more or less), uneven distribution of the contamination over the surface, etc. It is not unreasonable to expect significant variations in areas of greater contamination. However, when an entire area shows little or no significant transferable contamination, that is a reliable indication that the area can be accurately called 'clean' (per the 5480.11 guidelines). The 5480.11 limits for transferable contamination have been given for a 'radiologically acceptable' facility as ≤ 20 dpm/100 cm² for unidentified isotopes emitting alpha (worst case) and ≤ 200 dpm/100 cm² for unidentified isotopes emitting beta/gamma (worst case) (and if radiation levels are below the 5480.11 limits and inventory levels are below the Category 3 limits). [The term dpm/100 cm² is disintegrations per minute per 100 square centimeters of surface area.] [The respective limits for fixed plus transferable contamination are 300 dpm/100 cm² and 1,000 dpm/100 cm² (for alpha and beta/gamma). The facility levels of fixed and transferable as total contamination (for comparison with the 5480.11 limits) are not available from the HP reports.] If the facility levels are greater than these limits, the facility is classified as 'radiologically contaminated'. Results for SDL are as follows (transferable contamination only):

Entire facility --	alpha - all < 20 dpm/100 cm ² (beta/gamma masks the alpha in the first three hot cells, which is probably low)
Main floor; west air lock --	beta/gamma - all < 200 (except one = 230) dpm/100 cm ²
Cell charging area (including ⁶⁰ Co Garden) --	beta/gamma - < 200 to 2,600 (7 hot spots) with average ~ 400 if < 200 counted as 200) dpm/100 cm ²
Cell operating area --	beta/gamma - all < 200 dpm/100 cm ²
Exterior face of Cell # 3 --	beta/gamma - < 200 to 1,150 dpm/100 cm ²
Roof --	beta/gamma - all < 200 dpm/100 cm ²
Cell 1 --	beta/gamma - all $\leq 160,000$ dpm/100 cm ² ; average of all readings $\sim 50,000$ dpm/100 cm ²
Cell 2 --	beta/gamma - unknown; assumed to be about five (could be fifty; but there is no basis for a higher value) times Cell # 1 due to external radiation readings
Cell 3 --	beta/gamma - unmeasured; probably about the same as Cell 2 (based on external and internal radiation reading comparisons)
Cell 4 --	beta/gamma - $< 50,000$ dpm/100 cm ² ; average of all readings $\sim 7,500$ dpm/100 cm ²

Individual Isotopes. Tentative identification of the individual isotopes present in the facility as residual surface radioactive contamination has been determined from the operational history of the facility and by gross spectrometry of a few of the most contaminated areas. [It is not feasible to identify the isotopes from all of the HP smears or contaminated areas due to the low levels of contamination generally found throughout the facility.] Most, if not all of the short-lived fission products have decayed away; ⁹⁰Sr and ¹³⁷Cs are the prominent remaining beta/gamma activities. Based on a worst case for beta/gamma activity, ⁹⁰Sr probably represents as descriptive a typical contaminant as can be found in SDL. Therefore, beta/gamma residual surface radioactive contamination is best represented by one category:

⁹⁰Sr; beta/gamma

There is no significant alpha contamination in any of the cells (beta/gamma masks the small amount there may be in the first three hot cells) or in the balance of the facility. Therefore, no alpha, based on the HP data, is included in the isotopic inventory listing for the residual surface radioactive contamination)

A.3. INVENTORY ESTIMATE

Balance of the Facility (Excluding the Hot Cells). The surface area of the first floor is about 300 m² [quoted as 3,000 ft²]. The height of the facility is about 3 m. Those areas that consistently show smears and radiation readings below the 5480.11 limits have been assumed to be clean (relatively uncontaminated). [This assumption is also considered prudent due to the much larger relative contribution from the contaminated areas that do not fit this criterion.] The area (assumed to be clean) is: the main floor exclusive of the cell operating areas. The cell areas are assumed to be contaminated with significant residual surface radioactive contamination (no alpha, but beta/gamma as indicated above). The entire surface area of SDL is about 800 m². A relatively low level of overall beta/gamma contamination could be assumed; but, as will be shown below, historical data indicate some very high levels of contamination in a few hot spots. These hot spots are especially important in the cell charging area. An average contamination level for beta/gamma was chosen to be 1,000 dpm/100 cm² as a single, conservative illustration of how little contamination is within the balance of the facility and how much more contamination is present in the hot cells. [A realistic overall level of contamination might be one-fourth or about 250 dpm/100 cm². This is the average of the readings ranging from < 200 (counted as 200) to 2,600 dpm/100 cm²] Utilizing the higher level of contamination, a balance of facility inventory was calculated to be:

Beta/gamma as ⁹⁰Sr -- < 40 μCi

[Note: this is microCuries.]

Hot Cell Estimate. Cell 1 is an area measuring about 1 m by 3 m (about 3 m² floor area and about 30 m² total surface area - walls, ceiling, and floor [the floor is expected to be the most contaminated, but for purposes of this document, the entire surface area is assumed to be equally contaminated]). Cells 2 and 3 have about the same dimensions. Cell 4 is an area of about 1 m by 1 m (about 1 m² floor area and about 15 m² total surface area). The ⁶⁰Co Garden (included here because of presumed greater internal contamination levels similar to the hot cells) is about the same floor area as Cell 4 (about 1 m²) and about one-third to one-half the overall surface area (5 to 10 m²).

With an average radiation level of 75 mRem/hr @ 30 cm in Cell 1 (average of six readings) and an average floor contamination level of approximately 50,000 dpm beta/gamma/100 cm², total contamination within Cell 1 is estimated to be about 65 μCi of beta/gamma. (NOTE: this is microCuries.) The second cell area has about five times the level of beta/gamma contamination and is estimated to contain about 350 μCi of beta/gamma. The third cell area has an average radiation level of 50 mRem/hr @ 30 cm and, when compared with Cell 1, probably contains an estimated 200 μCi of beta/gamma. Cell 4 has an average floor contamination level of 7,500 dpm/100 cm², and the total contamination within the cell is estimated to be about 5 μCi. The ⁶⁰Co Garden is estimated to have a remaining inventory of about 2 Ci specifically identified as ⁶⁰Co. The total hot-cell and ⁶⁰Co-Garden inventory is given as:

Beta/gamma as ⁹⁰Sr -- < 650 μCi [Note: this is microCuries.]
Beta/gamma as ⁶⁰Co -- ~ 2 Ci

Total Facility. The total facility contamination levels for alpha and beta/gamma are then estimated to be about:

Alpha -- 0 μCi (No alpha contamination present)
Beta/gamma -- < 700 μCi as ⁹⁰Sr [Note: this is microCuries.] and
~ 2 Ci as ⁶⁰Co

Category 3 and Radiological Threshold Limits. The Category 3 and Radiological Threshold Limits for ^{60}Co and ^{90}Sr were applied to the inventory and SDL has about the following equivalence to the limit:

Total facility = < 1 percent of Category 3 and ~ 20 percent of the Radiological Threshold Limits

A.4. HISTORICAL RESULTS FOR THE PAST TWO YEARS

Total Radiation Levels. By area, the following historical perspectives are available.

Main floor; west air lock --	all < 1.0 (< 6 when low-level radioactive waste is being packaged) mRem/hr @ 30 cm
Cell charging area (including ^{60}Co Garden) --	up to 160 (consistent on exterior face of hot cell) mRem/hr @ 30 cm
Cell operating area --	< = 3.0 mRem/hr @ 30 cm
Exterior face of Cell # 3 --	up to 160 mRem/hr @ 30 cm
Roof --	up to 25 mRem/hr @ 30 cm
Cell # 1 --	< = 180 mRem/hr @ 30 cm (only one survey)
Cell # 2 --	unknown; assumed to be about the same as the other cells
Cell # 3 --	< = 400 mRem/hr @ 30 cm (only one survey)
Cell # 4 --	unknown; <i>assumed to be</i> about the same as the other cells [might be expected to be lower due to significantly lower smear levels]

Smear Results. By area, the following historical perspective has been evaluated for the facility.

Entire facility --	alpha - all < 20 dpm/100 cm ² (beta/gamma masks the alpha, which is probably little)
Main floor; west air lock --	beta/gamma - all < 200 (except a few hot spots; all < 310) dpm/100 cm ²
Cell charging area (including ^{60}Co Garden) --	beta/gamma - < 200 to 76,000 (multiple hot spots that have been cleaned; new hot spots found) with average ~ 250 (over two-year historical two-year period if < 200 counted as 200) dpm/100 cm ²
Cell operating area --	beta/gamma - < 200 (except for a few hot spots up to 8,880) dpm/100 cm ²
Exterior face of Cell # 3 --	beta/gamma - < 200 to 1,150 dpm/100 cm ² (one survey only)
Roof --	beta/gamma - all < 200 dpm/100 cm ²
Cell 1 --	beta/gamma - all < = 160,000 dpm/100 cm ² ; average of all readings ~ 50,000 dpm/100 cm ² (one survey only)
Cell 2 --	beta/gamma - unknown; assumed to be about five times Cell # 1 due to external radiation readings
Cell 3 --	beta/gamma - unmeasured; probably about the same as Cell 3 (based on external and internal radiation reading comparisons)

Cell 4 --

beta/gamma - < 50,000 dpm/100 cm²; average of all readings ~ 7,500 dpm/100 cm² (one survey only)

Older data have not been averaged with newer data in determining surface-radioactive-material-contamination levels for several reasons. First, some hot spots, especially the worst ones outside the hot cells, have been cleaned and contamination levels reduced. Second, repetitive hot spot smears are not consistent. Third, the overwhelming surface area of the facility outside the hot cells has much less contamination than the hot spots would indicate.

A.5. HP REPORTS: DATA UTILIZED IN THIS REPORT

The latest reports were utilized for calculation and reporting purposes. The sources of data were from HP reports on file in the Building 3047 Field Office and are as follows:

Main floor; west air lock --	smears - 11/4/94; 10/19/94 radiation - 10/19/94 historical - 10/7; 9/30, 22, 9, 2; 8/25, 18, 12, 5; 7/26, 18, 15, 8; 6/28, 23, 17, 10, 3; 5/19; 4/29, 19, 15, 7; 3/25, 19, 11; 2/15/94
Cell charging area --	smears - 10/17/94; 9/29/94 radiation - 9/29/94 historical - 9/23, 12, 2; 8/29, 19, 15, 5; 7/29, 8; 6/13, 6; 5/19; 4/22, 18, 6; 3/21, 18, 12; 1/7/94; 12/1; 10/25; 9/24; 8/6; 7/1/93
Cell operating area --	smears - 9/30/94 radiation - 9/30/94 historical - 9/22, 9, 1; 8/26, 18, 12, 5; 7/21, 8; 6/28, 23, 17, 10; 5/31, 19; 4/29, 22, 15, 7; 3/31, 25, 18; 1/7/94; 8/10; 3/5/93; 12/29/92
Cell # 1 --	smears - 6/10/94 (from inside hot cell) radiation - none historical - none
Cell # 2 --	smears - none radiation - none historical - none
Cell # 3 --	smears - none radiation - 10/26, 19/88 historical - none
Cell # 4 --	smears - 2/14/94 (from inside hot cell) radiation - none historical - none
Roof --	smears - 12/8/93 radiation - 12/8/93 historical - none

A.6. RATIONALE FOR ASSUMPTIONS/CALCULATIONS

Isotope Identification. Except for a few alpha scintillation and gamma spectrometry measurements, no attempt at specific isotope identification is feasible. Therefore, no particulate (alpha, beta) energy has been determined; and no specific gamma-ray energy is available. As a result, no radiation measurements can be converted into equivalent decay/Ci contents.

Surface Contamination Levels: Entire Facility: Alpha. Alpha contamination is not extensive; none of significance has been found in the balance of the facility or in Hot Cell # 4. Levels in the remaining three hot cells would be masked by the high levels of beta/gamma; however, the alpha remaining in these three cells cannot be at a level of more 0.1 to 1 percent of the beta/gamma levels

(otherwise it would not be masked; thus, the alpha is $< < 1 \times 10^4$ dpm/100 cm²). The maximum alpha inventory can easily be estimated to be $< < 1$ mCi by:

total surface area in Cells 1, 2, and 3 is ~ 100 m²
 multiply by 1×10^4 dpm alpha/100 cm²
 $= 10^8$ dpm alpha in the facility
 converting to Ci by dividing by 60 s/min and 3.7×10^{10} dps/Ci
 $= 4.5 \times 10^{-6}$ Ci or ~ 45 μ Ci

Thus, the maximum possible surface contamination as alpha inventory is < 50 μ Ci ($< < 1$ mCi).

Surface Contamination Levels: Balance of Facility: Beta/Gamma. The beta/gamma contamination for the balance of the facility (excluding the hot cells) is low enough for most of the facility that it can be categorized as negligible (< 200 dpm/100 cm²). Even the few hot spots, such as in the west air lock (230 dpm/100 cm²) and on the exterior face of the hot cells in the cell operating area (1,150 dpm/100 cm²) are not significant in contribution to the facility inventory. This is well illustrated when the cell charging area contamination is averaged over the entire cell charging surface by adding all readings together (counting < 200 as 200 dpm/100 cm²) and dividing by the total number of readings. The result is an average surface contamination level of ~ 400 dpm/100 cm². If the rest of the balance of facility (including the roof) is considered clean (or averages < 50 dpm/100 cm²), then the overall balance-of-facility contamination level is ≤ 250 dpm/100 cm². With a total surface area of about 800 m², there is about 2×10^7 dpm beta/gamma in the balance of the facility. Converting to Ci yields a final value of ~ 8 μ Ci or < 10 μ Ci. If the 8,000 dpm/100 cm² hot spot predominated over the entire facility, the balance of facility beta/gamma inventory would still be only about 300 μ Ci.

Surface Contamination Levels: Hot Cells: Beta/Gamma. The smears from Cell # 1 were averaged for all readings and the final value is $\sim 50,000$ dpm/100 cm². The values for the Cell # 4 smears average to $\sim 7,500$ dpm/100 cm². The front window (exterior) sides of Cells 1, 2, and 3 seem to show the following maximum radiation levels, in mRem/hr, from a composite of the most recent surveys:

Overall:	Cell # 1 -- 0.1, general area; 6, contact at face; and 1 @ 30 cm from face
	Cell # 2 -- 0.1, general area; 5, contact at face; and 3 @ 30 cm from face
	Cell # 3 -- 0.3, general area; 14, contact at face; and 1 @ 30 cm from face

The best survey for direct comparison of all three cells in one set of readings comes from the report of 3/5/93 - this shows the greatest differences:

Cell # 1 --	0.12, general area; 2.0, contact at face; and 1.0 @ 30 cm from face
Cell # 2 --	0.13, general area; 5.0, contact at face; and 3.0 @ 30 cm from face
Cell # 3 --	0.20, general area; 8.0, contact at face; and 1.0 @ 30 cm from face

A conservative estimate for Cell # 2 is that the internal contamination levels are about five times those inside Cell # 1 (beta/gamma; overall it would appear to be equal or less than Cell # 1, but the maximum difference has been utilized for the worst case, realistic estimate). Thus, the higher (five times) estimate must be applied to Cell # 3 as well for consistency. A higher level, for example fifty times, could be assumed; but, there is no basis for a value greater than five times.

Residual Material: ^{60}Co Garden. The only information regarding residual material remaining in the ^{60}Co Garden is from HP estimates made after the source material had been removed from the garden. The estimates indicate about 2 Ci of material remaining as a contamination inventory. That value has been assumed and has been specifically identified as that isotope - ^{60}Co . No calculation or other supporting evidence is available.

Calculations: Accuracy and Precision. All calculations are to the nearest, single, significant digit. No estimates of accuracy or precision are possible. Based on the HP historical data, smear data maxima, for any given large surface area, may range over factors of from five to seven; but, the surface averages vary much less than a factor of two (usually by a factor of about 1.25 or less when the surveys cover the same area). Variability in radiation levels is low except in a location where radioactive waste material may be packaged and levels are compared when waste is present to after it has been removed. More historical data for an area enhance the confidence that an area is clean or, conversely, increase the confidence in the correctness of observed surface contamination levels.

APPENDIX B

NUCLEAR MATERIAL INVENTORY

(Residual Contamination Only)

Nuclear Material Inventory

in Curies
Sheet 1 of 1Facility Number: 3029Facility Name: SDL

The following isotopes have been determined as possible contributors to the residual surface contamination.

Table B-1. Nuclear Material Inventory

Isotope	Inventory (in Ci)	Cat 2 Threshold	Cat 3 Threshold	% of Cat 3 Threshold
Co-60	2.0 E +00	1.90 E +05	2.80 E +02	< 1.0 E +00
Sr-90	< 1.0 E -03	2.20 E +04	1.60 E +01	< 1.0 E -01

Isotope	Inventory (in Ci)	Radiological Level Threshold (in Ci)	% of Radiological Level Threshold
Co-60	2.0 E +00	1.0 E +01	2.0 E +01
Sr-90	< 1.0 E -03	1.0 E -01	< 1.0 E +00

For each Isotope, indicate the maximum amount that may be present within the facility in the foreseeable future (within 1 year of preparation of this report). Indicate on the worksheets the percentage of each quantity of the isotope compared to the highest threshold value. (This does not need to be performed for Category 1 facilities.) Indicate the highest category obtained (Cat 2, Cat 3, RAD, or IND) and the isotope summation in the spaces provided below.

IND Category~ 20 % of Next Higher Category

Note: All inventory as listed refers to residual contamination. No discrete, individual "items" or "units" of inventory remain within the facility.

APPENDIX C

PRELIMINARY HAZARD IDENTIFICATION MATRIX FORM

PRELIMINARY HAZARD IDENTIFICATION MATRIX

DATE: 11/94
FACILITY: SDL

HAZARD TYPE

Item No.	System/Subsystem Description	Special Nuclear Material	Radiation Sources	Toxic Corrosive/ Reactive Materials	Flammable Materials	Explosive/ Pyrophoric Materials	Electrical Energy	Thermal Energy	Kinetic Energy	Potential Energy	Other	Remarks
1a.	Hot cells and hoods/gloveboxes		✓	✓			✓					Contamination; most fixed (non-transferable), some isolated transferable
1b.	⁶⁰ Co garden		✓									Contamination; secured and considered non-dispersable
2.	Balance of facility		✓	✓			✓	✓	✓			Contamination; most fixed (non-transferable), some isolated transferable

APPENDIX D

PRELIMINARY HAZARDS ANALYSIS WORKSHEET FORM

PRELIMINARY HAZARDS ANALYSIS WORKSHEET

DATE: 11/94
FACILITY: SDL

Item No.	System/Subsystem Description	Hazard Type	Consequence	Initiating Event	Standard Industrial Hazard Y or N	Justification for Std. Ind. Hazard and Comments
1a.	Hot cells, gloveboxes/hoods	Radiation sources	Personnel exposures	Human error or natural phenomenon	N	Non-dispersable; isolated and secured from casual exposures
		Toxic, Corrosive/reactive materials	Personnel exposures to chemicals, burns, injury	Same	Y	All quantities less than 29 CFR 1910.1000 laboratory amounts
		Electrical energy	Shock, burns, physical injury	Same	Y	All sources <600 V
1b.	⁶⁰ Co garden	Radiation source	Personnel exposures	Human error or natural phenomenon	N	Non-dispersable; isolated and secured from casual exposures
2.	Balance of facility	Radiation sources	Personnel exposures	Human error or natural phenomenon	N	Non-dispersable; isolated and secured from casual exposures
		Toxic, Corrosive/Reactive materials	Personnel exposures to chemicals, burns, injury	Same	Y	All quantities less than 29 CFR 1910.1000 laboratory amounts
		Electrical energy	Shock, burns, physical injury	Same	Y	All sources <600 V
		Thermal energy	Burns, physical injury	Same	Y	No excessive temperature (steam)
		Kinetic energy	Physical injury	Same	Y	No unique equipment

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