Nevada
Environmental
Restoration
Project

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Streamlined Approach for
Environmental Restoration Plan
for
Corrective Action Unit 113:
Reactor Maintenance, Assembly,
And Disassembly Building
Nevada Test Site, Nevada

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Nevada Operations Office

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**STREAMLINED APPROACH FOR ENVIRONMENTAL
RESTORATION PLAN FOR CORRECTIVE ACTION
UNIT 113: REACTOR MAINTENANCE,
ASSEMBLY, AND DISASSEMBLY BUILDING
NEVADA TEST SITE, NEVADA**

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RESTORATION PLAN FOR CORRECTIVE
ACTION UNIT 113: REACTOR MAINTENANCE,
ASSEMBLY, AND DISASSEMBLY BUILDING
NEVADA TEST SITE, NEVADA**

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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos-Containing Material
ALLW	Asbestiform Low-Level Waste
BN	Bechtel Nevada
CA	Contamination Area
CAS	Corrective Action Site
CAU	Corrective Action Unit
CFR	Code of Federal Regulation
cm	Centimeter
cm ²	Square Centimeter
Co	Cobalt
COPC	Constituents of Potential Concern
Cs	Cesium
DCGL	Derived Concentration Guideline
D&D	Deactivation and Decommissioning
DOE	United States Department of Energy
dpm	Disintegrations per Minute
DQO	Data Quality Objective
E-MAD	Engine Maintenance, Assembly, and Disassembly Facility
ER	Environmental Restoration
ERD	Environmental Restoration Division
ES&H	Environment, Safety, and Health
FFACO	Federal Facilities Agreement and Consent Order
FMP	Field Management Plan
FR	Federal Register
ft	Foot/Feet
ft ²	Square Feet
g	Gram
HA	Hazard Assessment
HEPA	High Efficiency Particulate Air
HPGe	High Purity Germanium
hr	Hour
HVAC	Heating, Ventilation, and Air Conditioning
in	Inch
in ²	Square Inches
ISM	Integrated Safety Management
LLW	Low-Level Waste
m	Meter
m ²	Square Meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	Milli Curie

ACRONYMS AND ABBREVIATIONS (Cont.)

mrem	Milli Roentgen Equivalent Man
MSDS	Material Safety Data Sheet
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Protection Act
Nb	Niobium
NRC	U. S. Nuclear Regulatory Commission
NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site
NV	Nevada
PCB	Polychlorinated Biphenyls
pCi	Pico Curies
POC	Performance Objective for Certification on Nonradioactive Hazardous Waste
ppm	Parts per Million
Pu	Plutonium
Ra	Radium
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
REOP	Real Estate/Operations Permit
RMA	Radiological Material Area
R-MAD	Reactor Maintenance, Assembly, and Disassembly
RWP	Radiological Work Permit
SAFER	Streamlined Approach for Environmental Restoration
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
S&M	Surveillance and Maintenance
Sr	Strontium
SSHASP	Site-Specific Health and Safety Plan
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristic Leaching Protocol
Th	Thorium
TL	Technical Lead
TM	Task Manager
TPH	Total Petroleum Hydrocarbon
TSCA	Toxic Substances Control Act
U	Uranium
VOC	Volatile Organic Compound
WAC	Waste Acceptance Criteria
WMP	Waste Management Plan
XRF	X-Ray Fluorescence

ACRONYMS AND ABBREVIATIONS (Cont.)

YMP	Yucca Mountain Project
yr	Year

EXECUTIVE SUMMARY

The Area 25 Reactor Maintenance, Assembly, and Disassembly (R-MAD) Building has been identified within the Federal Facility Agreement and Consent Order (FFACO) as Corrective Action Unit (CAU) 113. Appendix III of the FFACO has identified CAU 113 to be closed in place under the Streamlined Approach for Environmental Restoration (SAFER) process. The R-MAD Building was identified in 1993 as a surplus facility and transferred into the U.S. Department of Energy, Nevada Operations Office (DOE/NV) Deactivation and Decommissioning (D&D) source group. Since 1993, the R-MAD Building has been maintained by the DOE/NV D&D Surveillance and Maintenance activity.

The R-MAD Building was constructed between 1958 and 1961 and was used to support the Nuclear Rocket Development Station (NRDS) program. The R-MAD Building was used to assemble and disassemble reactor rockets associated with the Nerva, Kiwi, and two Phoebus reactor series. The assembly high bays were used to load the reactor rockets on rail cars for transfer to the test facilities. After the tests were completed, the reactor rockets were transferred back to the R-MAD disassembly high bay hot cell. The reactor rocket was removed from the rail car and large scale disassembly activities performed. The reactor sections were transferred to the smaller postmortem hot cells for detailed inspection and dissection. The fuel associated with the reactor was removed and subsequently transferred to the Idaho National Engineering & Environmental Laboratory in 1975 for reprocessing.

The R-MAD Building was placed into long-term mothball status in 1970. Reactor assembly and disassembly operations were transferred to the Engine Maintenance, Assembly, and Disassembly (E-MAD) Building. Once operations were stopped in 1970, no scheduled maintenance was conducted on the facility. After the NRDS project was deactivated in 1973, extensive demarcation and decontamination activities were conducted. The post-decontamination radiological status of the R-MAD Building was summarized in a 1984 report commonly referred to as the "Miller Report."

This document contains all of the elements necessary for the closure in-place of the R-MAD Building. The goal of the SAFER Plan is to remove all of the regulated hazardous materials and accessible radiological contamination and free release the building. This is an interim stabilization action. When additional funding becomes available, some time in the future, the building will be demolished.

The closure in-place of CAU 113 will be accomplished by completing the following activities:

- Removal and proper disposal of accessible equipment, utilities (light fixtures and conduits, ventilation systems, sanitary fixtures), exposed piping, floor tile, ceiling tile, and lead glass windows.

- Characterization and remediation of radiologically impacted surfaces such as floors, walls, and ceilings.
- Characterization and stabilization of radiologically impacted inaccessible ventilation ducting and piping.
- Final radiological survey to determine free release status of the building.

The R-MAD decommissioning is scheduled to be completed by September 30, 2002. Since this is a multi-year project, activities will be conducted in stages. All attempts will be made to conduct work in a manner that minimizes the amount of mobilizing and demobilizing of equipment and personnel required to complete the decommissioning process.

1.0 INTRODUCTION

This Streamlined Approach for Environmental Restoration (SAFER) Plan addresses the action necessary for the closure in place of Corrective Action Unit (CAU) 113 Area 25 Reactor Maintenance, Assembly, and Disassembly Facility (R-MAD). CAU 113 is currently listed in Appendix III of the Federal Facility Agreement and Consent Order (FFACO) (NDEP, 1996). The CAU is located in Area 25 of the Nevada Test Site (NTS) and consists of Corrective Action Site (CAS) 25-04-01, R-MAD Facility (Figures 1-2).

This plan provides the methodology for closure in place of CAU 113. The site contains radiologically impacted and hazardous material. Based on preassessment field work, there is sufficient process knowledge to close in place CAU 113 using the SAFER process. At a future date when funding becomes available, the R-MAD Building (25-3110) will be demolished and inaccessible radiologic waste will be properly disposed in the Area 3 Radiological Waste Management Site (RWMS).

1.1 SAFER PROCESS

The SAFER process combines elements of the Data Quality Objectives (DQO) process and the observational approach to plan and conduct corrective actions. DQOs are used to identify the problem and define the type and quality of data needed to complete the investigation phase of the SAFER process. The observational approach provides a framework for managing uncertainty and planning decision making. The purpose of the investigation in the SAFER process is to verify the adequacy of existing information to implement the corrective action.

Use of the SAFER concept allows for technical decisions to be made based on incomplete, but sufficient information, and the experience of the decision maker. Any uncertainties are addressed by documented assumptions that are verified by sampling and analysis, data evaluation, and on-site observations as planned activities progress, and by contingency plans as necessary. The remediation and closure may proceed simultaneously with site characterization as sufficient data are gathered to confirm or disprove the assumptions made in selecting the closure method. If, at any time during the decommissioning process, new information is developed that indicates that the decommissioning method should be revised, the closure activities will be redirected to more appropriately protect human health and the environment.

Closure of CAU 113 will consist primarily of decontamination activities which will result in the removal of radiologically impacted and hazardous material from the R-MAD Building. The objective is to place the R-MAD Building in a safe condition (i.e., free release). The objective is to remove all accessible hazards from the building and to quantify and stabilize the remaining hazards in such a manner that they do not become an unacceptable risk to human health and the environment in the future. Based on a detailed review of historical documentation there is

FIGURE 1
LOCATION OF THE AREA 25 R-MAD FACILITY ON THE
NEVADA TEST SITE

FIGURE 2
LOCATION OF THE R-MAD BUILDING WITHIN THE R-MAD COMPOUND

sufficient process knowledge to develop this SAFER Plan. The Constituents of Potential Concern (COPC) have been determined and the locations of contamination identified.

1.2 SUMMARY OF PROPOSED CORRECTIVE ACTION

The closure in-place of CAU 113 will be accomplished by completing the following activities:

- Removal and proper disposal of accessible equipment, utilities (light fixtures and conduits, ventilation systems, sanitary fixtures), exposed piping, floor tile, ceiling tile, and lead glass windows.
- Characterization and remediation of radiologically impacted surfaces such as floors, walls, and ceilings.
- Characterization and stabilization of radiologically impacted inaccessible ventilation ducting and piping.
- Final radiological survey to determine free release status of the building.

1.3 HOLD/DECISION POINTS

During characterization and closure activities, certain conditions affecting the project schedule and budget may require decisions to be made prior to continuing work. The goal of the R-MAD decommissioning activity is to anticipate as many hold points as possible. By establishing specific alternative actions, work disruptions will be minimized. Key decommissioning activities have been analyzed and specific hold point schematics have been prepared and are provided in Appendix A. Hold point examples include:

- Equipment Removal
- Ventilation System Removal
- Piping System Removal
- Surface Decontamination

1.4 SAFER WORK PLAN CONTENTS

This SAFER Work Plan has been developed to support the proposed characterization and closure of CAU 113. The format of the plan is:

- Introduction (Section 1.0)
- Unit Description and Closure Objectives (Section 2.0)
- Field Activities (Section 3.0)
- Reports and Records Availability (Section 4.0)
- Investigation/Remediation Waste Management (Section 5.0)
- References (Section 6.0)
- Appendix A - Decommissioning Hold Points
- Appendix B - Nevada Test Site, Area 25 Radiological Survey and Cleanup Project 1974-1983 (Miller Report) (REECo, 1984)
- Appendix C - Gamma Spectroscopy Measurements R-MAD Rooftop Survey (BN, 2000a)
- Appendix D - Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site (Tinney & Wheeler, 1999)
- Appendix E - Waste Management Plan
- Appendix F - NDEP Comment Response
- Distribution List

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2.0 UNIT DESCRIPTION AND CLOSURE OBJECTIVES

2.1 HISTORY OF CAU 113

The main portion of the R-MAD Building (3110) was constructed in 1958. In 1961, a structural steel frame with aluminum siding and roof structure along with a two story concrete block structure were added. In addition to the office and assembly bay construction, two separate construction cycles resulted in the creation of the seven postmortem hot cells. The R-MAD Building was utilized during testing for Project Rover between 1959 and 1970 to assemble and remotely disassemble various reactors. A diagram of the R-MAD in it's current configuration is provide in Figures 3-6 .

2.1.1 History of Operation

The R-MAD facility was used to support Phase I and Phase II of the Rover Project. The majority of the reactors assembled and disassembled (after testing) at the R-MAD facility were of the Kiwi design. In addition to the Kiwi reactors, early Nerva reactors (used to design the Kiwi reactor) and two Phoebus reactors were assembled and disassembled (after testing).

Work flow through the R-MAD Building is described below:

- The reactor was assembled and loaded onto a railroad test car in either of the two, high assembly bays.
- The reactor was transported along the rail line to either Test Cell A or Test Cell C to conduct the reactor test.
- After the test, the reactor was returned to the R-MAD Building. The reactor was placed into the high bay hot cell for disassembly.
- Remote manipulators were used to remove the reactor from the railroad test car. The railroad test car would then be moved out of the hot cell and stored in a shielded area just south of the R-MAD compound.
- The high hot-cell mezzanine area was used for disassembly of the reactor core components and inspecting the fuel rods. This work was done remotely from the observation gallery. Operators controlled the manipulator arms by looking through a 1.8 meter (m) (6 foot [ft]) thick oil filled-lead glass window.

FIGURE 3
DETAILED R-MAD BASEMENT DIAGRAM

FIGURE 6
 DETAILED R-MAD THIRD FLOOR DIAGRAM

- The smaller components were passed through a hatch in the mezzanine floor to the postmortem cell access area. The individual components were then carried into specific postmortem cells for further work activities.
- Activities commonly conducted within the postmortem cells included: sawing, milling, visual inspections, photography, and radiography.
- Between reactor tests the hot cells were decontaminated. The standard technique used was to pressure wash the entire surface area of the cells. Any areas that still had elevated radiological readings were controlled by the application of several layers of paint.

The R-MAD Building was placed into long-term mothball status in 1970. Reactor assembly and disassembly operations were transferred to the Engine Maintenance, Assembly, and Disassembly (E-MAD) Building. Once operations were stopped in 1970, no scheduled maintenance was conducted on the facility. Extensive demarcation and decontamination activities were conducted after the Nuclear Rocket Development Station (NRDS) project was deactivated in 1973. The post-decontamination radiological status of the R-MAD Building was summarized in a 1984 report commonly referred to as the "Miller Report" (REECo, 1984). The R-MAD relevant portions of the Miller Report is provide in Appendix B.

After half of the R-MAD Building was released for occupancy in 1984, the building was used to support the MX Missile Project and storage/training for the Mine Rescue Service. Since January 1999, access to the R-MAD Building has been restricted through the NTS Deactivation & Decommissioning (D&D) Surveillance & Maintenance (S&M) activity.

2.2 SITE LOCATION AND DESCRIPTION

CAU 113, R-MAD, is located on F Road in Area 25 of the NTS (Figure 1). It is comprised of a single CAS, CAS 25-04-01, R-MAD Facility, and consists of the R-MAD Building (3110) (Figure 2).

The R-MAD Building consists of a basement, and four floors with approximately 80 rooms (Figures 3-6). The various room types include: offices, two assembly bays, a disassembly bay, disassembly bay mezzanine, control room, seven postmortem cells, a photography room, operating and viewing galleries, equipment and storage rooms, mechanical rooms, and restroom and shower facilities. Total floor space is estimated to be 4,550 square meters (m²) (49,000 square feet [ft²]).

SAFER activities planned for CAU 113 will result in the removal of radiologically impacted and hazardous material from the R-MAD Building. Specific activities include: the removal and proper disposal of accessible equipment, utilities (light fixtures and conduits, ventilation systems, sanitary fixtures), exposed piping, floor tile, ceiling tile, and lead glass windows.

Characterization and decontamination of radiologically impacted surfaces such as floors, walls, and ceilings will be conducted until unrestricted release criteria has been achieved. In addition, inaccessible ventilation ducting and piping will be characterized and residual radiological material stabilized in place.

2.3 PROCESS KNOWLEDGE

The NRDS program was extremely well documented. There are extensive reports and documentation that has been obtained and reviewed. In addition to the written documentation, a number of former employees have been interviewed regarding standard operational activities performed at the R-MAD Facility. This information has been evaluated and a conceptual model developed for the types and location of radiological and hazardous contamination present within the R-MAD Building.

2.3.1 Facility Conceptual Model

The radiological contamination is confined to the hot cell (Disassembly Bay and Postmortem Cells) and the gallery viewing area portion of the R-MAD Building. Approximately 10 to 40 percent of the surface area in this portion of the R-MAD Building is impacted by the radiological contamination. Within the hot cells, the concrete was sealed prior to starting nuclear activities. The majority of radiological contamination within the hot cells is contained in paint layers that were used to control removable radiological contamination. Radiological contamination in the gallery viewing areas are anticipated to be sporadic and of limited extent. Sampling and analysis has confirmed the presence of polychlorinated biphenyls (PCB) at various concentrations (from less than 1 part per million [ppm] to 260 ppm) in the paint used in the disassembly bay and postmortem cell area (Table 1). Applied dried paints are classified as PCB Bulk Waste under Title 40 Code of Federal Regulations (CFR) 761.50 (b) 7 (EPA, 1996d), will be disposed of in a on-site disposal facility without further treatment. The paint outside of the hot cells does not contain PCBs. Based on field screening using an X-ray fluorescence (XRF) portable detector and limited analysis (Table 1), no lead or chromium was used in the paints.

Heating, ventilation, and air conditioning (HVAC) systems were designed for both the "hot" and "cold" portions of the R-MAD Building. However, due to inadvertent radiological releases within the cell service area it is possible that radiological contamination could be present in the "cold" HVAC system. Preliminary instrument and swipe surveys of a limited portion of the "cold" side HVAC did not detect any radiological contamination (Table 2).

Waste drainage systems were designed for both the "hot" and "cold" portions of the R-MAD Building. It is possible that some radiological waste was disposed into "cold" drains. Preliminary instrument and swipe surveys of some of the "cold" side drains did not detect any radiological contamination (Table 2).

TABLE 1 - R-MAD HOT CELL ANALYTICAL DATA

Sample ID	Location	Date Collected	TCLP¹ Barium	Arcolor² -1242	Arcolor -1254	Arcolor -1260	Arcolor -1262
113-HB-F2	Disassembly Bay floor	4/20/2000	0.79 mg/L	ND ⁴	ND	ND	260 mg/Kg ⁵
113-HB-F2A	Disassembly Bay floor	8/21/2000	N/A ⁶	ND	ND	140 mg/Kg	ND
113-HB-F2B	Disassembly Bay floor	8/21/2000	N/A	ND	ND	100 mg/Kg	ND
SHC001PCB	Room 132, Drain	7/5/2000	N/A	11 mg/Kg	ND	1.3 mg/Kg	ND
SHC002PCB	Room 147, Drain	7/5/2000	N/A	ND	ND	32 mg/Kg	ND
SCA001PCB	Room 150, Wall	7/5/2000	N/A	25 mg/Kg	ND	1.6 mg/Kg	ND
SCA002PCB	Room 205, Wall	7/5/2000	N/A	5.4 mg/Kg	ND	ND	ND
CSL001PCB	Room 116, Wall	7/5/2000	N/A	ND	1.2 mg/Kg	1.1 mg/Kg	ND
CSU001PCB	Room 207, Wall	7/5/2000	N/A	ND	0.52 mg/Kg	0.33 mg/Kg	ND
CLDB001PCB	Room 123, Floor	7/5/2000	N/A	28 mg/Kg	ND	3.4 mg/Kg	ND

Notes:

¹ - Toxicity Characteristic Leaching Protocol

² - Polychlorinated biphenyls isomers

³ - milligrams per liter

⁴ - Non-detect

⁵ - milligrams per kilogram

⁶ - Not analyzed

TABLE 2 - R-MAD RADIOLOGICAL SURVEY SUMMARY SHEETS

Bechtel Nevada Surveys

Miller Report (REECo, 1984)

SAMPL. SAMPLE LOCATION		ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²
1	Room 124A	0	0	5,000	617		17		526
2	Room 128	0	0	4,000	5,000		20		552
3	Room 152	0	0	1,000	1,000		10		371
4	Top of plastic cover HB	0	8	177	111				
5	Bottom of plastic cover	0	12	15,000	78				
6	Room 136 (Highbay)	0	0	0	0		736		241
7	Room 208 (Men's Room)	0	0	80	0		16		162
8	Room 217 (utility Room)	20	0	60	1		5		0
9	Room 209(Women's Room)	0	3	70	3		3		76
10	Room141(Equip. Room)	0	6	240	3		6		0
11	Room104(A/C Refrig.)	0	6	80	20		10		18
12	Room105(Boller Room)	0	3	220	15		3		36
13	Room101 (Small bay)	0	3	160	3		22		0
14	Room 114(Women's Room)	0	3	150	8		6		0
15	Room111(Utility Room)	0	0	350	0		10		490
16	Room110(Men's Room)	0	0	220	0		3		0
17	Room 128 - Drain	0	0	9,000	133		20		552
18	Room 148 - Drain	0	0	150,000	82		578		513,000
19	Room 147 - Drain	0	0	350,000	36		725		87,200
20	Room 146 - Drain	0	10	350,000	213		128		25,200
21	Room 145 - Drain	0	0	150,000	52		1,780		145,000
22	Room 149 - Drain	0	4	1,500,000	87		437		52,100
23	Room 149 - Drain	0	0	120,000	19		437		52,100
24	Room 149 - Drain	0	2	350,000	231		437		52,100
25	Room 127 - Drain	0	10	200,000	98		2,170		284,000
26	Room 132 - Drain	0	18	1,400,000	37		110		15,800
27	Room 134 - Drain	0	18	200,000	45		1,200		843,000
28	Room 135 - Drain	0	0	60,000	45		12		1,130
29	Room 132 - Drain	0	0	400,000	65		110		156,000
30	Room 124 - Drain	16	0	600,000	12		630		118,000
31	Room 124A - Drain	0	0	700,000	4		6		526
32	Room 109 - Drain	0	0	500,000	2				
33	Room 123 - Drain	18	0	300,000	45		630		118,000
34	Room 123 - Drain	0	0	75,000	28		630		118,000

TABLE 2 - R-MAD RADIOLOGICAL SURVEY SUMMARY SHEETS

Bechtel Nevada Surveys

Miller Report (REECo, 1984)

SAMPL. SAMPLE LOCATION		ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²
35	Room 202 (Mez) - Drain	20	27	1,400,000	429		4,830		707,000
36	Room 116 Hallway Vent # 1	5	3	89	0		12		1,360
37	Room 116 Hallway Vent # 2	5	3	42	0		12		1,360
38	Room 116 Hallway Vent # 3	17	0	31	0		12		1,360
39	Room 116 Hallway Vent # 4	3	0	55	0		12		1,360
40	Room 116 Hallway Vent # 5	0	0	64	1		12		1,360
41	Room 116 Ramp Vent # 6	0	0	97	3		12		1,360
42	Room 115 Vent	12	3	0	0		21		140
43	Room 114 Vent	0	0	0	3		6		99
44	Room 113 A Vent	0	0	111	3		20		882
45	Room 113 Vent	17	0	18	1		20		882
46	Room 212 Vent	0	0	72	0		5		115
47	Room 213 Vent	18	0	78	3		16		26
48	Room 214 Vent	0	0	26	3		16		1,430
49	Room 216 Vent	18	6	136	0		16		280
50	Room 215 Vent	11	0	44	0		3		34
51	Room 215 Vent (divider)	6	3	0	0		3		34
52	Vent in front of Rm.217	0	0	0	1		5		65
53	Room 146 - Vent # 1	0	0	5,000	10		128		25,200
54	Room 146 - Vent # 2	0	0	1,500	25		128		25,200
55	Room 146 - Vent # 3	0	0	10,000	10		128		25,200
56	Room 145 - Vent # 4	32	0	25,000	13		1,780		145,000
57	Room 145 - Vent # 5	0	0	10,000	29		1,780		145,000
58	Room 149 - Vent # 6	0	0	22,000	27		1,780		145,000
59	Room 127 - Vent # 7	61	0	45,000	58		2,170		284,000
60	Room 133 - Vent # 8	10	0	145,000	282		1,360		109,000
61	Room 134 - Vent # 9	0	0	20,000	104		1,200		84,300
62	Room 147 - Vent # 10	21	22	10,000	326		725		87,200
63	Room 147 - Vent # 11	0	15	30,000	162		725		87,200
64	Room 147 - Vent # 12	40	28	30,000	333		725		87,200
65	Room 148 - Vent # 13	0	0	300	75		578		513,000
66	Room 148 - Vent # 14	13	0	8,000	37		578		513,000
67	Room 148 - Vent # 15	0	0	12,000	25		578		513,000
68	Room 124 - Vent # 16	0	0	<1000	27		17		526

TABLE 2 - R-MAD RADIOLOGICAL SURVEY SUMMARY SHEETS

Bechtel Nevada Surveys

Miller Report (REECO, 1984)

SAMPL	SAMPLE LOCATION	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²
69	Room 124 - Vent # 17	0	0	<1000	5		17		526
70	Room 124 - Vent # 18	0	0	<1000	17		17		526
71	Room 124 - Vent # 19	0	0	<1000	10		17		526
72	Room 124 - Vent # 20	0	0	<1000	1		17		526
73	Room 124 - Vent # 21	0	0	<1000	3		17		526
74	Room 124 - Vent # 22	0	0	<1000	8		17		526
75	Room 124A - Vent # 23	0	0	<1000	13		17		526
76	Room 124A - Vent # 24	0	0	<1000	3		17		526
77	Room 124A - Vent # 25	0	0	<1000	3		17		526
78	Grid A-1	0	6	710,000	32		650		118,000
79	Grid A-2	0	0	128,000	20		650		118,000
80	Grid A-3	27	16	144,000	225		650		118,000
81	Grid A-4 (2 Hot Spots)	0	2	790,000	63		650		118,000
82	Grid A-5	0	0	31,000	32		650		118,000
83	Grid A-6 (2 Hot Spots)	0	5,063	105,000	39		650		118,000
84	Grid B-1	0	0	110,000	1		650		118,000
85	Grid B-2	0	0	182,000	4		650		118,000
86	Grid B-3 (4 Hot Spots)	15	32	3,700,000	458		650		118,000
87	Grid B-4 (2 Hot Spots)	0	2	390,000	180		650		118,000
88	Grid B-5	0	2	135,000	20		650		118,000
89	Grid B-6	0	0	60,000	13		650		118,000
90	Grid C-1	0	2	100,000	130		650		118,000
91	Grid C-2 (2 Hot Spots)	19	35	1,400,000	804		650		118,000
92	Grid C-3	0	0	320,000	46		650		118,000
93	Grid C-4	0	8	105,000	6		650		118,000
94	Grid C-5	0	0	135,000	6		650		118,000
95	Grid C-6	0	0	53,000	13		650		118,000
96	Grid D-1	0	0	40,000	11		650		118,000
97	Grid D-2 (2 Hot Spots)	0	6	96,000	11		650		118,000
98	Grid D-3	0	0	30,000	8		650		118,000
99	Grid D-4	0	2	1,100,000	39		650		118,000
100	Grid D-5 (2 Hot Spots)	0	6	348,000	37		650		118,000
101	Grid D-6	0	0	114,000	42		650		118,000
102	Wall w-1,w-2 Filter Banks	47	262	20,000	1,870		650		118,000

TABLE 2 - R-MAD RADIOLOGICAL SURVEY SUMMARY SHEETS

Bechtel Nevada Surveys

Miller Report (REECo, 1984)

SAMPL SAMPLE LOCATION		ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²
103	Wall E2	0	3	1,000,000	12		650		118,000
104	Wall N3	0	30	10,000	141		650		118,000
105	Wall N4 (Manipulator)	0	6	910,000	383		650		118,000
106	Wall N5 (Manipulator)	0	20	50,000	249		650		118,000
107	Wall N6	6	23	45,000	344		650		118,000
108	Wall S1 (Manipulator)	16	40	50,000	797		650		118,000
109	Wall S2 (Manipulator)	0	9	40,000	584		650		118,000
110	Wall S3 (Manipulator)	0	33	160,000	369		650		118,000
111	Wall S6 (DoorChain& Motor)	0	40	100,000	210		650		118,000
112	Trough T-1	0	16	411,000	210		650		118,000
113	T-2	0	1	290,000	29		650		118,000
114	T-3	0	3	15,000	2		650		118,000
115	T-4	0	0	5,000	17		650		118,000
116	T-5	0	0	18,000	19		650		118,000
117	T-6	0	20	32,000	215		650		118,000
118	T-7	0	6	390,000	105		650		118,000
118	T-8	0	0	1,200,000	175		650		118,000
119	T-9	0	23	120,000	268		650		118,000
120	T-10	0	13	95,000	234		650		118,000
121	T-11	0	26	158,000	447		650		118,000
122	T-12	0	3	110,000	212		650		118,000
123	T-13	0	3	125,000	41		650		118,000
124	T-14	0	23	160,000	432		650		118,000
125	T-15	0	0	60,000	36		650		118,000
126	T-16	0	3	240,000	352		650		118,000
127	T-18	8	30	1,400,000	95		650		118,000
128	T-19	0	9	2,600,000	90		650		118,000
129	T-20	0	20	1,100,000	344		650		118,000
130	Grid A-1	0	0	107,000	18		4,830		707,000
131	A-2 (2 Hot Spots)	0	9	110,000	170		4,830		707,000
132	A-3 (2 Hot Spots)	0	9	810,000	109		4,830		707,000
133	A-4	0	19	80,000	506		4,830		707,000
134	B-1	0	2	540,000	107		4,830		707,000
135	B-2	0	0	330,000	78		4,830		707,000

TABLE 2 - R-MAD RADIOLOGICAL SURVEY SUMMARY SHEETS

Bechtel Nevada Surveys

Miller Report (REECO, 1984)

SAMPL	SAMPLE LOCATION	Bechtel Nevada Surveys				Miller Report (REECO, 1984)			
		ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²	ALPHA Fixed + Removable dpm/100 cm ²	ALPHA Removable dpm/100 cm ²	BETA/GAMMA Fixed + Removable dpm/100 cm ²	BETA/GAMMA Removable dpm/100 cm ²
136	B-3 (3 Hot Spots)	0	15	2,100,000	119		4,830		707,000
137	B-4 (4 Hot Spots)	0	25	1,100,000	421		4,830		707,000
138	C-1 (2 Hot Spots)	0	9	440,000	390		4,830		707,000
139	C-2	0	12	125,000	64		4,830		707,000
140	C-3 (4 Hot Spots)	21	79	4,400,000	1,757		4,830		707,000
141	C-4	0	15	4,700,000	337		4,830		707,000
142	Grid W-1	0	14	110,000	216		4,830		707,000
143	W-2	21	34	60,000	393		4,830		707,000
144	W-3	0	4	3,000	77		4,830		707,000
145	W-4	0	0	16,000	58		4,830		707,000
146	W-5	0	0	16,000	44		4,830		707,000
147	W-6	58	103	16,000	1,721		4,830		707,000
148	W-7	0	14	10,000	204		4,830		707,000
149	W-8	0	0	10,000	44		4,830		707,000
150	W-9	32	30	58,000	891		4,830		707,000
151	W-10	0	24	18,000	254		4,830		707,000
152	W-11	0	14	18,000	216		4,830		707,000
153	W-12	178	143	248,000	1,800		4,830		707,000
154	W-13	0	14	5,000	214		4,830		707,000
155	Grid T-1	20	27	1,400,000	429		4,830		707,000
156	T-2	0	87	430,000	955		4,830		707,000
157	T-3	0	24	48,000	285		4,830		707,000
158	T-4	0	4	130,000	130		4,830		707,000
160	T-5 Highest Reading	0	27	940,000	472		4,830		707,000
161	T-6	0	44	1,300,000	735		4,830		707,000
162	T-7	0	27	760,000	592		4,830		707,000
163	T-8 Highest Reading	0	24	430,000	510		4,830		707,000
164	T-9	52	116	1,300,000	3,484		4,830		707,000
165	T-10	0	44	1,100,000	716		4,830		707,000
166	T-11	0	44	1,600,000	939		4,830		707,000
167	T-12	67	305	600,000	8,556		4,830		707,000
168	T-13	0	67	500,000	828		4,830		707,000

The hot cell drainage piping is enclosed in the R-MAD concrete walls and floor. It is anticipated that the radiological contamination within the piping will meet the near surface disposal criteria (Section 2.4.1.2) and can be left in-place. The piping will be sampled and, upon confirmation that it meets the disposal criteria, will be grouted and capped to immobilize the waste.

Potentially hazardous material associated with lead shielding or within mechanical equipment fluid reservoirs are located throughout the R-MAD Building. Prior to commencing decommissioning activities, equipment reservoirs will be field screened and sampled to determine if the contents are hazardous. The following field screening analyses will be preformed: Chlor-detect (detects the presence of chlorine, a key component in chlorinated solvents), PCBs colormetric test, and total petroleum hydrocarbon (TPH) colormetric test. Any field screening sample that reads positive for chlorine or PCBs, will require further analysis by an approved off-site laboratory.

Asbestos containing material (ACM) has been found in many portions of the R-MAD Building. Non-friable ACM such as floor tile and drop ceiling panels have already been partially abated. ACM (both friable and non-friable) associated with piping elbows, insulation, etc., has been identified and sampled throughout the entire R-MAD Building and will be abated during the SAFER field work.

2.3.2 Radiologically Impacted Areas

Radiologically impacted areas have been identified in the following areas of the R-MAD Building: Disassembly Bay, Postmortem Cells, Basement Utility Rooms, and the Gallery Viewing Area (Table 2). Each area will be discussed separately except for the Gallery Viewing Area which, due to the sporadic and limited nature of the contamination, does not require additional description.

2.3.2.1 Disassembly Bay

The Disassembly Bay is divided into the main Disassembly Bay and the Mezzanine. The main Disassembly Bay was used to dismantle the rocket reactors. Common activities included removing the reactor from the rail car and segregation of the fuel rods from the other reactor components.

More detailed work was done in the Disassembly Bay Mezzanine. Manipulators were used to further disassemble reactor components. Once the required amount of disassembly was completed, the components were lowered, with a bridge crane, through an opening in the Mezzanine floor into the Postmortem cells for further analysis.

Due to the nature of the disassembly work, higher levels of radiological contamination is expected in the Mezzanine than in the Disassembly Bay. Preliminary evaluation indicates that this conceptual model is correct. However, due to the high background (shine) within the Disassembly Bay, the extent of radiological contamination is difficult to determine. In addition, it is expected that radiologically impacted dust will be detected on flat horizontal surfaces in the Disassembly Bay (i.e., crane assembly, lighting fixtures, etc.). Based on waste characterization samples, the majority of the radiological contamination is confined within the paint covering the concrete floors and walls.

2.3.2.2 Postmortem Cells

Seven Postmortem Cells and a service corridor were added to the R-MAD Building in two construction efforts. The Postmortem Cells were constructed to further dissect and photograph post test reactor component conditions.

Due to the varied activities within the Postmortem Cells, radiological contamination was expected to be higher than in the Disassembly Bay. However, preliminary radiological survey results (Table 2) indicate that, other than around drains and HVAC ducting, fixed contamination levels are lower. HVAC and drains are discussed in a later section.

2.3.2.3 Basement Utility Rooms

Two basement utility rooms are located under the Postmortem Cells. These utility rooms were constructed to control Postmortem Cell doors and the HVAC High-Efficiency Particulate Air (HEPA) filter system for each Postmortem Cell.

Preliminary investigative sampling has indicated that radiological contamination associated with either the HVAC or hydraulic door systems failed, contaminating portions of the utility rooms. Future radiological surveys will provide additional information regarding the extent and level of radiological contamination within these utility rooms.

2.3.2.4 Gallery Viewing Area

The gallery service area was designed to support the remote disassembly of the reactor rockets. However due to facility design problems, movement of some contaminated components between hot cells was accomplished by using the gallery service area. During the movement of these components, sporadic and limited contamination of the gallery service area occurred.

All removable radiological contamination was removed from the gallery service area during the decontamination activities conducted in the late 1970s. The remaining sporadic fixed contamination has been identified and its location spray painted on the floor and stairs.

2.3.3 Ventilation Systems

This section describes how ventilation of both the contaminated and uncontaminated portions of the R-MAD Building was provided.

2.3.3.1 Contaminated Side

There are three independent HEPA filtration systems that serviced the various portions of the building used for "hot" work activities. The larger of the three systems serviced the lower and upper (mezzanine) disassembly bays (Figure 5). This system was designed to maintain a negative pressure in the bays during the disassembly and inspection of the nuclear rockets. The HEPA filters, air handler, and exhaust stack for this system are located on the exterior of the building near the northwest corner on the lower disassembly bay. The HEPA filters were removed from the system in earlier decontamination efforts. Recent radiological surveys show that the metal grate protecting the inlet of the system has considerable levels of removable contamination. Given the large volume of air pulled through the system and the inability to judge the effectiveness of the HEPA filters, the air handler and exhaust stack are assumed to be contaminated and will be treated as such until the system is dismantled and surveyed.

The two smaller HEPA filtration systems were used to maintain negative pressure in the postmortem cell area while examinations and tests were performed on the reactor fuel (Figure 3). When operational, air was drawn into inlet vents situated on the sides of each of the postmortem cells, through ducting formed into the concrete walls and ceilings, through a series of HEPA filters located in the basement mechanical room (Rooms 6 and 7) (Figure 3), and out through the two small stack located on the east side of the building. Although not present, the mouth of the inlet vents are engineered for a prefilter that reduces the amount of contamination entering the ventilation system. The effectiveness of the prefilters is undeterminable, but recent surveys show negligible removable contamination and fixed contamination of approximately 20,000 dpm/100 square centimeters (cm²) β - γ (Figures 7 and 8). A video survey of the basement mechanical rooms shows considerable ventilation ducting that is not contained within the concrete ceiling and walls. The portion of ducting leading from the ceilings to the HEPA filters is considered contaminated to the same extent as the inlet vents located in the postmortem cell area. It is assumed that the HEPA filters were removed at the same time the prefilters were removed. The extent of contamination in the ducting leading from the HEPA filters to the air handlers and out through the exhaust stack has not been assessed. This portion of the HEPA filtration system is assumed to be contaminated and will be treated as such until the system is dismantled and surveyed.

Separate air handling units located on the roof directly above each area, supplied HVAC to the disassembly bay and postmortem cell area. These systems operate on forced air (into the serviced area) with no air returns located in either the disassembly bay or postmortem cell area. Recent surveys show that the HVAC vents located in areas of the contaminated side are not

FIGURE 7
 DETAILED R-MAD RADIOLOGICALLY IMPACTED AIR DUCT DIAGRAM

contaminated. No radiological contamination was detected on the roof during a recent survey using a High Purity Germanium (HPGe) gamma spectroscopy system (Appendix C).

2.3.3.2 Uncontaminated Side

The HVAC system on the uncontaminated side is a forced air system using multiple air handlers and a common boiler and water chiller. Recent surveys show that the HVAC vents located in the uncontaminated side had no detectable contamination. In addition, no contamination was detected in the roofing material during a recent survey using a HPGe detector. Based upon this information, the HVAC systems supporting the uncontaminated side will be treated as being free from radiological COPC.

All HVAC systems suspected of containing asbestos have been identified, and all materials determined to containing asbestos will be abated.

2.3.4 Drains and Piping

This section describes the drainage system for both the contaminated and uncontaminated portions of the R-MAD Building.

2.3.4.1 Contaminated Side

The drainage system originating in the disassembly bay and postmortem cell area was designed to collect the rinseate from gross decontamination efforts and direct it to the radioactive leach field located approximately 250 m (813 ft) southwest of the building. Several former workers have indicated that once contamination reached a particular level, surfaces were decontaminated, primarily with high pressure water, and the rinseate washed down the drains. It is suspected that there is considerable residual radioactivity in the pipes associated with this drainage system, but the actual extent and levels of this contamination are unknown. A recent radiological survey of the drain inlets located within the disassembly bay and postmortem cell area returned direct reading instruments results from 9,000 to 1.5 million dpm/100 cm² β - γ when placed directly over the drain inlets (Figure 9). While there is no method to directly correlate the direct reading instrument results do not represent the total activity in the pipes, they do indicate that the drainage system was used extensively. At the time of this SAFER Plan was prepared, the activity in each of the drainage pipes had not been quantified.

A radiological survey of the drain inlets located outside of the disassembly bay and postmortem cell area show no signs of being radiologically impacted except for the drain inlet in the center of Room 126 (Figure 9). This drain inlet is connected to the radiological leach field and will be included in any assessment of the radiological drainage system.

Several systems on the contaminated side of the building contain extensive piping. These systems include the heating, cooling, electrical, lighting, hydraulic, and pneumatic. At present, there is no indication that these systems are radiologically impacted. Hazardous (Resource Conservation and Recovery Act [RCRA]) constituent determinations for the residual fluids remaining in system piping will be made before the systems are removed.

2.3.4.2 Uncontaminated Side

The drainage system in the non-radiological impacted portion of the R-MAD Building is serviced by a separate leach field. A recent radiological survey of the drain inlets showed no sign of the system being used for the disposal of radioactive material (Table 2). All piping associated with this drainage system is considered not to be radiologically impacted. Piping that was removed as part of the "Salvage Activities" from this side of the building was determined to be free of radiological and hazardous constituents. Therefore, it is anticipated that the remaining uncontaminated side piping will also be free of any hazardous or radiological constituents.

2.3.5 Equipment

The equipment within the R-MAD Building can be divided into two types. The first type supported activities outside of the hot cells and are not radiologically impacted. The second type was used to support the disassembly of reactors in the various hot cells. In addition to radiological contamination, some of the equipment have hydraulic fluid reservoirs as well as oils and grease necessary for their operation.

2.3.5.1 Contaminated Side

Equipment within the radiologically impacted portion of the R-MAD Building include: manipulator arms, bridge cranes, and hoists. Hydraulic fluid associated with hoists is suspected to have elevated concentrations of PCBs. The bridge crane and associated motors and rigging have oils and greases required for proper operation. Areas with open oils and greases are especially prone to attract radiologically impacted dust. All residues and reservoirs will be assessed for radiological contamination and hazardous materials.

2.3.5.2 Uncontaminated Side

Equipment in the non-radiologically impacted portion of the R-MAD Building include: bridge cranes, compressors, boilers, and other building HVAC equipment. The bridge crane and associated motors and rigging have oils and greases required for proper operation. All residues and reservoirs will be assessed for hazardous materials.

2.3.6 Offices

The R-MAD Building includes a series of offices along the main corridor of the first floor (Room 116) of the building (Figure 4) and additional offices on the second floor (Figure 5). The offices on the first floor were used for administrative purposes while the second floor offices were used for engineering and design work. The first floor administrative offices all contain floor tile that has been classified as ACM, concrete walls, acoustical tile ceilings, and strip fluorescent lighting. The one exception is the main corridor (Room 116); the ceiling was a suspended tile and fluorescent light ceiling which is partially removed. Areas where the suspended ceiling has been removed reveal duct work and a concrete waffle slab structure (floor of the second level). Between offices 115 and 117 (Figure 4) a concrete ramp connects the main corridor with the viewing galleries of the disassembly bay and postmortem cells. This ramp had flooring and a suspended ceiling consistent with the main corridor. The ACM flooring has been partially abated in 1999 - 2000, as apart of the R-MAD "Salvage Activity." Metal supports are all that remains of the suspended ceiling.

The second floor engineering offices consist of a main room ringed by several smaller rooms (Figure 5). All of the engineering offices had ACM flooring which have been subsequently abated during the "Salvage Activity." The ceilings of these rooms were covered with 0.6 X 1.2 m (2 X 4 ft) acoustical tiles. These tiles have been removed. The offices are separated (interior walls) with partial height frame construction. The exterior walls are concrete masonry. The rooms have all been emptied. All that remains are the recessed fluorescent light fixtures.

The fluorescent light fixture ballasts are known to contain PCBs. Additionally, thermostats may include mercury filled switches or thermometers. These materials will be removed and disposed of accordingly. As previously mentioned, the office areas have ACM throughout. All remaining ACM has been identified and will be removed and disposed of accordingly. Both groups of offices were on the "cold" side of the building. These rooms have no radiological contamination based on initial radiological surveys. However, as the remaining fixtures in the rooms are removed, they will be assessed for residual radioactive material. Once the rooms are completely stripped, a final radiological demarcation survey will be conducted to document the final release status.

2.3.7 Cold Bays

R-MAD contains two cold bays (also known as assembly bays) located on the west side of the building (Figure 4). The first cold bay (Room 101) is a large rectangular room with a concrete floor, walls, and ceiling. A 5-ton crane is supported by an "I" beam track attached to the top of the pilasters with brackets. At the north end of the bay a large metal tracked door opens to allow railroad car access. The railroad tracks extend into almost the entire length of the bay. The south wall of the bay includes two sets of double door openings (doors removed) into the machine shop (Room 102) and electrical shop (Room 103). Attached to the south and west walls are conduit and piping. The east wall, has wall vents and six large rectangular sheet metal ducts mounted on

the lower half. The south wall has a caged ladder that extends from the floor to a cat walk near the ceiling. Surface-mounted strip fluorescent lighting runs north-south at the ceiling. Three large boxes of sand are located along the east wall. The sand is known to be free of COPC. It was used for heat dissipation studies in support of the Yucca Mountain Project (YMP). The first cold bay is attached to the second cold bay by a rolling metal door.

The second cold bay (Room 136) was constructed during a later construction phase. This bay is larger than the first. The floor and a portion of the east and lower portion of the south walls are concrete. The remaining walls and ceiling are constructed with corrugated sheet metal. The roof is supported by metal trusses that rest on steel support columns along the east and west walls. A 15-ton crane is on a track supported by the same metal support columns as the roof. Railroad tracks that are in the floor along the east wall and enter the bay from a door on the northern building exposure. Caged ladders are located on both the east and west walls. They service a catwalk located half-way up both the east and west walls. The bay is lit with ceiling mounted conical silver-metallic pendant mercury vapor lamps.

Fluorescent light ballasts are known to contain PCBs. Additionally thermostats may include mercury filled switches or thermometers. The second cold bay has mercury vapor lamps. These materials will be removed and disposed of accordingly.

2.3.8 Roof

The R-MAD Building is an intricate mass of rectangular flat-roofed blocks. Therefore, the roof portions, as they occur, are at multiple elevations and made of varied materials. Those portions of the roof that are associated with the original construction are made of reinforced concrete. The more recent portions of the building have corrugated aluminum roofs. In general the roof is accessible by an external ladder system. Roof components include vertical stacks, piping, and air conditioning units.

Preliminary radiological surveys of the roof (Appendix C) indicate that they have not been impacted by past facility operations. No individual surveys of vertical stacks or air condition units have been conducted. However, it is not anticipated that any of these systems will be impacted by radiological contamination.

2.4 CLOSURE STANDARDS

The current radiological protection requirements for residual radioactivity are listed in DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE, 1993).

Guidelines for residual radioactive materials identified to be removed from the rubble after demolition of the building (i.e. contaminated piping - Figure 10) will be derived from Environment, Safety, and Health (ES&H) concerns, and potential disposal pathway limitations.

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FIGURE 10
 REMAINING R-MAD RADIOLOGICALLY IMPACTED PIPING DIAGRAM

Above grade radiological piping guidelines are discussed in Section 2.4.2.1. While there are no generic soil guidelines for radionuclides other than radium and thorium, DOE Order 5400.5 (DOE, 1993) does state that residual soil guidelines will be derived from the basic dose limit of 100 milliroentgen equivalent man (mrem) per year. The guidelines for all residual radioactive material left below grade will be based on a fraction of this basic dose limit, and are discussed in Section 2.4.1.2. Allowable total surface contamination guidelines for accessible surfaces are taken from the "NV/YMP Radiological Control Manual" (DOE/NV, 2000a), which are based upon DOE Order 5400.5 (DOE, 1993), and are discussed in Sections 2.4.2. Allowable total surface contamination guidelines for inaccessible surfaces that will be removed when the building is demolished are based upon industrial landfill criteria and are discussed in Section 2.4.3.

2.4.1 Radiological Drainage System

Piping associated with the radiological drainage system will be assessed to determine the maximum extent of contamination contained within the piping. Several methods have been proposed to make this assessment. Each method will be investigated, with the results of the investigations used to select the most suitable technology(s). The long-term end-state for the R-MAD Building is demolition. Therefore, the piping in the R-MAD building will be remediated in two phases. In the first phase, after the activity in the piping contained within the footprint of the building has been assessed, the piping will be grouted with a cement slurry, or other suitable material, and left to cure. This will stabilize the residual radioactive material and prevent access.

The second phase will be addressed after the CAU has been closed out under the FFACO process. After the building is demolished, the piping contained in the above grade walls and floors (Figure 10) will be removed from the pile and assessed for proper disposal. The portion of piping contained in the ceiling of the basements will be removed. The portion of piping where access is restricted by the foundation of the building will be left in place.

2.4.1.1 Above Grade Radiological Piping

In its current condition, the residual radioactive material contained within the above grade radiological drainage piping is not accessible and does not present a radiological hazard. To prevent access to piping while the building awaits demolition, the piping will be filled with a cement slurry or other suitable material. Once cured, the grout will seal the drainage system and prevent access and stabilize the residual radioactive material in the piping. The integrity of the radiological piping system is expected to be maintained during the demolition of the R-MAD Building to a sufficient degree that the majority of residual radioactive material will be contained within the piping. The small fraction of residual radioactive material not contained by the piping will be controlled by standard dust suppression methods.

Once the radiological drainage piping is removed from the encasing concrete during demolition, exposure rates from the unshielded piping could present a radiological hazard. To prevent this from happening, the quantity of residual radioactive material allowed to remain in the radiological drainage system before being stabilized will be limited by the gamma emitting radionuclides. To derive the concentration guidelines, a 0.6 m (24 inches [in]) section of pipe was considered to be an unshielded line source. The exposure rate from this section of pipe was limited to 5.0 mrem per hour (mrem/hr) at 0.3 m (12 in), (definition of a Radiation Area). The quantity of cesium-137 (^{137}Cs) that generates this exposure rate is approximately 3.0 milli Curie (mCi). This activity also includes the contributions to the exposure rate from cobalt-60 (^{60}Co) and niobium-94 (^{94}Nb), but their relative abundance (see Section 3.1.6) results in a negligible contribution to the exposure rate.

DOE Order 435.1, "Radioactive Waste Management" (DOE, 1999a), requires that before a waste is generated a suitable waste disposal path must be identified. To ensure that the radiological drainage piping meets the NTS Waste Acceptance Criteria (WAC) (DOE/NV, 1999), the disposal path is identified for this waste, the ES&H derived concentration guideline (DCGL) of 3.0 mCi of ^{137}Cs , in a 0.60 m (24 in.) section of 15 cm diameter (6 in) pipe, was compared to the action level found in the NTS WAC (DOE/NV, 1999). The result was that the ^{137}Cs concentration was three percent of its action level, and the sum of the fractions for the remaining COPC (see Section 3.1.6) was 0.12. Therefore, 5.0 mCi/m of ^{137}Cs DCGL will be used for the above grade piping.

2.4.1.2 Below Grade Radiological Piping

The remaining below grade radiological piping is estimated at 100 m (325 ft) of 15.2 cm (6 in) piping and 200 m (650 ft) of 7.62 cm (3 in) piping. As stated in Section 2.4, guidelines for the maximum residual radioactivity allowed to be left in this below grade piping will derived from a fraction of the 100 mrem/yr basic dose limit. The fraction of the basic dose limit is set at 25 mrem per year (mrem/yr).

For developing site-specific DCGLs, DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE, 1993), directs that "authorized limits" shall be established to:

- Provide that, at a minimum, the basic dose limits of 100 mrem will not be exceeded under the "worst case" or "plausible-use" scenarios, consistent with the procedures and guidance provided in DOE/CH-8901 (DOE, 1989).
- Or, the "authorized limits" must be consistent with applicable "generic guidelines."

The potential exposure scenarios in DOE/CH-8901, "A Manual for Implementing Residual Radioactive Material Guidelines" (DOE, 1989), were investigated to identify future "worst case" and "probable-use" scenarios for the R-MAD compound. Each of the potential scenarios that

could result in an appreciable dose to a potential receptor were evaluated. This analysis determined that the only exposure pathway was residual radioactive material being brought to the surface by either drilling or excavation. Therefore, scenarios that relied on natural advection (evapotranspiration) or bio intrusion to bring the residual radioactivity to the surface were not evaluated. It was assumed that the cement foundation and depth of burial will restrict these processes to the first few centimeters, thus restricting the transport of the residual radioactive material to the surface.

2.4.1.2.1 Guidelines for Below Grade Radiological Piping

The DOE does not have generic DCGLs for residual radioactivity in soil for radionuclides other than radium (^{226}Ra and ^{228}Ra) and thorium (^{230}Th and ^{232}Th). In their absence, other governmental agency regulations were reviewed to see if they had generic DCGLs that could be used. The Nuclear Regulatory Commission (NRC) recently published screening values for surface soil contamination release levels in Federal Register (FR) Notice Vol. 64, No. 234 (64 FR 68395), December 7, 1999 (NRC, 1999). Values given in Table 3 of the FR Notice correspond to surface soil concentrations that would comply with the 25 mrem/yr dose limit. A review of the methodology and computer code used to generate these values revealed that there is considerable conservatism incorporated in the scenarios and default parameters values. Based on this review, the values listed in 64 FR 68395 (NRC, 1999) will be used as generic DCGLs for the below grade piping. The resulting COPC soil concentrations from the drilling and excavation scenarios discussed above will be compared against the generic DCGLs, and, if they exceed these concentrations, a more detailed, site-specific performance assessment will be performed. The generic DCGL values for the COPC defined in Section 3.1.6, are listed in Table 3.

TABLE 3 - GENERIC DERIVED CONCENTRATION GUIDELINES FOR THE R-MAD CONSTITUENTS OF POTENTIAL CONCERN

NUCLIDE	GENERIC DCGL (pCi/g ¹)
^{60}Co	3.8
^{90}Sr	1.7
^{94}Nb	5.8
^{137}Cs	11
^{234}U	13
^{235}U	8
^{239}Pu	2.3

¹ pico Curie per gram.

2.4.1.2.2 Derived Guidelines For Below Grade Radiological Piping

Either scenario, drilling or excavation, will result in potential receptors being exposed to the residual radioactive material. However, the mechanical process of bringing the residual radioactive material into the accessible environment will result in considerable dilution of the contaminants. In either case, drilling or excavation, the following assumptions are made: these activities will take place 100 years from the time of closure; any deed restriction to the property are no longer in place; and the piping is no longer distinguishable from the surrounding soil.

Drilling through a horizontal or vertical section of pipe would result in residual radioactive material contained in a relatively small section of pipe being combined with the column of soil displaced by the borehole. Using this scenario, the derived guidelines for any vertical run or 30.5 cm (12 in.) section of horizontal pipe is calculated by multiplying the screening concentrations in Table 3 by the mass of soil displaced by drilling a 215 m (700 ft.) deep, 30.5 cm (12 in.) water well. The resulting concentrations are corrected for the relative abundance of the COPCs and 100 year decay period. The results are shown in Table 4.

TABLE 4 - DRILLING AND EXCAVATION DERIVED GUIDELINES

NUCLIDE	DRILLING DERIVED GUIDELINES (pCi)	EXCAVATION DERIVED GUIDELINES (pCi)
⁶⁰ Co	6.72E+05	1.14E+08
⁹⁰ Sr	3.48E+08	5.90E+10
⁹⁴ Nb	5.04E+05	8.55E+07
¹³⁷ Cs	1.68E+08	2.85E+10
²³⁴ U	3.46E+07	5.87E+09
²³⁵ U	2.20E+06	3.73E+08
²³⁹ Pu	7.06E+05	1.20E+08

Although a complete excavation of the footprint of R-MAD by future homesteaders/settlers is unlikely, industrial usage of the land that would require excavation is somewhat feasible. In this instance, the activity in the entire below grade drainage system would be combined with the soil displaced by the excavation of the soil beneath the footprint of the R-MAD building to the depth of the lowest drainage pipe. The dimensions of the excavated area would be 37 m x 24 m x 3 m (120 ft. x 80 ft. x 10 ft). These dimensions reflect the foot print of the original construction of

the building without the hot cell addition or additional hot cells. These are the minimum dimensions needed to unearth the majority of below grade piping. The derived guidelines for the total activity in the below grade piping is calculated by multiplying the screening concentrations in Table 3 by the displaced volume of the excavated soil and correcting the results for the relative abundance of the COPCs and the 100 year decay period. The results are shown in Table 4.

2.4.2 Accessible Surface Release Limits

All accessible surfaces will be decontaminated to less than or equal to the levels in Table 4-2 of the NV/YMP Radiological Control Manual (Table 5) (DOE/NV, 2000a). These limits are the total residual surface contamination for unrestricted release of materials and equipment to the general public allowed by DOE Order 5400.5 (DOE, 1993), and deemed appropriate for the release of the R-MAD building. Although a detailed analysis of the final end use of the Building could potentially support higher release limits, by reducing contamination to unrestricted release limits provides greater freedom in selecting demolition methods after regulatory concerns have been addressed.

TABLE 5 - ALLOWABLE TOTAL RESIDUAL SURFACE CONTAMINATION
VALUES IN dpm/100 cm² (Note 1) (from DOE, 1993) (DOE/NV, 2000a)

RADIONUCLIDE (See note 2)	REMOVABLE (See note 5)	TOTAL (FIXED & REMOVABLE) (See Notes 3 & 4)	ALLOWABLE FIXED & REMOVABLE (See Note 4)
Transuranics, ¹²⁵ I, ¹²⁹ I, ²²⁶ Ra, ²²⁷ Ac, ²²⁸ Ra, ²²⁸ Th, ²³⁰ Th, ²³¹ Pa	20	500	1,500
Th-nat, ⁹⁰ Sr, ¹²⁶ I, ¹³¹ I, ¹³³ I, ²²³ Ra, ²²⁴ Ra, ²³² U, ²³² Th	200	1,000	3,000
U-natural, ²³⁵ U, ²³⁸ U and associated decay products, alpha emitters	1,000 α	5,000 α	15,000 α
β & γ emitters (radionuclides with decay modes other than α- emission or spontaneous fission) except ⁹⁰ Sr and others noted above. See Note 6.	1,000 β+γ	5,000 β+γ	15,000 β+γ

- Note 1. Disintegrations per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrument.
- Note 2. Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exist, the limits established for alpha and beta-gamma-emitting radionuclides apply independently.
- Note 3. Measurement of average contamination should not be averaged over an area of more than one square meter. For objects of less surface area, the average should be derived for each such object.
- Note 4. The maximum contamination level applies to an area of not more than 100 cm².
- Note 5. The amount of removable material per 100 cm² of surface area should be determined by wiping an area of that size with a dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if detected scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
- Note 6. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where Sr-90 has been enriched.

3.0 FIELD ACTIVITIES

3.1 CONSTITUENTS OF POTENTIAL CONCERN

Constituents of potential concern (COPC) include: Volatile Organic Compounds (VOC), Semi-Volatile Organic Compounds (SVOC), PCBs, Metals, TPH, Radionuclides, and ACM.

3.1.1 VOC

Volatile organic compounds are not considered to be a major COPC for the R-MAD Building. Chemicals and solvents containing VOCs have all been removed from the R-MAD Building during previous activities. Volatile organic compounds may have been used during some decontamination activities but process knowledge suggests that if it occurred only minor amounts were used. Due to the volatile nature of these compounds, detecting their presence on building materials is extremely unlikely. As part of the waste characterization process, liquids associated with equipment reservoirs will be field screened for the presence of VOCs (i.e., Chlor-detect test).

3.1.2 SVOC

Semi-volatile organic compounds are not considered to be a major COPC for the R-MAD Building. Chemicals and materials containing SVOCs have all been removed from the R-MAD Building during previous cleanup activities. Due to the somewhat volatile nature of these compounds and the impermeable nature of the building materials, detecting their presence on building materials is extremely unlikely. As part of the waste characterization process, liquids associated with equipment reservoirs will be tested for the presence of SVOCs.

3.1.3 PCB

Polychlorinated biphenyls were commonly used in a variety of products for both its plastic and heat regulating properties. Polychlorinated biphenyls have been detected in the paint located in the R-MAD hot cells (Table 1). In addition, during the Engine Maintenance, Assembly, and Disassembly (E-MAD) characterization in 1997, PCBs were detected in the hydraulic fluid used

to operate mechanical arms, hoists, and other hydraulic assisted equipment. It is anticipated that the equipment containing hydraulic fluids at R-MAD will also contain PCBs. As part of the waste characterization process, liquids associated with equipment reservoirs will be tested for the presence of PCBs.

3.1.4 RCRA Metals

Lead and mercury have been identified within the R-MAD Facility. Lead is present in many forms. Its primary use was as shielding. Lead shot was used to secure shield doors and was placed around interior of the lead glass observation windows. Mercury is associated mercury vapor light bulbs and heating/cooling thermostats. Due to the nature of this type of waste, it is easily recognized and will be managed appropriately.

3.1.5 TPH

Total petroleum hydrocarbons are primarily associated with oils and greases required to operate equipment in the R-MAD Building. Where possible oils and greases will be removed from the equipment and managed while samples are being analyzed. All fluids will be field screened for the presence of TPH. Depending on the results of other analysis (SVOCs and PCBs), a laboratory TPH sample may be required.

3.1.6 Radionuclides

The effluents and residues resulting from the nuclear reactor tests conducted at the NRDS are well known. Considerable amounts of information on the operation of each of the facilities associated with the NRDS can be found in published literature and historical records. Information available includes the types of reactors, the type of fuel used in the reactors, power levels and run times for each of the reactors, effluent from the reactors, and results of past decontamination efforts. In addition, interviews with past workers were conducted to provide information on COPC and facility operations were conducted.

A report titled Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site (Tinney and Wheeler, 1999) (Appendix D) was developed using much of the information discussed above. This document discusses the production method, relative quantities, and waste classifications for the radionuclides expected to be presently in the

radiological waste dump that serviced the NRDS during its operational period. The COPCs identified in the CAU 143 Radiological Calculation report (Tinney and Wheeler 1999) are ^{60}Co , Strontium-90 (^{90}Sr), ^{94}Nb , ^{137}Cs , Uranium-234 (^{234}U), Uranium-235 (^{235}U), and Plutonium-239 (^{239}Pu). Approximately 99 percent of the current activity can be associated with ^{90}Sr , ^{137}Cs , and ^{234}U .

Niobium- 94 was produced from the activation of Niobium used as a cooling channel liner in the reactor. The Niobium liner prevented degradation of the cooling tubes and is suspected to be present in minimal quantities. The remaining ^{60}Co contamination is the result of the activation of the stainless steel support structures used during the project. Because of its relatively short half-life, the majority of ^{60}Co has decayed away and does not contribute significantly to the activity at the NRDS. Plutonium- 239 was produced in the fuel by the neutron activation of the relatively small fraction of ^{238}U contained in reactor fuel. Therefore, ^{239}Pu is present in concentrations approximately 0.15 percent of ^{137}Cs . Based upon its relative contribution to the total activity, ^{239}Pu is not expected to impact waste classifications or work processes. Uranium-234 and ^{235}U contribute approximately 18 percent of the total activity and 99 percent of the total alpha activity.

In order to evaluate specific isotopes during characterization and waste disposal activities, a document entitled Cesium-137 Scaling Factors for Concrete, Insulation, Wood, and Concrete Surfaces Wipes for the Former ROVER Project and NERVA Facilities in Area 25, Nevada Test Site, Nevada, (DOE/NV, 2000b) was developed. The COPC identified in this document are identical to those identified in the CAU 143 Radiological Calculation report (Tinney and Wheeler, 1999). During the analysis of historical records and sampling results from recent NRDS characterization efforts (Table 6), it was recognized that although the COPC were fairly consistent, the relative abundances of each of the COPC varied depending on the media the contaminants were found in. For this reason, scaling factors for the various media were developed.

Table 6 shows the scaling factors developed in the report and compares the results of paint samples taken from radiologically impacted areas of R-MAD. Before sampling, it was determined that the majority of contamination was contained between the layers of paint. Prior to commencing operation at the R-MAD Facility, all concrete surfaces were sealed. This comparison demonstrates that the residual radiological contamination present in Area 25 is well defined and COPC are limited to those identified in the CAU 143 Radiological Calculation report (Tinney and Wheeler, 1999). The omission of ^{94}Nb and ^{60}Co in the recent R-MAD

**TABLE 6 - AREA 25 SCALING FACTORS AND RESULTS OF RECENT R-MAD
CONTAMINATED PAINT SAMPLES**

RECENT R-MAD SAMPLING RESULTS							
	Nuclide Concentration (pCi/g)¹						
Sample	¹³⁷Cs	⁶⁰Co	⁹⁰Sr	⁹⁴Nb	²³⁴U	²³⁵U	²³⁹Pu
Disassembly Bay	2,930	ND ²	1,610	ND	456	27.7	4.39
Postmortem Cells	2,730	ND	1,330	ND	854	57.5	12.7
Mezzanine	4,280	ND	6,040	ND	2,630	110	18.5
Average	3,310	-	2,990	-	1,313	64.7	11.9
Percent of Total Activity	43	-	39		17	0.84	0.15
AREA 25 MEAN MEDIA SCALING FACTORS (DOE/NV, 2000b)							
	Nuclide Scaling Factor						
	¹³⁷Cs	⁶⁰Co	⁹⁰Sr	⁹⁴Nb	²³⁴U	²³⁵U	²³⁹Pu
Concrete	1	0.00399	2.07	0.00304	0.206	0.0129	0.0042
Wood	1	0.010	1.75	0.0020	1.06	0.0688	0.0042
Insulation	1	ND	0.47	ND	1.99	0.145	ND
Concrete Surface Wipes	1	24.6	1.49	0.00608	0.930	0.0263	0.00133

¹ - pico Curies per gram

² - Not Detected

sampling was expected because neither were produced in the fuel which is the expected source of the contamination inside R-MAD.

3.17 ACM

Asbestos containing material has been identified within the R-MAD Building. Material within the R-MAD Building containing greater than 1 percent asbestos by volume include: floor tile, adhesive mastic, ceiling tile, pipe elbows, and roofing material. Samples have been collected and analyzed from suspected building materials within the R-MAD Building. Based on the sampling results, specific types of building materials have been labeled as ACM. These materials will be removed and disposed following all state and federal regulations by qualified personnel.

3.2 REMEDIATION

Remedial activities associated with this project include the removal and disposal of various equipment and utilities to prepare the R-MAD Building for demolition. Prior to dismantlement and removal, the presence of radiological or hazardous substances will be determined by process knowledge or characterization. Utilities will be deactivated prior to removal.

3.2.1 Equipment

R-MAD equipment is defined as all items that were used during facility operations (i.e., floor mounted, wall mounted, ceiling/roof, and loose equipment). Examples include machine shop equipment, manipulator arms, control panels, overhead and wall mounted cranes, carts, tools, etc.

3.2.2 Ventilation

Two types of ventilation systems will need to be remediated. The first type is the HVAC system including the compressors, boilers, and ductwork. The HVAC system is not anticipated to be radiologically impacted. However, there is a possibility of contamination in areas where they serviced the radiologically impacted areas. The second type is the radiological air handling system. This was used to filter the air during disassembly and postmortem cell operations and includes filters, blowers, and ductwork. This system is expected to be radiologically impacted and will be characterized prior to removal and disposal.

3.2.3 Piping

Pipes were used to transport various liquids and gases to support activities at R-MAD. These include process water, waste water, sanitary waste, compressed air, and other compressed gases. Exposed pipes and concrete encased pipes (within floors and walls) will be encountered.

The sources of the exposed piping will be identified to determine whether they may be impacted with either radiological or hazardous substances. Concrete encased pipe will be characterized to determine contaminant levels prior to closing in-place.

3.2.4 Lead Glass

Leaded glass windows were used to view disassembly operations. These windows are 1.8 m (6 ft) thick and contain layers of leaded glass immersed in mineral oil. The windows are hot side loaded and were installed in a metal frame. Lead shot was used as shielding and was placed between the window frame and walls. The windows are expected to be radiologically impacted and do contain a hazardous substance (i.e., lead shot).

3.2.5 Asbestos Containing Material

Asbestos containing material is present in R-MAD in the form of floor tiles, drop ceiling tiles, and pipe insulation. The ACM may be radiologically impacted depending on its location in the R-MAD Building. The ACM in the non-impacted side of the building is not expected to be radiologically impacted. Asbestos containing material on the impacted side of the building may be radiologically impacted and will be characterized prior to removal.

3.2.6 Electrical System

Electrical equipment includes conduit, outlets, fixtures, cables, cable trays, breaker boxes, ballasts, and bulbs. Electrical equipment will be de-energized prior to removal. Mercury-vapor bulbs are universal waste and will be disposed as such. Fluorescent bulbs will also be disposed as universal waste (40 CFR 260.10). Fluorescent light ballasts that contain PCBs will be collected into a 208-liter (L) (55-gallon [gal]) drum and disposed as bulk PCB waste.

3.2.7 Decontamination

Decontamination may be required on vertical and horizontal surfaces (walls, floors, and ceilings). Types of contamination that may be encountered include radiological, hydraulic fluids containing PCBs, and hydrocarbon-based liquids.

3.3 CLOSURE ACTIVITIES

3.3.1 Equipment Removal

This section will describe all of the steps required to remove and dispose of equipment within the R-MAD Building.

3.3.1.1 Draining and Disposal of Fluids

Equipment may contain fluids that must be drained prior to being removed. These liquids are typically petroleum hydrocarbon based and include hydraulic fluid, lubricating oils, cutting oils, and transformer oil. In addition, based on E-MAD characterization data, the hydraulic fluid may contain PCBs.

Fluids will be drained from the equipment and collected in appropriate containers. The liquids will be sampled to determine if radiological or hazardous materials are present. Once the fluids have been characterized, they will be properly disposed. Waste management activities are summarized in Section 5.0.

3.3.1.2 Removal Process

Mounted equipment will be unbolted or cut from their mountings, as appropriate, and moved to a staging area using a forklift or other appropriate equipment. Overhead cranes will either be disassembled in sections or dropped using explosives before being moved to the staging area. Loose equipment will be moved, as is, to the staging area.

3.3.1.3 Release

Prior to release, all equipment will be radiologically surveyed. Equipment that can be free released, will be sent to the Area 9 U-10c landfill for disposal. Radiologically impacted equipment will be either decontaminated and disposed within the Area 9 U-10c landfill, or disposed as low-level waste. Criteria for release will follow Table 4-2 of the NV/YMP Radiological Control Manual (Table 5).

3.3.2 Ventilation System Removal

This section will describe all the steps required to remove and dispose of the various ventilation systems within the R-MAD Building.

3.3.2.1 Waste Classification

The HVAC systems will be classified according to their location in the building. The system that serviced the cold side of the building is not expected to be radiologically impacted. This system will be radiologically surveyed prior to disposal.

Other types of waste that may be encountered include compressor oils and lubricants, refrigerants such as Freon™, and thermostats containing mercury. These substances will be properly removed and disposed prior to ventilation system dismantlement.

3.3.2.2 Dismantlement

Dismantlement of the ventilation systems will be done by removing the ductwork and registers. Equipment such as the blowers, compressors, and boilers will also be removed either from the roof or equipment rooms using appropriate heavy equipment.

System components determined to be radiologically impacted will be disposed in an appropriate landfill. Non-radiologically impacted components will be disposed or salvaged, as appropriate.

3.3.3 Radiological Air Handling System Removal

The radiological air handling system was used to filter the air during disassembly and hot cell operations and includes filter banks, blowers, ductwork, and exhaust stacks. This system is expected to be radiologically impacted.

3.3.3.1 Waste Characterization

The air handling system will be characterized to determine the amount and type of radiological contamination present. Once characterized, the components will be classified and disposed according to classification requirements.

3.3.3.2 Filter Removal and Storage

The filters will be removed before any dismantling begins. The filter system is comprised of a bank of HEPA filters enclosed in a frame assembly. Air from the disassembly areas was pulled through the filters and exhausted up the stacks. The filters will be removed from the frame assembly, under a controlled work process and stored on-site until being disposed.

3.3.3.3 Dismantlement

The radiological air handling system will be dismantled following removal of the filters. The filter assembly, blowers, and ductwork will be dismantled or disassembled as necessary. Radiologically impacted components will be characterized, classified, and disposed in an appropriate landfill. Nonradiologically impacted components will be disposed or salvaged, as appropriate.

3.3.4 Lighting Removal

Lighting removal includes the removal of light bulbs, ballasts, and fixtures. Types of bulbs that may be present include incandescent, fluorescent, and mercury vapor. Fixtures may be ceiling or wall mounted.

3.3.4.1 Waste Classification

The lighting components may be classified as radiologically impacted, nonradiologically impacted, or universal waste. Mercury vapor light bulbs and fluorescent light bulbs are universal waste. Nonradiologically impacted fixtures, incandescent light bulbs, and fluorescent light ballasts will be disposed as construction debris.

It is anticipated that any radiological contamination present will be in the form of dust. Therefore, any potentially hazardous components (mercury vapor and fluorescent bulbs) will be decontaminated prior to disposal. All other radiologically impacted components will be disposed as low-level waste.

3.3.4.2 Dismantlement

The first step in the dismantlement of the lighting system will be verifying that the circuits have been de-energized. Radiological surveys will then be conducted. Then the bulbs and ballasts will be removed and decontaminated as necessary. Finally, the fixtures will be removed. Ceiling mounted fixtures will be accessed using a scissors lift or other appropriate means. After removal, the components will be staged prior to disposal.

3.3.5 Conduit Removal

Conduit removal includes the removal of conduit, outlets, cables, cable trays, breaker boxes, and electrical equipment such as motors, control panels, and transformers.

3.3.5.1 De-energize Circuits

Prior to any work being done on electrical systems, the circuits will be de-energized and disconnected from the main power supply by a qualified electrician.

3.3.5.2 Waste Classification

Waste will be classified based on the results of radiological surveys. In addition, transformer oil may contain PCBs which must be disposed in a permitted hazardous waste landfill.

Radiologically impacted components will be assessed and classified appropriately. Nonradiologically impacted components will be disposed at the NTS Construction Landfill or sent to salvage, as appropriate.

3.3.5.3 Dismantlement

All exposed conduits, outlets, and breaker boxes will be removed flush to the walls. Any wires or components within walls will be left in place. Cables that pass through walls from hot to cold areas will be cut flush with the cold side wall. Cables will be removed from their trays and the trays will be removed from the walls. Equipment such as motors, transformers, and control panels will be drained, if necessary, and then removed.

Items such as copper wire and cable will be salvaged where practical. Items such as motors and transformers will be salvaged unless the radiological surveys required for free release are not feasible. Otherwise, the items will be disposed in an appropriate landfill.

3.3.6 Restroom/Shower Room Removal

Restroom and shower room dismantling includes the removal of toilets, sinks, showers, and stalls. Exposed piping will also be removed.

3.3.6.1 Waste Characterization

Rest/shower rooms may be radiologically impacted based on their intended use. Two types of rest/shower rooms are present in R-MAD. The facilities in the cold and administrative areas are not expected to be radiologically impacted. Facilities used for hot change and personnel decontamination are likely to be radiologically impacted. The facilities in both areas will be radiologically surveyed to determine the appropriate disposal. Joints were sealed with lead solder. Therefore, any lead solder joints removed from these areas will be recycled, used as scrap metal, or disposed as hazardous waste.

3.3.6.2 Dismantlement

Toilets, urinals, and sinks will be removed. Exposed piping and shower heads/valves will be

removed flush to the walls or floors. Stalls and dividers will also be removed. Drains and pipes within walls and floors will be sealed and are covered in Section 3.3.8.

3.3.7 Exposed Piping Removal

Pipes were used to transport various liquids and gases to support activities at R-MAD. These include process water, waste water, compressed air, and other compressed gases.

3.3.7.1 Determination of Pipe Source

The sources of the exposed piping will be identified to determine whether they may be impacted with radiological or hazardous substances. The pipes will also be bled or drained to reduce spillage or injury due to pressurization or ignition of flammable gases.

3.3.7.2 Waste Classification

Pipes will be classified for waste disposal based on their location and contents. Pipes in radiologically impacted areas or those which contained waste water are expected to be radiologically impacted. Pipes in non-radiologically impacted areas or those which contained compressed gases, process water, or domestic water are not expected to be radiologically impacted. All piping will be radiologically surveyed prior to disposal. Copper pipes may be salvaged, if practical. Any pipe joints sealed with lead solder will be removed and either recycled or disposed as scrap metal or hazardous waste. Pipe elbows may be insulated with ACM.

3.3.7.3 Dismantlement

All exposed pipe will be removed flush to walls and floors. Pipe hangars and racks will also be removed. If pipe elbows are insulated with ACM, the entire elbow will be removed and disposed as ACM.

3.3.8 Concrete Encased Piping Stabilization

In addition to exposed piping, drains and other pipes exist within floors and walls (Figure 10). Due to safety and practicality issues, these pipes will not be removed. Grout will be introduced into the pipes, and floor drains will be sealed to prevent the accumulation of additional liquid or debris and to stabilize pipe contents.

3.3.8.1 Pipe Grouting

A free-flowing, slightly expanding grout, and/or epoxy or foam, will be introduced into the pipes under pressure. This will allow the entire pipe to be filled, the contents encased, and void spaces minimized due to shrinkage. Pipes will be grouted from the farthest upstream drain or clean-out. If possible, the grout introduced into radiologically contaminated piping will be colored to visually identify the presence of contamination. This will assist in the segregation of the contaminated material when the building is demolished.

3.3.8.2 Verification of Closure

Verification is necessary to confirm that the pipes have been filled with grout. Verification will be done by locating and opening the farthest downstream clean-out for each pipe run still within the building. Grout observed at these clean-outs will verify the pipes are completely grouted within the building.

3.3.9 Floor Tile Removal

Floor tiles are used extensively throughout the R-MAD facility in both the radiological and nonradiological areas. These tiles need to be removed prior to building demolition.

3.3.9.1 Waste Classification

Two types of floor tiles are expected. Waste classification will be based on the particular type of tile.

3.3.9.1.1 ACM Floor Tile

Asbestos containing material floor tile is that which contains >1 percent ACM. Tile adhesive (mastic) is also ACM. Based on work done during the "Salvage Activity", 23 centimeters (cm) (9 in) by 23 cm (9 in) tile will be considered ACM. All other tile sizes will be sampled as necessary to determine asbestos content. This tile will be disposed as asbestos waste.

3.3.9.1.2 Floor Tile

Floor tile and mastic containing <1 percent asbestos is not considered ACM. This type of tile will be disposed as construction debris.

3.3.9.2 Removal Process

Asbestos containing material tile will be removed following industry-standard asbestos abatement procedures. Personnel removing ACM will be qualified asbestos workers. Any tiles that are radiologically impacted will be decontaminated, as appropriate, prior to removal. If tiles cannot be decontaminated, they will be disposed as low-level waste.

Non-ACM tiles will be removed following standard procedures. Any tiles that are radiologically impacted will be decontaminated, as appropriate, prior to removal. If tiles cannot be decontaminated, they will be disposed as low-level waste.

3.3.10 Drop Ceiling Removal

Drop ceilings are used extensively throughout the R-MAD facility in both the radiological and non-radiological areas. These ceilings need to be removed prior to building demolition.

3.3.10.1 Waste Classification

Two types of drop ceilings (ACM tile and non-ACM tile) are expected and waste classification will be based on the particular type of ceiling.

3.3.10.1.1 ACM Ceiling Tile

ACM ceiling tile is that which contains >1 percent ACM. This ceiling tile will be disposed as asbestos waste. Ceilings will be sampled as necessary to determine ACM content.

3.3.10.1.2 Ceiling Tile

Ceiling tile containing <1 percent asbestos is not considered ACM. This type of ceiling tile will be disposed as construction debris.

3.3.10.2 Removal Process

Asbestos containing material ceiling tile will be removed following industry-standard asbestos abatement procedures. Personnel removing ACM will be qualified asbestos workers. Any ceiling tiles that are radiologically impacted will not be decontaminated; they will be disposed as low-level waste.

Non-ACM tiles will be removed following standard procedures. Any tiles that are radiologically impacted will not be decontaminated; they will be disposed as low-level waste.

The ceiling brackets and framework will also be removed. This material will be disposed as construction debris. Any radiologically impacted framework will be disposed as low-level waste, if it cannot be decontaminated.

3.3.11 Lead Glass Window Removal

Leaded glass windows were used to view disassembly operations. These windows are 1.8 m (6 ft) thick and contain layers of leaded glass immersed in mineral oil. The windows are hot side loaded and are set in a metal frame. Lead shot used as shielding was placed between the frame and walls. The windows are expected to be radiologically impacted, the leaded glass will be evaluated to determine if it is a hazardous substance. The lead shot used as packing/shielding around the leaded glass frame will be recycled or disposed as a mixed waste.

3.3.11.1 Waste Classification

Waste will be classified based on the presence of radiological and/or hazardous constituents. Portions of the window assembly are anticipated to be radiologically impacted. Lead shot is hazardous waste. The window glass may contain lead and will be sampled prior to disposal. The mineral oil will also be sampled prior to disposal to determine if hazardous constituents are present. Any hazardous components that are also radiologically impacted will be considered mixed waste.

3.3.11.2 Window Removal

Since the windows consist of several layers of glass, it has similar characteristics to an electrical circuit capacitor (i.e., it is capable of storing a significant electric charge). Therefore, the window units will be grounded prior to removal. In addition, the window openings are configured such that the window assemblies can only be removed from the "hot" side.

Mineral oil will be drained from the window assemblies before window removal. The oil will be drained into an appropriate container before being sampled and disposed.

The window assemblies will be removed using a fork lift or other appropriate equipment. A collection system will be set up to contain the lead shot as the window assembly is withdrawn from the wall opening. Once removed, the windows and lead will be moved to a staging area to be radiologically surveyed prior to disposal.

3.3.11.3 Lead Shot and Mineral Oil Waste Management

The lead shot will be radiologically surveyed prior to disposal. Radiologically impacted lead shot will be managed as a mixed waste. Nonradiologically impacted lead shot will be managed as hazardous waste.

Mineral oil will be sampled to determine if it contains radiological or hazardous constituents. The oil will be managed based on sample results or recycled.

3.3.12 Surface Decontamination

Vertical and horizontal surfaces (walls and floors) and irregular surfaces (corners, curved surfaces) may be impacted with radiological and hazardous constituents and will require decontamination. The two primary forms of contamination that may be encountered are radiological impacted paint and hydrocarbon-based liquids including hydraulic fluid containing PCBs.

3.3.12.1 Hot Spot Characterization

Due to the high background radiation levels, areas expected to be impacted will be decontaminated prior to conducting radiological surveys. Once the high background (shine) has been reduced, radiological surveys will be done on surfaces to locate and identify areas of radiological contamination. Areas with removable contamination will be decontaminated by wiping with maslin cloth or rags. Areas of fixed contamination will be decontaminated using more substantial methods which are discussed in the following sections.

3.3.12.2 Shot Blast and HEPA Vacuum System

The preferred method of decontaminating surfaces is the Shot Blast and HEPA Vacuum system. This system uses high velocity hardened steel shot to remove the paint and abrade the concrete. The steel shot is propelled onto and fractures the paint and concrete. The fractured paint/concrete and steel shot is vacuumed up and the shot is separated and reused. The paint and concrete dust is conveyed through a dust collection system into drums. The air is passed through pre-filters and finally a HEPA filter before being exhausted to the atmosphere. The steel shot is continually recycled through the system until it is spent. Then the spent shot is vacuumed into the drums with the paint/concrete dust. This method will be used to decontaminate large surface areas and for removing concrete up to 2.54 cm (1 in) thick, and with special attachments in corners and on irregular surfaces.

3.3.12.3 Scabbling Removal

Areas where contamination is greater than 2.54 cm (1 in) thick will be decontaminated by scabbling. This involves the use of an air or electric hammer with a specialized tip. This tip

chips out the surface and removes the impacted area. The removed concrete will be swept or HEPA vacuumed and placed into drums.

3.4 VERIFICATION

The final radiological unrestricted release surveys will be conducted by Radiological Control Technicians (RCT) under the direction of the Environmental Restoration (ER) Health Physicist. They will be performed to applicable Bechtel Nevada (BN) company directives and BN Radiological Operations organization instructions. Documentation will include floor plans, survey maps and BN Radiation Survey Report forms. Initial data verification is the responsibility of the ER health physicist with final review and concurrence by the BN Radiological Operations Manager and Radiological Control Manager. No additional verification surveys are necessary for final release. After all D&D activities have been completed within the building, unrestricted access will be allowed with General Employee Radiological Training, necessary, due to the Controlled Area posting at the compound perimeter.

3.4.1 Radiological Release Surveys

Radiological release surveys are required to verify that radiological contamination within the building, equipment, and debris created during SAFER activities meet project DCGLs.

3.4.1.1 Surface Surveys

Radiological release surface surveys will be conducted following the standards, instruments, and methods outlined below.

3.4.1.1.1 Release Standards

Radiological surveys for total and removable contamination are required for relatively non-porous surfaces such as high-density concrete, metal, glass and painted wood. Table 4-2 of the NV/YMP Radiological Control Manual (DOE/NV, 2000a) describes the radiological criteria for releasing material to uncontrolled areas or for unrestricted use (see Table 5).

3.4.1.1.2 Instruments

Surface contamination surveys will use the NE Technology Electra portable rate meter combined with the DP series Dual Scintillation probe. The Electra is set to display in dpm. The probe has an active area of 100 cm² (15.5 in²) and a two-layer polycarbonate window. The probe allows for the simultaneous survey of alpha and beta-gamma contamination. The RCTs can change the Electra display to show the alpha or beta activity only, or the alpha and beta activity combined. Audio alarm levels can also be input to alert the RCT to elevated alpha or beta activity when they are using the combined alpha-beta activity channel, and the alpha-only or beta-only channels. The RCT can then change the display to the alarming alpha or beta channel to observe the activity level.

The Tennelec Model LB 5100 scaler, or equivalent instrument, is used for assessing removable alpha and beta-gamma contamination on swipes taken during radiological surveys. It is a very low-background gas proportional counter with a multi-sample changer controlled by a terminal. The data is saved to a printer. The printout is attached to the appropriate radiation survey report after the results of the Electra survey, and swipe surveys are summarized and reviewed.

3.4.1.1.3 Methods

The final verification survey plans will be developed for each room within the radiologically impacted portions of the building after all remediation activities have been completed. Prior to the remediation, the following areas have been classified according to the guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA, 1997):

- The Class 1 areas are impacted with concentrations of residual radioactivity greater than NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values for beta-gamma emitters and the uranium alpha emitters ²³⁴U, ²³⁵U and ²³⁸U. The Class 1 areas are the Contamination Areas presently posted within the building and include Rooms 121 (mechanical room), 123 (high bay), 202 (mezzanine), 127, 132, 133, 134, 143, 144, 145, 146, 147, 148, 149 (small hot cells) and 6 and 7 (basement utility rooms) (Figures 2, 3, & 4).
- The Class 2 areas are impacted with concentrations of residual radioactivity that are not expected to exceed the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values for beta-gamma emitters and the uranium alpha emitters ²³⁴U, ²³⁵U and ²³⁸U. However, small discrete areas of residual radioactivity exceeding the NV/YMP Radiation

Control Manual Table 4-2 (DOE/NV, 2000a) values are possible based on present survey data and planned remediation operations. The Class 2 areas include the remainder of the rooms within the building that were radiologically posted before the Title 10 CFR 835 (DOE, 1997) criteria had been adopted. These rooms are referenced as the cell service areas.

- The Class 3 areas are those with a low probability of being impacted with concentrations of residual radioactivity exceeding natural background. The Class 3 areas include the remainder of the rooms within the R-MAD Building, all the exterior walls and the roof. Some roof sections could become Class 2, if ventilation or exhaust systems are determined to be radiologically impacted.

The minimum grid size for documenting the final survey results will be 1 m² (10.6 ft²). It is expected that the Class 1 areas will require a 1 m² (10.6 ft²) grid survey summary map to document final residual radioactivity on the floors and to a 2 m (6.5 ft) height on the walls. For the remainder of the wall areas in the larger Class 1 rooms, grid sizes of 4-10 m² (169-1,056 ft²) are expected. Any survey results from beams, ledges, fixtures or other horizontal surfaces above 2 m (6.5 ft) from the floor will be documented on separate survey maps. If these areas are Class 1, each item less than 1 m² (10.6 ft²) will be documented and lengths of 1 m (3.25 ft) will be used for the final map. If these areas are Class 2, survey intervals from 1-5 m (3.25-16.3 ft) are expected for final maps.

The Class 2 area verification survey results are expected to be reported using grid sizes from 4-10 m² (169-1,056 ft²). For small areas impacted above NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values, the maps will include 1 m² (10.6 ft²) grid results to demonstrate compliance with the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values for removable and total contamination, if necessary.

The Class 3 area verification survey results are expected to be reported using grid sizes from 10-100 m² (1,056-105,625 ft²). Some interior room dimensions will allow for reporting single results for each wall, the floor and the interior ceiling. Final survey results for the building exterior are expected to be reported in grid sizes of 100 m². The outside surveys should be more random and will be limited to a reasonable safe height as determined by the ER health physicist.

Since the COPC are limited to ¹³⁷Cs and ⁹⁰Sr as the primary beta-gamma emitters, and ²³⁴U and ²³⁵U as the primary alpha emitters, the removable contamination value of 1,000 dpm/100 cm² and the total contamination value of 5,000 dpm/100 cm² applies for both alpha and beta-gamma results for the final verification surveys. Also, the scaling factors used for waste determination

show the total beta-gamma activity exceeds the total alpha activity by an approximate 4.5:1 ratio. The final survey maps can then summarize only beta-gamma results to demonstrate compliance with Table 4-2 (DOE/NV, 2000a). BN Radiological Operations procedures also allow for reporting only portable instrument results, if they are less than the limits for removable contamination.

The RCTs will be instructed to record the beta-gamma results from the Electra surveys in their grid or other survey maps. A swipe sample will only be necessary for a location that exceeds 1,000 dpm/100 cm² beta-gamma minus the area background. The scanning speed should be approximately 1.3 cm/second (sec) (0.5 in/sec) and at not more than 1.3 cm (0.5 in) above the surface being surveyed. They should average measurements less than 1,000 dpm minus background, but an integrated count will be taken at any location exceeding 1,000 dpm minus background.

3.4.1.2 Pipe, Ventilation, and Wall Penetration Surveys

Radiological release surveys of piping, ventilation, and wall penetrations will be conducted following the standards, instruments, and methods outlined below.

3.4.1.2.1 Release Standards

Radiological surveys for total and removable contamination are required for relatively non-porous surfaces such as high-density concrete, metal, glass and painted wood. Table 4-2 of the NV/YMP Radiological Control Manual (DOE/NV, 2000a) describes the radiological criteria for releasing material to uncontrolled areas or for unrestricted use. However, as the surfaces to be surveyed become more complex or inaccessible, demonstrating compliance with the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) becomes a greater challenge. In some cases, complete surface surveys are not possible and the contamination must be fixed in place.

Some of the radiologically impacted pipe and ventilation systems will remain within the R-MAD Building due to the original construction design. Access to these systems will be limited to locations where they penetrated the concrete walls or floors. Final contamination values or activity levels for these systems may be calculated from a variety of count rate and exposure rate instruments. The pipe and ventilation systems will then be grouted or filled with epoxy or foam. Final surface surveys will be conducted for release of the floor or wall section where the pipe or duct was filled.

3.4.1.2.2 Instruments

For surface contamination surveys of the larger diameter pipes, ventilation ducts and wall penetrations, the NE Technology Electra portable rate meter combined with the DP series Dual Scintillation probe will be used. Most pipe and ventilation duct surveys will use the beta-gamma display only because of the difficult survey conditions (i.e., curved surfaces, sharp turns, long reach, etc.).

The Tennelec Model LB 5100 scaler or equivalent instrument will be used to count swipes taken during radiological surveys for assessing removable alpha and beta-gamma contamination.

Additional surveys will be performed using a variety of Geiger-Mueller detectors. The two types expected to be used are the "pancake" and side-window probe. They are more rugged and durable than the Electra probe for internal pipe and duct surveys. They are sensitive to beta-gamma radiation. These instruments will be used primarily as indicators of contamination in inaccessible areas. Calculations to convert exposure rate or count rate readings to dpm/100 cm² or total activity may be necessary to characterize sections of pipe or ducting before it is sealed.

3.4.1.2.3 Methods

The final verification survey plans will be developed for the radiologically impacted portions of any piping, ducting system, or wall penetration expected to remain after remediation activities have been completed. If decontamination is attempted, interim surveys will be conducted to evaluate progress. Prior to the remediation, the following piping and duct systems have been classified according to the guidance provided in the MARSSIM (EPA, 1997):

- The Class 1 systems are impacted with concentrations of residual radioactivity greater than the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values for beta-gamma emitters and the uranium alpha emitters ²³⁴U, ²³⁵U and ²³⁸U. The Class 1 areas are the floor drains and pipes in Rooms 121 (mechanical room), 123 (high bay), 202 (mezzanine), 127, 132, 133, 134, 143, 144, 145, 146, 147, 148, 149 (postmortem cells) and 6 and 7 (basement utility rooms) (Figures 3, 4, & 5). The ventilation ducts from the small hot cells into basement Rooms 6 and 7 HEPA filter banks are also Class 1. The small hot cells have a number of plugs in the walls used for manipulators, pass troughs and other handling tools. It is expected that the plugs or the housings will be contaminated above the NV/YMP Radiation Control Manual Table 4-2 limits (DOE/NV, 2000a). The manipulator arm mechanisms and utility line piping into the big bay and

mezzanine are also suspected of containing some residual contamination inside the wall penetrations.

- The Class 2 systems are impacted with concentrations of residual radioactivity that are not expected to exceed the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values for beta-gamma emitters and the uranium alpha emitters ^{234}U , ^{235}U and ^{238}U . However, small discrete areas of residual radioactivity exceeding the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) are possible based on present survey data and planned remediation operations. The Class 2 systems include the remainder of the cell service area room floor drains and piping within the building that may have been affected during previous decontamination operations. A number of the rooms had fixed contamination locations on the floor tile or concrete possibly indicating higher levels of contamination prior to decontamination activities in the 1970s. The exhaust side of the HEPA filter banks for the hot cells and big bay are considered Class 2 until surveys are conducted.
- The Class 3 systems are those with a low probability of being impacted with concentrations of residual radioactivity exceeding natural background. The Class 3 systems include the remainder of the floor drains and associated piping within the R-MAD Building. All of the water, electrical, air, and other utility piping within the building are expected to be Class 3 except where they have been routed inside the hot cell areas. Some of the commercial ventilation or exhaust systems could become Class 2 if they are determined to be radiologically impacted.

It is expected that the remnants of Class 1 systems will require grouting, epoxy, or foam sealants to prevent access to any contaminated internal surfaces. The fill material will be colored such that the remnants can be recovered from the rubble after the building is demolished. The final survey data for building release will include the survey results on the floors or walls where the pipe or duct system was sealed. These areas will generally be less than 1 m² (10.6 ft²).

Class 2 system verification survey results are expected to be reported using lengths from 1-2 m (3.25-6.5 ft). Any remnants of the pipe, conduit or duct systems are expected to be less than 2 m (6.5 ft) in length to facilitate demolition and loading for landfill disposal. For small internal areas impacted above the NV/YMP Radiation Control Manual Table 4-2 (DOE/NV, 2000a) values, that section of the pipe or duct may be filled with colored grout or foam, if necessary.

The Class 3 system remnant verification survey results are also expected to be reported using lengths of 1-2 m (3.25-6.5 ft). These surveys will be of a random fraction of the total number of remnant sections left in place.

3.4.1.3 Porous Materials Survey

Radiological release surveys of porous materials will be conducted following the standards, instruments, and methods outlined below.

3.4.1.3.1 Release Standards

Radiological surveys for total and removable contamination are required for porous surfaces such as ceiling tiles, pipe and wall insulation and unpainted wood. Table 4-2 of the NV/YMP Radiological Control Manual (DOE/NV, 2000a) describes the radiological criteria for releasing material to uncontrolled areas or for unrestricted use. However, since the surfaces to be surveyed are porous, demonstrating compliance with Table 4-2 (DOE/NV, 2000a) is difficult. A conservative approach will be taken and all potential internal and external contamination will be assumed to be uniformly distributed on the outside surface of the porous material. The removable contamination limit of 1,000 dpm/100 cm² for beta-gamma and uranium alpha will be used for any porous material remaining within the building after the D&D activities have concluded. Any subsequent disturbance or removal of this material will not result in removable contamination exceeding the NV/YMP Radiation Control Manual Table 4-2 limits (DOE/NV, 2000a).

3.4.1.3.2 Instruments

For surface contamination surveys of porous material, the NE Technology Electra portable rate meter combined with the DP series Dual Scintillation probe will be used. The probe allows for the simultaneous survey of alpha and beta-gamma contamination. The Electra can detect both alpha and beta-gamma surface activity below the removable contamination limit of 1,000 dpm/100 cm².

3.4.1.3.3 Methods

The RCTs will be instructed to record the beta-gamma results from the Electra surveys on their survey maps. A swipe sample will not be necessary for any location exceeding 1,000 dpm/100 cm² beta-gamma minus the area background because the suspect area or piece will be removed for later characterization as landfill or low-level waste. The scanning speed should be approximately 1.3 cm/sec (0.5 in/sec) and at not more than 1.3 cm (0.5 in) above the surface being surveyed. They should average measurements less than 1,000 dpm minus background, but shall take an integrated count at any location exceeding 1,000 dpm minus background.

The porous materials expected to remain within the R-MAD Building should be Class 3 with a low probability of being impacted with concentrations of residual radioactivity exceeding natural background. These Class 3 materials include the non-asbestos ceiling tiles, unpainted wood braces and walls, insulation, and possibly some roofing material.

3.5 DURATION

The R-MAD decommissioning is scheduled to be completed by September 30, 2002. Since this is a multi-year project, activities will be conducted in stages. All attempts will be made to conduct work in a manner that minimizes the amount of mobilizing and demobilizing of equipment and personnel required to complete the decommissioning process.

The present end-state for the R-MAD Building is demolition. However, based on funding restrictions, an interim status will be achieved during this phase of the decommissioning process. The R-MAD Building will be placed in a safe condition which will minimize long-term S&M costs. The safe condition will result in having all hazardous materials removed from the building, all accessible radiological contamination removed to free-release levels, and stabilization of radiological contamination located in inaccessible (i.e., pipes & ventilation) spaces within the R-MAD Building foot print.

Figure 11 provides a schedule for putting the R-MAD Building in the safe configuration identified above. This schedule is based on the assumption that the funding required to complete this scope of work will be available for this project.

FIGURE 11
 CAU 113 -RMAD SAFER SCHEDULE

4.0 REPORTS AND RECORDS AVAILABILITY

Prior to beginning R-MAD decommissioning field activities a number of work processes need to be in-place. These work processes are documented in planning documents such as:

- Site-Specific Health and Safety (SSHASP) Plan.
- Field Management Plan (FMP).
- National Environmental Policy Act (NEPA) checklist.
- Real Estate/Operations Permit (REOP).
- Radiological Work Permit (RWP).

These documents will be on-site and referred to as necessary to perform work in a safe and orderly manner. Specific daily activities will be documented in Daily Activity Reports. Radiological survey results will be documented on Radiological Survey Reports and all waste generated will be documented on Waste Tracking Forms.

4.1 SITE-SPECIFIC HEALTH AND SAFETY PLAN

A SSHASP (including a Hazard Assessment [HA]) will be prepared and the signed original, or a copy, will be kept at the work site by the Site Health and Safety Officer (SHSO). The site SSHASP will be available for review and signature by all workers prior to beginning work. The SHSO will also maintain a material safety data sheet (MSDS) file, available for review, of chemicals brought to the site. The SSHASP will provide detailed, job-specific information covering physical and environmental hazards, protection against accidents and exposure to contamination by workers. The SSHASP also provides details for weather/air monitoring, accident reporting, and emergency procedures. Additional copies of the SSHASP will be kept on file in the BN Environmental Restoration office in Mercury, Nevada.

4.2 FIELD MANAGEMENT PLAN

An FMP will be prepared for the decommissioning activities. The FMP will outline how the

work will be accomplished and will provide an integrated safety management (ISM) plan and a detailed schedule for the project. In addition, the FMP will identify the responsible parties for each aspect of the project and will indicate how decisions will be made. Copies of the FMP will be available at the work site and will be on file in the BN Environmental Restoration office in Mercury, Nevada.

4.3 NATIONAL ENVIRONMENTAL POLICY ACT CHECKLIST

A NEPA checklist and any subsequent documentation will be completed prior to beginning any decommissioning activities. A cultural resource evaluation of the historical significance of the R-MAD Building is required. In the event that decommissioning support activities impact areas and wildlife adjacent to the R-MAD Building, follow-up surveys will be performed. Copies of the NEPA checklist and support documentation will be on file in the BN Environmental Restoration office in Mercury, Nevada.

4.4 OTHER PERMITS

Other permits required before starting decommissioning activities include a REOP and RWP. In addition, hot work and utility clearance permits will be required before specific activities are performed. Copies of all permits will be available at the work site and on file in the BN Environmental Restoration office in Mercury, Nevada.

4.5 DAILY ACTIVITY REPORT

A detailed daily activity report will be compiled by the R-MAD decommissioning field team. The purpose of the report is to document activities that have been completed. The report also identifies any issues on that day and reports how each issue was resolved. A copy of the Daily Activity Report is sent out to R-MAD Decision Team members to update them on project progress.

The DOE/NV Environmental Restoration Division (ERD) R-MAD Task Manager (TM) will transmit a copy of the daily activity report to Nevada Division of Environmental Protection (NDEP) oversight staff member. The DOE/NV ERD R-MAD TM will liaison with the NDEP oversight staff member and will provide any requested additional field information. Copies of

the daily activity report and support documentation will be on file in the BN Environmental Restoration office in Mercury, Nevada.

4.6 RADIOLOGICAL SURVEY REPORTS

A radiological survey report will be completed for each radiological survey completed during the R-MAD decommissioning. Typical radiological surveys include:

- Material being removed from Contamination Areas (CAs).
- Equipment used inside CAs.
- Characterization Surveys.
- Final Status (Verification) Surveys.

Radiological survey reports are filled out by RCTs following procedures outlined in the Radiological Control Technician Field Manual. Specific information includes fixed contamination readings, removable contamination readings, and exposure readings. Copies of the Radiological Survey Reports and support documentation will be kept on file in the BN Environmental Restoration office in Mercury, Nevada.

4.7 WASTE TRACKING FORM

A Waste Tracking Form will be prepared for each waste package generated during the R-MAD decommissioning field work. The following information is provided in the Waste Tracking Form:

- Waste generation location.
- Date waste was generated.
- Volume and/or weight of waste.
- Who released the waste from site.

- Where the waste is being taken.
- Who received the waste.

Copies of the Waste Tracking Form and support documentation will be on file in the BN Environmental Restoration office in Mercury, Nevada.

5.0 INVESTIGATION/REMEDIATION WASTE MANAGEMENT

All waste will be stored, sampled, analyzed, and disposed of in accordance with applicable state and federal regulations, the RCRA Part B Permit (NDEP, 1995), DOE Orders, and BN Procedures. Details for the management of waste containers and each waste stream identified in Section 5.4 are discussed in greater detail in the Waste Management Plan (WMP) located in Appendix E.

5.1 WASTE IDENTIFICATION PROCESS

Waste needing additional characterization will be sampled following an approved sampling and analysis plan (SAP). The SAP will be reviewed and approved by the BN D&D TM. The majority of this waste has sufficient characterization data to facilitate proper disposal. For waste that needs additional characterization, the minimum sampling requirements are discussed in this section.

5.1.1 Sampling Requirements

If waste is being characterized for radiological characteristics, the BN Waste Certification Official will review and approve the SAP. At a minimum, the SAP will address the following:

- Sampling plan objectives.
- Data quality objectives (includes quality assurance samples).
 - confidence levels
 - precision
 - accuracy
 - representativeness
 - comparability
 - completeness
- Number and location of samples.

- Sampling technique.
- Sampling equipment.
- Field decontamination of sampling equipment.
- Field observations and notebook.

Field observations and notes will be documented in a field notebook of all sampling procedures. All entries into the logbook will be made with indelible ink. Field observations include:

- Time and date.
- Sampler(s).
- Waste type and physical characteristics
- Sample locations cross-referenced to sample numbers.
- Any deviations from the SAP.

A copy of the field notes will be provided to the BN D&D TM upon completion of the sampling event.

At present, the Environmental Service Statement of Work incorporates much of the needed information discussed above. If found sufficient by the BN D&D TM, this form may replace the SAP.

5.2 WASTE HANDLING

Title 40 CFR 265, Subpart I (EPA, 1996c), requires that all hazardous waste container storage areas must have a containment system. However, if the containers hold only wastes that do not contain free liquids and the containers are elevated or are otherwise protected from contact with accumulated liquid, the storage area need not have a containment system (40 CFR 264.175 [c][2]) (EPA, 1996b). Drums containing liquid wastes will be placed on spill containment pallets.

5.2.1 Nonhazardous Waste

All solid waste generated outside the disassembly bay and postmortem cell area, and solid waste generated within the disassembly bay and postmortem cell area found to be below the permissible radiological surface and mass concentration for the Area 9, U-10c Industrial Landfill, will be managed as nonhazardous solid waste. All nonhazardous solid waste will be disposed of in the Area 9, U-10c Industrial Landfill.

5.2.1.1 Salvage

Material removed from the non-impacted portion of the R-MAD Building may be sent to NTS Salvage for sale or reuse. All material will be screened to verify that the permissible radiological surface and mass concentration for the Area 9, U-10c Industrial Landfill Permit is not exceeded. If the material exceeds this criteria it will be disposed as low-level waste (LLW).

5.2.1.2 Construction Debris

All waste generated within the disassembly bay and postmortem cell area will be screened for the presence of radiological COPC identified in Section 3.1. Non-hazardous solid waste that exceeds the permissible radiological surface and mass concentration for the Area 9, U-10c Industrial Landfill Permit will be classified as LLW. This waste will be managed in accordance with BN Organization Procedure OP-2151.304, "Radioactive Waste Tracking, Handling, and Management at the NTS" (BN, 2000b) and stored in the Radiological Material Area (RMA). All other waste will be disposed as non-LLW in the Area 9, U-10c Industrial Landfill.

5.2.2 Hazardous Waste

All items that have the potential of being RCRA-regulated hazardous waste were identified in an inspection conducted by Hazardous Waste Operations in May, 2000. The majority of items identified during this inspection are discussed in the WMP (Appendix E). The remaining waste consist of approximately six 208-L (55-gal) drums that, because of safety and work process controls, have not been breached for inspection, and clear plastic tubing containing residual fluid. After safety issues are addressed, these items will be removed, containerized, labeled and placed in a 90-Day Accumulation Area to await analysis. An appropriate sampling plan will be

developed and implemented. Results of this sampling effort will provide the basis for the appropriate treatment and disposal actions.

5.2.3 Asbestos-Containing Material

All ACM will be handled by a trained asbestos worker and managed in accordance with BN Company Directive CD-0444.012, "Asbestos Management" (BN, 1999). All ACM will be placed in appropriate containers and disposed of in the Area 9, U-10c Industrial Landfill.

5.2.4 Asbestiform Low-Level Radioactive Waste

Asbestiform Low Level Waste (ALLW) will be stored in an established RMA and managed in accordance with BN Organization Procedure OP-2151.304, "Radioactive Waste Tracking, Handling, and Management at the NTS" (BN, 2000b), BN Company Directive CD-0444.012, "Asbestos Management" (BN, 1999), and DOE Guidance Document L-E10.302.LRM "Management Plan for the Disposal of Low-Level Waste With Regulated Asbestos Waste" (DOE, 1999b).

5.2.5 Low-Level Waste

Low-level waste will be stored in an established RMA (Figure 12) and managed in accordance with BN Organization Procedure OP-2151.304, "Radioactive Waste Tracking, Handling, and Management at the NTS" (BN, 2000b), and all applicable state and federal regulations.

5.3 WASTE MINIMIZATION

Waste generation will be minimized by limiting the number of personnel and equipment/tools working inside the exclusion zone. Radiological waste will be further reduced by removing just the impacted paint during the hot cell decontamination process. Waste volumes will be further reduced by using field instrumentation to segment waste into specific waste streams. Substantial LLW waste reduction is expected to result from this strategy.

5.4 POTENTIAL WASTE STREAMS

Five waste streams are to be generated during the remediation of the R-MAD Building. These waste streams are:

- Polychlorinated Biphenyls
 - PCB Bulk Product Waste
 - Radioactive/PCB Bulk Product Waste
 - PCB Liquid Waste
- Resource Conservation and Recovery Act regulated hazardous waste
 - Hazardous Debris
 - Universal Waste
- Asbestos
 - Asbestos Containing Material
 - Asbestiform Low-Level Radioactive Waste
- Nonhazardous Radioactive Solid Waste
- Nonhazardous Solid Waste

FIGURE 12
 LOCATION OF R-MAD RADIOLOGICAL MATERIALS AREA

6.0 REFERENCES

BN, see Bechtel Nevada

Bechtel Nevada, 1999. Asbestos Management, CD-0444.012,, Rev. 0, Las Vegas, NV.

Bechtel Nevada, 2000a. Gamma Spectroscopy Measurements R-MAD Rooftop Survey, Area 25 Nevada Test Site, Las Vegas, NV.

Bechtel Nevada, 2000b. Radioactive Waste Tracking, Handling, and Management at the NTS, OP-2151.304,, Rev. 2, Las Vegas, NV.

DOE, see United States Department of Energy

DOE/NV, see United States Department of Energy, Nevada Operations Office

EPA, see United States Environmental Protection Agency

NDEP, see Nevada Division of Environmental Protection

Nevada Division of Environmental Protection, 1995. Permit for a Hazardous Waste Management Facility Number NEV HW009, United States Department of Energy, Nevada Operations Office, Nevada Test Site.

Nevada Division of Environmental Protection, 1996. Federal Facilities Agreement and Consent Order (FFACO) of 1996. Prepared by Nevada Division of Environmental Protection, U. S. Department of Energy, and U. S. Department of Defense.

NRC, see U. S. Nuclear Regulatory Commission

REECo, see Reynolds Electric and Engineering Company

Reynolds Electric and Engineering Company, Miller, M. G. 1984. NTS Area 25 Radiological Survey and Cleanup Project, 1974-1984, DOE/NV/10327-5, Rev. 1, December 1984.

6.0 REFERENCES (Cont.)

- Tinney, J. F. and Wheeler, D. L. 1999. Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, May 13, 1999.
- U. S. Department of Energy, 1989. A Manual for Implementing Residual Radioactive Material Guidelines, DOE/CH-8901.
- U. S. Department of Energy, 1993. Radiation Protection of the Public and the Environment, Rev. 2, DOE Order 5400.5, Washington, D. C.
- U. S. Department of Energy, 1997. Title 10 Code of Federal Regulations 835, Occupational Radiation Protection, Washington, D. C.
- U. S. Department of Energy, 1999a. Radioactive Waste Management, Rev. 0, DOE Order 435.1, Washington, D. C.
- U. S. Department of Energy, 1999b. Management Plan for the Disposal of Low-Level Waste With Regulated Asbestos Waste, L-E10.302.LRM, Washington, D. C.
- U. S. Department of Energy, Nevada Operations Office, 1999. Nevada Test Site Waste Acceptance Criteria, Rev. 2, Las Vegas, NV.
- U. S. Department of Energy, Nevada Operations Office, 2000a. NV/YMP Radiological Control Manual, DOE/NV/11718-079, Rev. 4, Las Vegas, NV.
- U. S. Department of Energy, Nevada Operations Office, 2000b. Cesium-137 Scaling Factors for Concrete, Insulation, Wood and Concrete Surface Wipes for the Former ROVER Project and NERVA Facilities in Area 25, Nevada Test Site, Nevada, DOE/NV-660, Rev. 0, Las Vegas, NV.
- U. S. Environmental Protection Agency, 1996a. Title 40 Code of Federal Regulations 260.10, Definition - Universal Waste, Washington, D. C.
- U. S. Environmental Protection Agency, 1996b. Title 40 Code of Federal Regulations 264.175, Containment, Washington, D. C.

6.0 REFERENCES (Cont.)

- U. S. Environmental Protection Agency, 1996c. Title 40 Code of Federal Regulations 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Washington, D. C.
- U. S. Environmental Protection Agency, 1996d. Title 40 Code of Federal Regulations 761.50, Applicability, Washington, D. C.
- U. S. Environmental Protection Agency, 1997. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-R-97-016, Washington, D. C.
- U. S. Nuclear Regulatory Commission, 1999. Screening Values for Surface Soil Contamination release Levels, Federal Register Notice, Volume 64, Number 234, December 7, 1999.

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APPENDIX A - DECOMMISSIONING HOLD POINTS

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Figure A1 - 3.3.1 Equipment Removal

Figure A2 - 3.3.2 Ventilation Removal

Figure A3 - 3.3.3 Filter Bank Removal

Figure A4 - 3.3.4 Lighting Removal

Fluorescent Lights

Mercury Lights

Figure A5 - 3.3.5 Conduit Removal

Figure A6 - 3.3.6 Sink and Toilet Removal

Figure A7 - 3.3.7 Exposed Piping Removal

Figure A8 - 3.3.9 Floor Tile Removal

Figure A9 - 3.3.10 Drop Ceiling Removal

Figure A10 - 3.3.12 Surface Decontamination

Figure A11 - 3.4 Final Verification Survey

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APPENDIX B
NEVADA TEST SITE
AREA 25
RADIOLOGICAL SURVEY AND CLEANUP PROJECT
1974-1983
(MILLER REPORT)
R-MAD PORTIONS

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NEVADA TEST SITE
AREA 25

RADIOLOGICAL SURVEY AND CLEANUP PROJECT
1974 - 1983

(A REVISED FINAL REPORT)

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BY

M. G. MILLER

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DECEMBER 1984

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WORK PERFORMED UNDER
CONTRACT NO. DE-AC08-84NV10327

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NEVADA TEST SITE
AREA 25

RADIOLOGICAL SURVEY AND CLEANUP PROJECT
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(A REVISED FINAL REPORT)

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Prepared for the

U.S. Department of Energy
Nevada Operations Office
Under Contract DE-AC08-84NV10327

through 1965. Further research encompassed the Nuclear Engine for Rocket Vehicle Application (NERVA) until termination in 1973.

Tests of various reactors resulted in nuclear activation of test cell structures and materials. Other reactor tests caused uranium-based fuel and fission product contamination of test cells, reactor maintenance facilities, and proximate land areas. Some land area contamination resulted from planned safety or experimental tests and demonstrations. A flight safety experiment designated KIWI Transient Nuclear Test (TNT) was conducted on a railroad trestle north-west of Test Cell "C". To gather data, the reactor was deliberately destroyed by means of a fast excursion. A full-power run on the PHOEBUS 1A engine was interrupted when inadequate cooling caused severe core damage.

NRDS Program Deceleration, 1973. In January, 1973, announcements stated that NRDS would terminate all activities ". . . except those necessary for continued safety and the public welfare." On July 1, 1973, the Nevada Operations Office of the DOE assumed both administrative and physical responsibility for NRDS facilities and areas from the joint AEC/NASA SNPO.

facility, a radioactive materials storage site, a warehousing space, a test car assembly and test facility, and a hot-cell and laboratory sample test area (Figure 8).

The R-MAD Building (Figures 9 and 10) contained an assembly bay, shop and office area, and a disassembly bay. Overall dimensions of the building were 250 by 140 feet, 63 feet high with 61,290 square feet of floor space. The R-MAD Building had been used for KIWI reactor assembly, and for remote disassembly and remote inspection of the reactor after tests. Assembly and disassembly of the advanced PHOEBUS reactors had also been performed in the R-MAD Building. The assembly bay shop and office area had a steel frame with metal siding and a concrete floor, and was used for fabrication of test cars with their associated plumbing and instrumentation. It consisted of a clean room, assembly bay, and supporting shop areas, a core and fuel storage vault, and a tool crib. The disassembly area, hot bays, and hot cells were of concrete construction. The concrete walls were six feet thick. The disassembly area, over sixty feet high, could be divided into upper and lower bays, the upper bay shielded from the lower by a five-foot thick concrete door (750 tons) that allowed personnel entry and emergency servicing of remote operating equipment in the upper bay even during reactor and test car disassembly in the lower bay.

The R-MAD Decontamination Building (2,500 square feet), accessible to the railroad, was primarily used to decontaminate disassembly tooling and test car hardware.

PRELIMINARY RADIOLOGICAL SURVEYS

Area 25 Preliminary Radiological Survey, 1973-74. A radiological survey was conducted in 1973 by REECO Environmental Sciences Department (ESD) for DOE/NV to assess the scope, nature and location of existing radioactive contamination at the time of assumption of responsibility. It was intended to identify radioactive contamination levels at many locations and to establish control of contaminated materials prior to site D&D. The survey identified residual radiation levels at a number of locations that ranged to thousands of mR/h (5×10^4 mR/h noted on reactor nozzles).

Surveys at the RCP, CSA, R-MAD compound, ETS-1, Test Cell "A", and Test Cell "C" encompassed all buildings, sheds, trailers, auxillary structures such as pipes, tunnels, shields, tanks, miscellaneous items, and equipment. The 1973 survey did not include radioactive waste material storage sites, buried waste lines, leach fields, or land area debris. Survey of waste storage and debris areas was planned for later effort as funding permitted.

During this time, radioactive or radioactively contaminated items with AEC or property numbers were bagged and stored in an R-MAD radioactive material storage area. Items carrying no property number or AEC identifier were labeled "Radioactive Material" and left in place. A listing of radioactive or contaminated items, the open-shield beta-gamma survey instrument readings obtained from them, and the dispositions into radioactive material storage area or contaminated warnings affixed to them are detailed in Appendix A.

buried disposal and 300 pounds were compacted at the NTS Area 6 decontamination pad before burial.

Decontamination patterns in the R-MAD Building were well set by the beginning of 1979. Standard decontamination techniques used included: the removal of gear and sorting for release of uncontaminated material into NTS-user supply and storage channels; and transport of waste to proper buried disposal; sweeping, vacuuming, mopping with hot soapy water; pressurized water-blasting to dislodge persistent contaminants; removal of floor tiles and the removal of debris; paint removal where paint would seal contamination to a surface; use of caustic cleaner/degreaser where effective; and when necessary, chipping surface concrete for removal (with a standard concrete scrubber technique).

Cleaning operations were followed consistently by swipe sample surveys to ascertain presence (or absence) of removable contamination. Rooms (or buildings or large fixtures) which could not be decontaminated to acceptable levels were secured or fenced off, and posted with warnings identifying the existence of residual contamination, the type of radiation, and usually, the levels found on surface near contact.

The R-MAD Building decontamination operation encompassed the upper disassembly bay, the hot cell rooms, the airlock areas, upper stairways and hallways, hot cell area, lower disassembly bay, and basement areas. Eventually the floors of the upper and lower disassembly bays were epoxy-painted to fix residual contamination and two basement rooms were blocked off. Signs posted indicated contaminated areas.

with E-520 beta-gamma portable survey instruments, open shield (some readings are noted as closed shield), and swipe samples for removable beta plus gamma.

The RMSF remains RESTRICTED and continues to be used as a radioactive materials storage area (Appendix G). Test Cell "A" site has been posted with warning signs particularly Test Cell "A" Building roof and inaccessible contaminated areas (Appendix H).

The R-MAD Building (Appendix I) and Compound (Appendix J) have been released for use with the following exceptions:

- o Upper and lower disassembly bays;
- o Hot cells R-MAD Building; and
- o Two basement rooms where hot cell doors were lowered.

Other areas are posted indicating radiation levels, as appropriate. The R-MAD facilities are presently in use. Weekly radiological surveys continue in all work areas. A permanent air sampling system exists in the R-MAD Building which can be activated if removable contamination in excess of 1×10^3 dpm/100 cm^2 beta plus gamma or 1×10^2 dpm/100 cm^2 alpha is detected.

The ETS-1 site is available for use; only the reactor shield needed to be posted (Appendix K). Test Cell "C" (Appendix L) was released for use in 1981 and remains occupied. The RCP and CSA facilities were all released at the time of the 1978 comprehensive radiological survey.

APPENDIX I
FINAL RADIATION SURVEY R-MAD
BUILDING #3110, 1983

DATE	LOCATION	mR/h OPEN SHIELD	MAXIMUM REMOVABLE Beta + Gamma dpm/100 cm ²
07/18/83	Room 101 Low Bay	0.05*	0
07/18/83	Room 103A	0.05	0
07/18/83	Room 103B	0.05	0
07/18/83	Room 117	0.05	0
07/18/83	Room 118	0.05	0
07/18/83	Room 119A	0.05	0
07/18/83	Room 119B	0.05	0
07/18/83	Room 136 High Bay	0.05	0
07/18/83	Room 137 High Bay	0.05	0
07/18/83	Room 138	0.05	0
07/18/83	Room 207 Low Bay	0.05	0
07/18/83	Room 208 Low Bay	0.05	0
07/18/83	Room 211 Low Bay	0.05	0
07/19/83	Hallway 124 (Contact reading on contaminated material)	0.3	0
07/19/83	Room 102	0.05	0
07/19/83	Room 105	0.05	0
07/19/83	Room 110	0.05	0
07/19/83	Room 112	0.05	0
07/19/83	Room 113A	0.05	0
07/19/83	Room 113B	0.05	0
07/19/83	Room 115	0.05	0
07/19/83	Room 129	0.05	0

*Release Limits: 0.05 mR/h - upper background limit. Removable beta plus gamma - 20 dpm/100 cm²

**Closed Shield - gamma only

APPENDIX I (continued)

DATE	LOCATION	mR/h OPEN SHIELD	MAXIMUM REMOVABLE Beta + Gamma dpm/100 cm ²
07/19/83	Room 130	0.05	0
07/19/83	Room 156	0.05	0
07/19/83	Room 210	0.05	0
07/20/83	Hall 116	0.05	0
07/20/83	Room 114	0.05	0
07/20/83	Room 143	0.05	0
07/20/83	Room 159	0.05	0
07/20/83	Room 209	0.05	0
07/20/83	Stairway to Mezzanine	0.05	0
07/28/83	Basement South Hall No. 1 (Drain beneath hatch, sign and radiation levels posted)	2.10	0
07/28/83	Room 122	0.05	0
07/28/83	Room 125	0.05	0
07/28/83	Room 125A (next to air lock door)	0.40	0
07/28/83	Room 125A (Shower Floor)	0.15	0
07/28/83	Room 128A (Floor at Northwest Door)	0.20	0
07/28/83	Room 131	0.05	0
07/28/83	Room 135 (Steps Northwest of Room)	0.70	0
07/28/83	Room 142	0.05	0
07/28/83	Room 143	0.05	0
07/28/83	Room 150 (at East Door)	0.90	0
07/28/83	Room 151	0.20	0

*Release Limits: 0.05 mR/h - upper background limit. Removable beta plus gamma - 20 dpm/100 cm²

**Closed Shield - gamma only

APPENDIX I (continued)

DATE	LOCATION	mR/h OPEN SHIELD	MAXIMUM REMOVABLE Beta + Gamma dpm/100 cm ²
07/28/83	Room 152	0.05	0
07/28/83	Room 153 (at West Entrance)	0.12	0
07/28/83	Room 163	0.05	0
07/28/83	Room 2	0.05	0
07/28/83	Room 3	0.05	0
08/02/83	Room 10	0.05	0
08/02/83	Room 154	0.05	0
08/02/83	Room 4	0.05	0
08/02/83	Room 5	0.05	0
08/02/83	Room 6 (Contact-Door Locked and Signs Posted)	40 (7 mR/h gamma)**	450
08/02/83	Room 7 (Contact-Door Locked and Signs Posted)	7 (0.5 mR/h gamma)**	450
08/02/83	Room 8	0.05	0
08/02/83	Room 9	0.05	0
08/02/83	West Stairway to Room 8	0.08	0
08/04/83	Room 212	0.05	0
08/04/83	Room 213	0.05	0
08/04/83	Room 214	0.05	0
08/04/83	Room 215	0.05	0
08/04/83	Room 216	0.05	0
08/04/83	Room 217	0.05	0
08/05/83	Electrician's Van	0.05	0

*Release Limits: 0.05 mR/h - upper background limit. Removable beta plus gamma - 20 dpm/100 cm²

**Closed Shield - gamma only

APPENDIX I (continued)

DATE	LOCATION	mR/h OPEN SHIELD	MAXIMUM REMOVABLE Beta + Gamma dpm/100 cm ²
08/05/83	Hallway 201 and 220 (South section on floor)	13	0
08/05/83	North stairs to Hall 201 (Radiation Sign Posted)	0.14	0
08/05/83	Refrigerated Hivac Room	0.05	0
08/05/83	Room 106 (Southeast Corner of Floor)	0.09	0
08/05/83	Room 107	0.05	0
08/05/83	Room 108	0.05	0
08/05/83	Room 109A (South Center Floor)	0.07	0
08/05/83	Room 109 (Beneath air lock door Radiation Sign Posted)	0.12	0
08/05/83	Room 121 (Cable Room Northeast Corner of Building Radiation Sign Posted)	0.08	0
08/05/83	South Stairs to Hall 201	0.07	0
08/05/83	Supply Shack	0.05	0
08/12/83	Room 202 (Contact-sign with Radiation Levels Posted)	30 (15 mR/h gamma)**	100
08/12/83	Room 203	0.05	0
08/12/83	Room 205 East Corridor (Heavy Equipment is stored in South Section of Room)	0.05	0
08/12/83	Room 206, 206A, B and C	0.05	0
08/19/83	Room 218	0.05	0
08/19/83	Room 219	0.05	0
08/19/83	Room 302	0.05	0
08/19/83	Room 303	0.05	0

*Release Limits: 0.05 mR/h - upper background limit. Removable beta plus gamma - 20 dpm/100 cm²

**Closed Shield - gamma only

APPENDIX I (continued)

DATE	LOCATION	mR/h OPEN SHIELD	MAXIMUM REMOVABLE Beta + Gamma dpm/100 cm ²
08/19/83	Stairs to Room 302	0.30	0
08/19/83	Stairs to Room 401	0.05	0
08/22/83	Room 149 and Hot Cells	70 (2 mR/h gamma)**	500
08/22/83	Room 301 (Skid Rollers - Sign with Radiation Levels Posted)	11	0
8/22/83	Room 401	0.05	0

A

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*Release Limits: 0.05 mR/h - upper background limit. Removable beta plus gamma - 20 dpm/100 cm²
 **Closed Shield - gamma only

APPENDIX C
GAMMA SPECTROSCOPY MEASUREMENTS
R-MAD ROOFTOP SURVEY

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Gamma Spectroscopy Measurements RMAD Rooftop Survey

**Area 25, Nevada Test Site
March 7, 2000**

1.0 INTRODUCTION

A tripod-mounted germanium detector was used to measure for possible radioactive contamination on the roof of the RMAD building in Area 25 of the Nevada Test Site. The roof was scheduled for removal and disposal since it contained asbestos material. Before it could be disposed, it needed to be tested for possible radioactivity. The origin of the possible contamination was hypothesized to be deposition from the tests conducted at Test Cells A and C.

The Sampling and Analysis Plan (SAP) prepared for this work indicated that the principal radioisotopes that were expected to appear on the roof were ^{137}Cs and ^{90}Sr . Since ^{90}Sr emits no gamma rays when it decays, its presence would be inferred from a predetermined ratio to ^{137}Cs as discussed in the SAP.

2.0 MEASUREMENTS

2.1 Preparation at RSL

Before fielding a germanium system, it must pass several tests in the laboratory to check its status and set some preliminary parameters for the system. These tests consist of an energy calibration in which the amplifier gain is adjusted to force the photopeaks of ^{241}Am (59.5 keV) and ^{137}Cs (661.6 keV) into specific channels of the multichannel analyzer (MCA). For this set of measurements, a gamma-ray spectrum from 0 to 1500 keV was chosen since the isotope of interest is ^{137}Cs , whose main photopeak is at 661.6 keV.

A series of test measurements were performed using different intensity ^{137}Cs check sources. While these sources are not NIST-traceable, the manufacturer's quoted activity has been found to be within about 5% of the true activity. The purpose of the tests was to check the integrity of the peak extraction and isotopic intensity algorithms. The results of these checks showed that the equipment was working properly and the correct activity values were being calculated.

Finally, a two-hour-long measurement of the background spectrum in the laboratory was taken. The purpose of this measurement is not for any later data

analysis, but simply to document the energies of the naturally-occurring radioisotopes typically found in building materials. To a lesser degree, the relative intensities of these background photopeaks can be used as a preliminary assessment as to whether the photopeaks in the roof-sample-spectra are caused by the natural background radioisotopes or whether there are possible contaminants at the same energy as a natural photopeak. Since most of the portion of the RMAD building and the roof to be surveyed is metal construction, the detected natural radioisotopic gamma rays originate in the ground around the building and therefore will be attenuated by the intervening air and construction material.

The particular detector used in these measurements has been characterized three times at RSL since 1994 and its response has not changed significantly over that period. Response measurements by the manufacturer during the period of 1989 to 1992 also indicated no significant changes. The results of these characterizations are used to determine the conversion factors used later to calculate the activity concentrations from the measured count rates.

2.2 Measurements at RMAD

The following list of equipment was used to make the gamma spectroscopy measurements.

1. ORTEC High-purity germanium detector S/N 29-TN20327
2. Davidson multichannel analyzer S/N 5856
3. NIST-traceable ^{137}Cs check source S/N 237-76-1
4. Tape measure
5. Tripod
6. Battery pack

The energy of the ^{137}Cs gamma ray (661.6 keV) is sufficiently high that it is difficult to attenuate without using massive quantities of steel or lead. Therefore, we decided not to use a collimator with the germanium detector. This would mean that the detector would measure the gamma ray flux from a large area of the roof surface around each designated location rather than being limited to a small spot directly beneath the detector.

The activity results were requested to be presented in units of pCi/g, which implies an average over the area being measured. By using the large field-of-view, nearly all of the roof could be measured, although in broad, averaged values. If the detector was collimated, the values reported would represent small, averaged areas directly around each location, but much of the roof area would not be measured in any fashion.

Once we arrived at the RMAD building, the detector system was assembled and an energy calibration was performed first using the ^{137}Cs source and then using the natural background gamma rays. This check verified that the amplifier gains were correct. Then an activity test was performed using the ^{137}Cs source. Finally, a "background" measurement was taken on the ground as a final check on the gain and stability of the system. This background measurement was used to set up the photopeak windows for the later calculations.

Figure 1. Sampling Locations (The square area in the northeast corner of the roof is not accessible, so no measurements were planned there.)

After passing these tests, the detector system and personnel were taken to the roof of the building. The locations of the measurements are shown in Figure 1 (reproduced from the SAP). A 5-minute measurement was made at Locations 1 through 7; location 8 was skipped. A duplicate measurement made at Location 2. The number and location of the measurements were specified in the SAP.

2.3 Roofing Material at RMAD

The R-MAD composite asbestos containing material (ACM) roof has a surface area of approximately 6,000 square feet (60'x100'). The roof is composed of several layers, consisting of (1) a 1" thick foam outer layer (non-ACM) and hardener top coating, (2) a double layer of tar and a layer of tar paper on top of the rigid insulation, (3) a 2"-thick asbestos-containing (60% chrysolite) rigid insulation layer, and (4) a tar tack coat between the steel roof decking and the rigid insulation layer. The density of the roof material above the steel roof was estimated to be 2 grams per cubic centimeter.

2.4 Analysis of the Data

After the detector system has been characterized, the minimum detectable activity (MDA) level can be calculated for different radioisotopes. For these measurements, the MDA depends on the length of counting time (5 minutes) and the "background" of gamma rays in the collected spectrum. The background count rate in the energy range of a specific photopeak contributes to the uncertainty in the "net" count rate for that photopeak. We usually define the MDA at the $3\sigma_B$ level, or three times the square root of the background count rate. For these measurements, the background count rate in the 661.6-keV window was 11 counts per second. This corresponds to a roof activity of 0.01 pCi/g.

The duplicate measurement at Location 2 was compared with the initial measurement and the two measurements were consistent with each other; differing by only a few percent. So nothing anomalous happened to the detector system during the measurements.

At each location, the ^{137}Cs activity was at or below the MDA. The level of concern for ^{137}Cs was 3 pCi/g, while the measurements all were less than 0.05 pCi/g. The values are presented in the following table. The conversion factors for Locations 1 and 3 were multiplied by a factor of 3 since the roof only fills about 1/3 of the detector's field-of-view. The conversion factor for Location 7 has been adjusted since the roof only fills about 75% of the detector's field-of-view.

Location	Conversion Factor (pCi/g per cps)	Measured Count Rate (cps)	Calculated Activity (pCi/g)
1	0.18	0.21	0.04
2	0.06	0.11	0.01
2 Duplicate	0.06	0.12	0.01
3	0.18	0.03	0.01
4	0.06	0.00	0.00
5	0.06	0.02	0.00
6	0.06	0.08	0.00
7	0.08	0.10	0.01

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APPENDIX D
RADIOLOGICAL CALCULATIONS FOR CORRECTIVE
ACTION UNIT 143: AREA 25 CONTAMINATED WASTE
DUMPS, NEVADA TEST SITE

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**Radiological Calculations for Corrective Action
Unit 143: Area 25 Contaminated Waste
Dumps, Nevada Test Site**

May 13, 1999

Prepared By:

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Radiological Calculations For Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site

EXECUTIVE SUMMARY

From 1959 through 1972, the U.S. Atomic Energy Commission participated in the development of nuclear rocket engines (Project ROVER) at the Nevada Test Site (NTS). During the rocket engine testing program, significant quantities of radioactive material were generated. Process knowledge indicates that analytical sample waste and activation products were discarded in a number of trenches located in the vicinity of the Reactor-Maintenance, Assembly and Disassembly (R-MAD) facility. This waste disposal area, referred to as Corrective Action Unit (CAU) 143, is being investigated for closure.

The nuclear rocket engine fuel was composed of graphite rods containing highly enriched uranium. In some of the tests, the reactor core was damaged and radioactive gases and small particles of reactor fuel were released into the atmosphere.

Following these tests, the nuclear rocket engines and experimental components were transported to the R-MAD facility for examination. Parts that were not scheduled for reuse and waste products were dumped into a pit. After 1963, a series of shallow trenches were used for the disposal of low activity radioactive materials.

The reactor fuel rods were removed from the nuclear rocket engine after each test. One-inch sections were reportedly cut from some fuel rods for isotopic analysis in a hot cell at R-MAD. The analytical sample discard solution (1-liter for each 1-inch fuel segment) was poured into five 1-liter plastic bottles filled with vermiculite for disposal in the waste trenches.

The special nuclear material (e.g. Uranium-235) in the reactor cores was valuable and protected for both safeguards and security concerns. Project ROVER reactor fuel has since been processed at the Idaho National Engineering and Environmental Laboratory (INEEL) to recover the highly enriched uranium. It is highly unlikely that any reactor fuel elements were discarded in CAU 143. A possible exception might be fragments of the KIWI-Transient Nuclear Test (TNT) reactor.

The nuclear rocket engine reactors generated large quantities of fission products that initially included many radioactive isotopes. Most of these isotopes have short half-lives and decay quickly. This decay has reduced the exposure levels by up to seven orders of magnitude in the 35 years since the reactor tests. The only fission products observed at CAU 143 are cesium-137 (Cs-137), which can

be detected with gamma instruments, and strontium-90 (Sr-90), a beta-only nuclide, which can be implied from the Cs-137 measurements.

The primary activation product from the reactor tests is cobalt-60 (Co-60). Co-60 was produced through neutron activation of stainless steel and has been detected in small quantities in the landfill trenches. Scandium was present as an impurity in the graphite fuel rods. It has been reported that scandium-46, with an 84 day half-life, produced high gamma exposure rates for several months following the reactor runs, but it would not be present today. Europium is an activation product resulting from neutron activation of soil. Europium-152 has a 12-year half-life and might be present in soil surrounding the test stand. Some of this soil might have been placed in the trenches during clean-up operations. The only other activation product of interest is niobium-94 (Nb-94) which is likely to be present in CAU 143. To reduce erosion and corrosion from the high velocity hydrogen coolant gas, niobium was used as a cooling channel liner in the graphite fuel rods.

The ROVER reactor fuel did not initially contain plutonium; however, small amounts of plutonium-239 (Pu-239) were produced from neutron irradiation of the uranium in the fuel.

ORIGIN Code calculations for a ROVER type reactor (e.g., highly enriched uranium-graphite moderated-gas cooled reactor) were completed by INEEL to determine maximum concentrations of fission products, activation products and Pu-239.

Potential concentrations of radionuclides that might be encountered in the sampling and investigation of CAU 143 are based on a number of relevant data sources. These data sources include: analytical measurements made at the NTS and INEEL; ORIGIN Code calculations performed by INEEL; a review of process procedures and activities; and interviews with Area 25 operations personnel.

Project ROVER reactor fuel processed at INEEL indicated the presence of U-235, Cs-137, and Nb-94. The Sr-90 concentration can be approximated from the Cs-137 concentration. A small amount of plutonium-239 (Pu-239) was also identified.

If the one-inch sections of reactor fuel analyzed at the Nuclear Rocket Development Station (NRDS) were dissolved and mixed with five liters of vermiculite, none of the fission products or activation products would exceed the concentration limits for a Class A disposal site. If fragments of irradiated fuel from reactors (e.g. NRX-A3 through PEWEE 1) were discarded in the trenches (e.g. one fuel rod in a cubic meter of waste), only plutonium would qualify as Class C. The other reactors did not produce enough Pu-239 to exceed Class A. There is no evidence that any of this fuel was discarded in CAU 143 (with the

possible exception of a few scattered micron sized particles of uranium carbide). It is reasonable to assume, based on process knowledge, that small fragments of the KIWI-TNT reactor were discarded in CAU 143.

No realistic scenario has been postulated that would lead to a waste classification greater than Class A. This assessment is based on analytical measurements made at NTS and INEEL; ORIGIN Code calculations performed by INEEL; a review of process procedures and activities; and interviews with Area 25 operations personnel. The waste classification for CAU 143 will be reevaluated based on data obtained through the planned site investigation.

Radiological Calculations for Corrective Action Unit 143: Area 25 Contaminated Waste Dumps, Nevada Test Site

INTRODUCTION:

From 1959 through 1972, the U.S. Atomic Energy Commission participated in the development of nuclear rocket engines (Project ROVER) at the Nevada Test Site. These nuclear rocket engines were tested at the Nuclear Rocket Development Station (NRDS), now known as the Nevada Research and Development Area (NRDA), located in Area 25 at the Nevada Test Site (NTS). In a separate but related program (Project PLUTO), nuclear ramjet engines were tested in Area 26 at the NTS. During the rocket engine test program, significant quantities of radioactive material were generated. Process knowledge indicates that activated materials (e.g., cobalt-60, niobium-94, and scandium-46), and analytical samples were discarded in a number of trenches and burial pits located in the vicinity of the Reactor-Maintenance, Assembly and Disassembly (R-MAD) facility. There is a possibility that small fuel particles may be found with in this disposal area.

The purpose of this document is to estimate the levels of transuranic waste (plutonium-239 [Pu-239]), activation products (e.g. cobalt-60, niobium-94), uranium, and mixed fission products (e.g. cesium-137, strontium-90) that might be encountered during characterization of the Area 25 waste dumps. These estimates are based on analytical measurements made at NTS (Reference 8), INEEL (References 2,3, 5, 7 and 7), ORIGIN Code calculations performed by INEEL (Reference 12), gamma-ray spectral measurements at Corrective Action Unit (CAU) 143, a review of process procedures and activities, and interviews with Area 25 operations personnel.

The materials evaluated include analytical sample discards generated in the Junior Hot Cell, activation products associated with neutron irradiation of support structures and reactor components; uranium; and mixed fission products produced in the reactor core materials (e.g., unrecoverable fuel particles).

Nature of Radioactive Material Placed in CAU 143

The nuclear rocket engine fuel was composed of graphite rods containing highly enriched uranium. Hydrogen gas pumped through small channels in the fuel rods provided reactor cooling and propellant. During the nuclear rocket engine tests, mixed fission products were produced in the reactor core and activation products were produced in the nuclear rocket engine and supporting structures. In some of the tests, the reactor core was damaged and small particles, resulting from erosion and corrosion of the reactor core, were ejected into the atmosphere.

As much as 650 grams of uranium is reported to have been released to the atmosphere from a single reactor core (Reference 11). It has been estimated that approximately 830,000 curies of radioactivity was released to the atmosphere in all Project ROVER and PLUTO tests (Reference 10). These releases were in the form of radioactive gases and small-radioactive particles (Reference 10 and 8). Some of these small particles are reported to have produced radiation fields as high as 500 R/hr within one day after deposition.

During some of the Project ROVER reactor tests (e.g., KIWI B-1B, September 1962; NRX A3, May 1965; PHOEBUS 1A, June 1965) the reactor core was damaged. In one test (KIWI-Transient Nuclear Test (TNT), January 1965) the reactor was deliberately destroyed by maximum excursion. It has been reported that subsequent to the test, reactor fragments were consolidated into CAU 143. Irradiated fuel elements, fuel fragments, and recoverable fuel particles from these reactor cores were transported to the Idaho National Engineering and Environmental Laboratory (INEEL) for disposition. The fuel was processed in the Idaho Chemical Processing Plant (ICPP) to recover the highly enriched uranium.

Following each test, the reactors were transported to the R-MAD facility for disassembly in hot bays designed for this purpose. Test components and fuel particles were also transported to the R-MAD facility. Most of the support vehicles and reactor structural components were composed of aluminum which has isotopes with relatively short half-lives. However, impurities in the graphite and other reactor components produced radioactive activation products, including some isotopes with relatively long half-lives. Parts that were scheduled for reuse were taken by rail to a "cooling" yard to allow the radioactivity to decay prior to reuse. Waste products were dumped into discard pits. In earlier years, at least one of the waste pits remained uncovered so that discarded items might be readily retrieved for examination or reuse. After 1963, a series of shallow trenches were used for the disposal of low activity radioactive materials.

Following each test, the reactor fuel rods were removed from the nuclear rocket engine, photographed, and stored for examination and nuclear materials accountability. The special nuclear material (e.g., uranium-235 [U-235]) in the reactor cores was valuable and protected for safeguards and security concerns. Project ROVER reactor fuel has since been processed at the INEEL to recover the highly enriched uranium.

It has been reported that one-inch sections were cut from selected fuel rods for isotopic analysis following each test. The rods were dissolved in acid and the organic contaminants were burned off. The residual solution was diluted to 1-liter, and 1-milliliter aliquots were removed for chemical analysis. The residual solution was poured into five 1-liter plastic bottles filled with vermiculite for disposal in the waste trenches. It is reported that some of these bottles had exposure rates exceeding 50 R/hr on contact at the time of disposal.

Reactor Core Disposition

Project ROVER utilized approximately 2,363 kg of U-235 in the 20 reactors tested between 1959 and 1972. A total of 2,342 kg of U-235 was sent to INEEL in the mid-1970s for reprocessing to recover enriched uranium (Reference 4).

Radionuclides of Interest

Uranium. The ROVER reactor fuel elements contained highly enriched uranium. Highly enriched uranium contains about 2 percent U-234.

Mixed Fission Products (MFP). The nuclear rocket engine reactors generated large quantities of MFP which initially included many radioactive isotopes. Most of these had short half-lives and decayed away quickly, reducing the exposure levels up to seven orders of magnitude in the 35 years since the reactor tests. Fragments reading 500 R/hr from MFP one day following the test would read 5mR/hr today. The only fission products observed at CAU 143 are cesium-137 (Cs-137), which can be detected with gamma instruments, and strontium-90 (Sr-90), a beta-only nuclide, which can be implied from the Cs-137 concentrations.

Activation Products. The primary activation product from the reactor tests was aluminum-28 with a 2.3-minute half-life. The presence of aluminum is likely in CAU 143, but it is not radioactive today. Cobalt-60 (Co-60), produced through neutron activation of stainless steel, has been detected in small quantities in the land fill trenches. Scandium was present as an impurity in the graphite fuel rods. It has been reported that Scandium-46, with an 84-day half-life and gamma-ray energies of 0.889 and 1.12 MeV, produced high gamma exposure rates for several months following the reactor runs, but it would not be present today. Radioactive europium is an activation product resulting from the neutron activation of soil. Europium-152 has a 12-year half-life and is present in soil surrounding the test stand. Some of this soil might have been placed in the trenches during clean-up operations. The only other activation product of interest is niobium-94 (Nb-94). Niobium was used as a cooling channel liner in the graphite fuel rods to reduce erosion and corrosion from the high velocity hydrogen coolant gas. Nb-94 has a 20,000-year half-life with gamma-ray energies of 0.703 and 0.871 MeV, and was detected in ROVER fuel processed at INEEL.

Plutonium. Even though plutonium is technically an activation product, it is treated separately. The ROVER fuel did not initially contain plutonium, but small amounts of plutonium-239 (Pu-239) were produced from the uranium in the fuel.

ASSUMPTIONS:

Fuel Rod Analytical Sample Discards: Interviews with a chemist responsible for R-MAD hot cell (Junior Hot Cell) operations provide information that, following each reactor test, 1-inch sections of selected fuel rods were dissolved in acid. The recovered materials were diluted in 1-liter plastic containers for analysis. These solutions were subsequently poured into five 1-liter containers filled with vermiculite to solidify the waste. The five 1-liter plastic containers were placed in a cardboard box and discarded in on-site burial trenches. The rods with the highest levels of radioactivity contained 600 milligram (mg) per cubic centimeter (cc) of uranium-235, yielding a maximum of 160 grams (g) U-235 and 3.4 g of U-234 per rod. According to Reference 3, 1,100 g of U-235 was contained in 6,000 g of fuel material, indicating that each fuel rod weighed about 870 g.

Activation Products: The primary activation products of concern are Co-60, associated with steel components, and niobium-94 (Nb-94) produced in the niobium used as a cooling channel liner to minimize fuel erosion and corrosion by high velocity cooling gases.

Fuel Rod Particles: Unrecoverable fuel rod particles contain U-234, U-235, Nb-94, and mixed fission products that have decayed over the past 35 years. The fission products of primary concern are Cs-137 and Sr-90. A small amount of Pu-239 was also produced in the reactor fuel.

CALCULATED ISOTOPIC CONCENTRATIONS FOR WASTE CLASSIFICATION:

The isotopic concentrations in the waste contained in pits and burial trenches at Area 25 were calculated as follows:

Fuel Rod Analytical Sample Discards

The Project ROVER fuel rods with the highest levels of radioactivity contained 600 mg/cc of uranium, yielding a maximum of 160 g U-235 per rod according to Reference 3. Each fuel rod is 52-inches in length. A 1-inch section of fuel rod contained about 3.1 g of U-235. This fuel sample was dissolved in acid and diluted into 1-liter of solution in a plastic container (solution weight of 1,000 g). The 1-liter sample solution was then poured into five 1-liter plastic containers filled with exfoliated vermiculite with an assumed density of 0.08 g/cc (total of 400 g of vermiculite). Thus, the original 3.1 g of U-235 was discarded in 1,800 g of solid waste (1,000 g of liquid solidified in 400 g of vermiculite and five 88 g plastic bottles). It was then assumed that 100 1-liter bottles were buried in a cubic meter of waste. Waste-classifications assignments are based on categories delineated in Reference 1.

Uranium

Calculations based on information provided by INEEL (Reference 3) indicate the maximum concentration of U-235 is 3.1 g per 1-inch of fuel rod. The specific activity of U-235 is 2.14×10^{-6} curies (Ci)/g of U-235. Thus, about 130* micro-curies (μ Ci) of U-235 was discarded in a cubic meter of solid waste weighing 36 kg. The U-235 concentration in the waste is 3.7 nanocuries (nCi)/g.

U-234 has a specific activity of 6.19×10^{-3} Ci/g. At 65 mg/in. of fuel rod, the concentration of U-234 would have been 8.1 mCi/m³ or 220 nCi/g of waste.

Assessment: All concentrations of uranium are considered Class A waste (Not listed in Table 1 or Table 2, Reference 1).

Waste Classification: Class A.

Cobalt-60

Analytical measurements of ROVER fuel at INEEL indicate a maximum concentration of Co-60 of 8.8×10^{-8} Ci/g of U-235 (Vessel 104, Reference 5). The 0.27 μ Ci of Co-60 (associated with 3.1 g of U-235) was discarded in 5,000 cc of solid waste. This represents a concentration of 5.4 μ Ci/m³ of Co-60 in the waste.

Assessment: The concentration of Co-60 does not exceed 700 Ci/m³ (Table 2, Reference 1).

Waste Classification: Class A.

Niobium-94

Analytical measurements of ROVER fuel at INEEL (Vessel 104, Reference 5) indicate a maximum concentration of Nb-94 of 7×10^{-6} Ci/g of U-235. The 22 μ Ci of Nb-94 (associated with 3.1 g of U-235) was discarded in 5,000 cc of solid waste. This represents a concentration of 440 μ Ci/m³ of Nb-94 in the waste.

Assessment: The concentration of Nb-94 does not exceed ten percent of the 0.2 Ci/m³ in Table 1 (Reference 1).

Waste Classification: Class A.

* All calculated values are rounded to two significant figures.

Cesium-137

Analytical measurements of ROVER fuel at INEEL (Reference 5) indicate a maximum concentration of Cs-137 of 2.9×10^{-4} Ci/g of U-235. The 0.9 mCi of Cs-137 (associated with 3.1 g of U-235) was discarded in 5,000 cc of solid waste. This represents a concentration of 18 mCi/m³ of Cs-137 in the waste.

Assessment: The concentration of Cs-137 does not exceed the 1 Ci/m³ value listed in Table 2 (Reference 1).

Waste Classification: Class A.

Strontium-90

Calculations using the ORIGIN code provide a ratio of Sr-90/Cs-137 of 0.94 resulting in a maximum Sr-90 concentration of 2.7×10^{-4} Ci/g of U-235. The 0.84 mCi of Sr-90 (associated with 3.1 g of U-235) was discarded in 5,000 cc of solid waste. This represents a concentration of 17 mCi/m³ of Sr-90 in the waste.

Assessment: The concentration of Sr-90 does not exceed the 0.04 Ci/m³ value listed in Table 2 (Reference 1).

Waste Classification: Class A.

Plutonium-239

Analytical measurements of ROVER fuel at INEEL (Reference 7) indicate a maximum concentration of 8.2×10^{-6} g of Pu-239 per gram of U-235. The specific activity of Pu-239 is 6.13×10^{-2} Ci/g of Pu-239. Thus, about 500 µg or 32 µCi of Pu-239 was discarded in a cubic meter of solid waste weighing 32 kg. The Pu-239 concentration in the waste is 1.0 nCi/g.

Assessment: The concentration of plutonium-239 is less than ten percent of the 100 nCi/g in Table 1 (Reference 1).

Waste Classification: Class A.

Activation Products:

The primary activation products of concern are cobalt-60 (Co-60) associated with steel components and niobium-94 (Nb-94) produced in the niobium cooling channel liner. The amount of Co-60 produced by neutron irradiation of stainless steel components located adjacent to the reactor core was estimated by ORIGIN Code calculations (Reference 12). Since niobium was used as a cooling channel

liner to minimize fuel erosion and corrosion by high velocity cooling gases, the Nb-94 activity produced is not directly related to the amount of U-235 in the fuel.

Cobalt-60

ORIGIN Code calculations performed by INEEL (Reference 12) indicate a maximum concentration of Co-60 of 20 mCi in 100 kg of Type 316 stainless steel. The stainless steel, and associated Co-60, discarded as solid waste would not exceed 1.6 Ci/m³ of waste, based on the density of steel of 7.8 g/cm³.

Assessment: The concentration of Co-60 does not exceed 700 Ci/m³ (Table 2, Reference 1).

Waste Classification: Class A.

Niobium-94

It is assumed that the Nb-94 activity produced in the niobium, used as a cooling channel liner, remained bonded (or attached) to the ROVER fuel elements or fuel particles. An assessment of Nb-94 that might have been discarded as solid waste is presented in the following discussion on fuel rod particles.

Fuel Rod Particles:

Unrecoverable fuel rod particles contain U-235, Nb-94, and mixed fission products that have decayed over the past 35 years. The fission products of primary concern are Cs-137 and Sr-90. A small amount of Pu-239 was also produced in the reactor fuel.

Uranium

Analytical measurements of ROVER fuel at INEEL (Reference 3) indicate that each fuel rod contained a maximum of 160 g of U-235. The fuel rods were 52-inches long and weighed approximately 870 g. The specific activity of U-235 is 2.14×10^{-6} Ci/g U-235. Thus, the U-235 concentration in fuel rod particles is 0.4 μ Ci of U-235/g of fuel. The specific activity of U-234 is 6.19×10^{-3} Ci/g U-234 and each fuel rod contained approximately 3.4 g of U-234. Thus, the U-234 concentration in fuel rod particles is 24 μ Ci of U-234 per gram of fuel.

Assessment: All concentrations of uranium are considered Class A waste (not listed in Table 1 or Table 2, Reference 1).

Waste Classification: Class A.

Cobalt-60

Analytical measurements of ROVER fuel at INEEL indicate a maximum concentration of Co-60 of 8.8×10^{-8} Ci/g of U-235 (Vessel 104, Reference 5). Each 52-inch long fuel rod contained a maximum of 160 g of U-235 and weighed about 870 g. Thus, 14 μ Ci of Co-60 would be associated with each fuel rod. To satisfy the Class A waste requirement of less than 700 Ci/m³, more than 10^7 fuel rods, or an equivalent amount of fuel rod particles, would have to be discarded in a cubic meter of waste and soil. Since less than 10^4 fuel rod were produced for the entire ROVER Project, this would not be possible.

Assessment: The concentration of Co-60 does not exceed 700 Ci/m³ for one or less fuel rods discarded in a cubic-meter of waste and soil (Table 2, Reference 1).

Waste Classification: Class A.

Niobium-94

Analytical measurements of ROVER fuel at INEEL (Vessel 104, Reference 5) indicate a maximum concentration of Nb-94 of 7×10^{-6} Ci/g of U-235. Each 52-inch long fuel rod contained a maximum of 160 g of U-235 and weighed about 870 g. Thus, 1.1 mCi of Nb-94 would be associated with each fuel rod. To satisfy the Class A waste requirement of less than 200 mCi/m³, more than 170 fuel rods, or an equivalent amount of fuel rod particles, would have to be discarded in a cubic meter of waste and soil. This possibility is considered highly unlikely.

Assessment: The concentration of Nb-94 does not exceed ten percent of the 0.2 Ci/m³ for one or less fuel rods discarded per cubic-meter of waste and soil (Table 1, Reference 1).

Waste Classification: Class A.

Cesium-137

Analytical measurements of ROVER fuel at INEEL (Reference 5) indicate a maximum concentration of Cs-137 of 2.9×10^{-4} Ci/g of U-235. Each 52-inch long fuel rod contained a maximum of 160 g of U-235 and weighed about 870 g. Thus, 46 mCi of Cs-137 would be associated with each fuel rod. To satisfy the Class A waste requirement of less than 1 Ci/m³, more than 20 fuel rods, or an equivalent amount of fuel rod particles, would have to be discarded in a cubic meter of waste and soil. This possibility is considered highly unlikely.

Assessment: The concentration of Cs-137 does not exceed 1 Ci/m³ for one or less fuel rods discarded in a cubic-meter of waste and soil (Table 2, Reference 1).

Waste Classification: Class A.

Strontium-90

Calculations using the ORIGIN code at INEEL provide a Sr-90/Cs-137 ratio of 0.94 resulting in a maximum Sr-90 concentration of 2.7×10^{-4} Ci/g of U-235. Each 52-inch long fuel rod contained a maximum of 160 g of U-235 and weighed about 870 g. Thus, 43 mCi of Sr-90 would be associated with each fuel rod. To satisfy the Class A waste requirement of less than 0.04 Ci/m³, about 90 percent of a fuel rod, or an equivalent amount of fuel rod particles, would have to be discarded in a cubic meter of waste and soil. Only the PHOEBUS 2A reactor had a power level high enough to produce more than 34 mCi of Sr-90 per fuel rod. We know that all of the fuel in PHOEBUS 2A was recovered; therefore only a Class A concentration of Sr-90 could be in CAU 143.

Assessment: The concentration of Sr-90 does not exceed 0.04 Ci/m³ for one or less fuel rods discarded per cubic-meter of waste and soil (Table 2, Reference 1).

Waste Classification: Class A.

Plutonium-239

Analytical measurements of ROVER fuel at INEEL (Reference 7) indicate a maximum concentration of 8.2×10^{-6} g of Pu-239 per gram of U-235. Each 52-inch long fuel rod contained a maximum of 160 g of U-235 and weighed about 870 g (Reference 3). Each fuel rod would, therefore, contain a maximum of 1.3 mg of Pu-239. The specific activity of Pu-239 is 6.13×10^{-2} Ci/g Pu-239. Thus, the maximum Pu-239 concentration in fuel rod particles is 92 nCi of Pu-239/g of fuel.

Assessment: The concentration of plutonium-239 does not exceed 100 nCi/g and is considered Class C waste (Table 1, Reference 1).

Waste Classification: Class C.

SUMMARY WASTE CLASSIFICATION TABLE:

The following table summarizes the maximum classification of radioactive materials which might have been discarded in the R-MAD waste disposal site (see Attachment 1 and Attachment 2).

<u>Radionuclide</u>	<u>Analytical Sample Discards (Ci/m³)</u>	<u>Activation Products (Ci/m³)</u>	<u>Fuel Rod Particles *** (Ci/m³)</u>
U-234	220 * Class A **		24,000 * Class A **
U-235	3.6 * Class A **		400 * Class A **
Nb-94 in Activated Metal	0.00044 Class A	See Fuel Rod Class A	0.0011 Class A
Pu-239	1.0 * Class A		92 * Class C
Co-60	0.0000054 Class A **	1.6 Class A	0.000014 Class A **
Sr-90	0.017 Class A		0.034 Class A
Cs-137	0.018 Class A		0.046 Class A

* Units are nanocuries per gram

** No limits established for these radionuclides in Class B and C waste

*** Assumes 1 fuel rod in a cubic meter of waste and soil

SUM OF FRACTIONS RULE ANALYSIS:

Instructions for determining the appropriate classification for waste containing a mixture of isotopes is presented in 10 CFR 61.55 (Reference 1). "The sum of fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each nuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column."

"If radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1, and some of which are listed in Table 2, classification is determined as follows:

- 1) If the concentration of a nuclide listed in Table 1 does not exceed 0.1 times the value listed in Table 1, the class shall be determined by the concentration of nuclides listed in Table 2.
- 2) If the concentration of a nuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of the nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2".

The sum of fractions for mixtures of radionuclides is determined by dividing each nuclide's concentration by the appropriate limit and adding the resulting values, as follows:

$$F_s = \sum C_i/L_i$$

Where F_s = the calculated "sum of fractions rule" value for waste type "S" (e.g. Analytical Sample Discards, ASD),

C_i = concentration of the i^{th} nuclide, and

L_i = nuclide limit for the i^{th} nuclide (all values taken from the same column of Table 1 or Table 2.

Table 1, Reference 5 Sum of Fractions Calculations

The Sum of Fractions for ASD, based on 0.1 times the nuclide concentration values listed in Column 1 of Table 1 is, therefore:

$$F_{ASD} (\text{Column 1, Table 1}) = C_{Nb-94}/(0.1 \times L_{Nb-94}) + C_{Pu-239}/(0.1 \times L_{Pu-239})$$

$$F_{ASD} (\text{Column 1, Table 1}) = 0.00044/(0.1 \times 0.2) + 1.0/(0.1 \times 100)$$

$$F_{ASD} (\text{Column 1, Table 1}) = 0.022 + 0.10 = 0.12$$

Thus, the disposal class for ASD is determined by the concentration of nuclides in Table 2.

The Sum of Fractions for Fuel Rod Particles (FRP), based on 0.1 times the nuclide concentration values listed in Column 1 of Table 1 is:

$$F_{FRP} (\text{Column 1, Table 1}) = C_{Nb-94}/L_{Nb-94} + C_{Pu-239}/L_{Pu-239}$$

$$F_{FRP} (\text{Column 1, Table 1}) = 0.0011/(0.1 \times 0.2) + 92/(0.1 \times 100)$$

$$F_{FRP} (\text{Column 1, Table 1}) = 0.055 + 9.2 = 9.3$$

The Sum of Fractions for FRP, based on the nuclide concentration values listed in Column 1 of Table 1 is:

$$F_{FRP} (\text{Column 1, Table 1}) = C_{Nb-94}/L_{Nb-94} + C_{Pu-239}/L_{Pu-239}$$

$$F_{FRP} (\text{Column 1, Table 1}) = 0.0011/0.2 + 92/100$$

$$F_{FRP} (\text{Column 1, Table 1}) = 0.0055 + 0.92 = 0.93$$

Since the Sum of Fractions for FRP, based on the nuclide concentration values listed in Column 1 of Table 1, is less than 1.0 (e.g. 100 percent), the waste is Class C unless the concentration of nuclides in Table 2 exceeds the values in Column 3 (see Attachment 3).

Table 2, Reference 5 Sum of Fractions Calculations

The Sum of Fractions for ASD, based on the nuclide concentration values listed in Column 1 of Table 2 is, therefore:

$$F_{\text{ASD}} (\text{Column 1, Table 2}) = C_{\text{Co-60}}/L_{\text{Co-60}} + C_{\text{Sr-90}}/L_{\text{Sr-90}} + C_{\text{Cs-137}}/L_{\text{Cs-137}}$$

$$F_{\text{ASD}} (\text{Column 1, Table 2}) = 0.0000054/700 + 0.017/0.04 + 0.018/1.0$$

$$F_{\text{ASD}} (\text{Column 1, Table 2}) = 8 \times 10^{-9} + 0.43 + 0.018 = 0.45$$

Thus, ASD falls into Class A.

The Sum of Fractions for FRP, based on the nuclide concentration values listed in Column 3 of Table 2 is:

$$F_{\text{FRP}} (\text{Column 3, Table 2}) = C_{\text{Sr-90}}/L_{\text{Sr-90}} + C_{\text{Cs-137}}/L_{\text{Cs-137}}$$

$$F_{\text{FRP}} (\text{Column 3, Table 2}) = 0.034/7000 + 0.046/4600$$

$$F_{\text{FRP}} (\text{Column 3, Table 2}) = 0.000005 + 0.00001 = 0.000015$$

Thus, FRP falls into Class C.

The maximum classification for radioactive materials, which might have been discarded in the R-MAD waste disposal site, CAU 143, is Class C (see Sum of Fractions summary in Attachment 3).

ORIGIN Code Calculations

ORIGIN Code calculations for a ROVER type reactor (e.g. highly enriched uranium-graphite moderated-gas cooled reactor) were completed by INEEL to determine concentrations of fission products, activation products and Pu-239 (Reference 12). The results of these calculations are presented in Attachment 4. The INEEL ORIGIN Code calculations are in general agreement with measured concentrations of radionuclides in ROVER reactor fuel.

CONCLUSIONS:

If the one-inch sections of reactor fuel analyzed at NRDS were dissolved and mixed with five liters of vermiculite, none of the fission products or activation products would exceed the concentration limits for a Class A disposal site. If particles of irradiated fuel from the reactors with the highest integrated power levels (e.g. NRX-A3, 5/65 through PEWEE 1, 12/68) were discarded in the waste trenches, only plutonium would qualify as Class C. There is no evidence that any

of this fuel was discarded in CAU 143, with the possible exception of a few scattered micron sized particles of uranium carbide (Reference 9).

If the stainless steel and associated Co-60 were discarded as solid waste, the Co-60 concentration would not exceed 1.6 Ci/m^3 of stainless steel, based on the density of steel of 7.8 g/cm^3 . This value is well below the limit of 700 Ci/m^3 for Class A waste.

No realistic scenario has been postulated that would lead to a waste classification greater than Class A. This assessment is based on analytical measurements made at NTS and INEEL; ORIGIN Code calculations performed by INEEL; a review of process procedures and activities; and interviews with Area 25 operations personnel.

REFERENCES:

- 1) *Code of Federal Regulations*. 1998. Title 10 CFR 61.55, "Waste Classification," Washington, DC: U.S. Government Printing Office.
- 2) Cottam, R.E., Lockheed Martin Idaho Technologies Company. 1999. Letter to David Wheeler (U. S. Department of Energy, Nevada Operations Office) regarding the ROVER FUEL DATA REQUEST-REC-01-99, 31 March. Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory.
- 3) Croson, D.V. 1991. *A Review of Rover Fuel Processing Campaign #39 At the Idaho Chemical Processing Plant*, WIN-312. Prepared for the U.S. Department of Energy, Idaho Operations Office. Idaho Falls, ID: Westinghouse Idaho Nuclear Company, Inc.
- 4) Durril, D.C. Nevada Test Site. 1979. Data sent to Dale Luke (Exxon Nuclear Corporation) (WN-SM-1799), 18 October.
- 5) Fillmore, D.L., Westinghouse Idaho Nuclear Company, Inc. 1994. Letter to J. M. Mines, DLF-02-94, regarding the contents of ROVER Vessels 100, 102, and 104, 7 April. Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory.
- 6) Frazee, B.J., Lockheed Martin Idaho Technologies Company. 1996. Interdepartmental Communication to C.S. Olsen (BJF-30-96) regarding Fuel Receipt Criteria Questionnaire for Rover Uranium Bearing Material, 15 July. Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory.
- 7) Griffith, D.L. Lockheed Martin Idaho Technologies Company. 1997. Interdepartmental Communication (DLG-2-97) regarding ROVER UMB Data, 26 March. Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory.
- 8) Hicks, H.G. 1981. *Calculated Concentrations of any Radionuclide Deposited on the Ground by Release from Underground Nuclear Detonations, Tests of Nuclear Rockets, and Tests of Nuclear Ramjet Engines*, UCRL-53228. Livermore, CA: Lawrence Livermore National Laboratory.
- 9) Miller, M.G. 1984. Radiological Survey and Cleanup Project, 1974-1983, (A Revised Final Report), M. G. Miller, DOE/NV/10327-5 (Revision 1). Las Vegas, NV: Reynolds Electrical & Engineering Company, Inc.

- 10) Raytheon Services Nevada. 1995. *Radiological Effluents Released from Nuclear Rockets and Ramjet Engine Tests at the Nevada Test Site 1959 through 1969*, Fact Book, DOE/NV-401, UC-702. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV.
- 11) U.S. Environmental Protection Agency. 1974. NRDS Nuclear Rocket Effluent Program, 1959-1970, NERC-LV-539-6. Prepared by D. E. Bernard, et al. Las Vegas, NV.
- 12) Wemple, C. and W. Terry, Idaho National Engineering and Environmental Laboratory. 1999. Results of ORIGIN Code calculations performed by Dr. Charles Wemple and William Terry, INEEL, 9 April. Idaho Falls, ID.

ATTACHMENT 1.

WASTE CLASSIFICATION FOR CAU 143 FROM TABLE 1, 10 CFR 61.55 (REFERENCE 9)

<u>Radionuclide</u>	<u>Table 1 Concentration (Ci/m³)</u>	<u>Analytical Sample Discards (Ci/m³)</u>	<u>Activation Products (Ci/m³)</u>	<u>Fuel Rod Debris*** (Ci/m³)</u>
C-14	8	ND/NC	ND/NC	ND/NC
C-14 in Activated Metal	80	ND/NC	ND/NC	ND/NC
Ni-59 in Activated Metal	220	ND/NC	ND/NC	ND/NC
Nb-94 in Activated Metal	0.2	0.00044 Class A	See Fuel Rod	0.0011 Class A
Tc-99	3	ND/NC	ND/NC	ND/NC
I-129	0.08	ND/NC	ND/NC	ND/NC
Alpha Emitting Transuranics Half-Life >5 years	100 *	1 * Class A	0	92 Class C
Pu-241	3,500 *	ND/NC	ND/NC	ND/NC
Cm-242	20,000 *	ND/NC	ND/NC	ND/NC

* Units are nanocuries per gram

*** Assumes only 1 fuel rod in a cubic meter of waste and soil

ND/NC means not detectable, not a concern

ATTACHMENT 2.

WASTE CLASSIFICATIONS FOR CAU 143 FROM TABLE 2, 10 CFR 61.55 (REFERENCE 9)

<u>Radionuclide</u>	Col. 1 Concentration (Ci/m ³)	Col. 2 Concentration (Ci/m ³)	Col. 3 Concentration (Ci/m ³)	Analytical Sample Discards (Ci/m ³)	Activation Products (Ci/m ³)	Fuel Rod Debris (Ci/m ³)
Total of all Nuclides with Half Life < 5 years	700	**	**	ND/NC	ND/NC	ND/NC
H-3	40	**	**	ND/NC	ND/NC	ND/NC
Co-60	700	**	**	0.000054 Class A	1.6 Class A	0.000014 Class A
Ni-63	3.5	70	700	ND/NC	ND/NC	ND/NC
Ni-63 in Activated Metal	35	700	7,000	ND/NC	ND/NC	ND/NC
Sr-90	0.04	150	7000	0.017 Class A		0.034 Class A
Cs-137	1	44	4600	0.018 Class A		0.046 Class A

** No limits have been established for these radionuclides in Class B and Class C waste
 ND/NC means not detectable, not a concern

ATTACHMENT 3.

SUMMARY: SUM OF FRACTIONS CALCULATIONS

WASTE <u>TYPE</u>	TABLE <u>0.1 X COLUMN 1</u>	TABLE 1 <u>COLUMN 1</u>	TABLE 2 <u>COLUMN 1</u>	TABLE 2 <u>COLUMN 2</u>	TABLE 2 <u>COLUMN 3</u>
ANALYTICAL SAMPLE DISCARDS	0.12	****	0.45	****	****
FUEL ROD PARTICLES	9.3	0.93	****	****	0.000016

**** Not used to determine classification.

ATTACHMENT 4.

ORIGIN CALCULATED NUCLIDE PRODUCTION IN ROVER REACTORS

TEST NAME	DATE	INTEGRAT. POWER (A) (MW-sec)	INT. POW. RATIO TO ORIGIN	TOTAL U-235 (B) (Kgs)	PU-239 PER GRAM OF FUEL (C) (nCi/g-FUEL)	SR-90 IN CORE (Ci)	CS-137 IN CORE (Ci)	CO-60 IN STEEL (Ci)
KIWI A	7/59	21,000	0.004	38.7	0.2	0.1	0.1	0.000
KIWI A PRIME	5/60	60,000	0.013	20	0.6	0.1	0.1	0.000
KIWI A-3	10/60	60,000	0.013	19.2	0.6	0.1	0.1	0.000
KIWI B-1A	12/61	30,000	0.006	79	0.3	0.2	0.2	0.000
KIWI B-1B	9/62	10,000	0.002	80	0.1	0.1	0.1	0.000
KIWI B-4A	11/62	40,000	0.008	178	0.4	0.6	0.6	0.000
KIWI B-4D	5/64	110,000	0.023	156	1.1	1.3	1.4	0.000
KIWI B-4E	9/64	680,000	0.142	168	6.9	9.0	9.5	0.001
NRX-A2	10/64	600,000	0.125	159	6.1	7.5	8.0	0.001
TNT	1/65	9,000	0.002	34	0.1	0.0	0.0	0.000
NRX-A3	5/65	1,680,000	0.346	157	16.8	20.5	21.7	0.002
PHOEBUS 1A	6/65	740,000	0.154	172	7.5	10.0	10.6	0.001
NRX-A4/EST	3/66	3,370,000	0.702	159	34.1	42.1	44.7	0.005
NRX-A5	6/66	2,200,000	0.458	158	22.3	27.3	29.0	0.003
PHOEBUS 1B	6/67	2,740,000	0.571	167	27.8	36.0	38.1	0.004
NRX-A6	12/67	4,500,000	0.938	143	45.6	50.6	53.6	0.006
PHOEBUS 2A	7/68	7,803,000	1.626	276	79.0	169.4	179.5	0.020
PEWEE 1	12/68	1,530,000	0.319	32	15.5	3.9	4.1	0.000
XE PRIME	2/69	763,000	0.159	159	7.7	9.5	10.1	0.001
NUC. FURN.	7/72	356,000 (C)		5				
MISC.				3				

(A) REFERENCE 1

(B) REFERENCE 3

(C) REFERENCE 10

(D) PER 100 KILOGRAMS OF STAINLESS STEEL

APPENDIX E - WASTE MANAGEMENT PLAN

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CAU-113
AREA 25, R-MAD
DEACTIVATION & DECOMMISSIONING
WASTE MANAGEMENT PLAN

Revision: 0

January 2001

Prepared for the
U. S. Department of Energy
Nevada Operations Office
Under Contract No. DE-AC08-96NV11718

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LIST OF ACRONYMS AND ABBREVIATIONS

ALLW	Asbestiform Low-Level Waste
BN	Bechtel Nevada
CAU	Corrective Action Unit
CFR	Code of Federal Regulations
COPC	Constituents of Potential Concern
D&D	Deactivation and Decommissioning
DOE	United States Department of Energy
E-MAD	Engine Maintenance, Assembly, and Disassembly
ER	Environmental Restoration
ft ²	square feet
gal	gallon
kg	kilogram
L	liter
LLW	Low-Level Radioactive Waste
LQG	Large Quantity Generator
m	meter
m ²	square meter
m/s	meter per second
NDEP	Nevada Division of Environmental Protection
NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site

LIST OF ACRONYMS AND ABBREVIATIONS (Cont.)

NV	Nevada
PCB	Polychlorinated Biphenyl
PPE	Personnel Protective Equipment
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RMA	Radioactive Material Area
R-MAD	Reactor Maintenance, Assembly, and Disassembly
RP	Remediation Project
SAP	Sampling and Analysis Plan
SVOC	Semi-Volatile Organic Compound
TL	Technical Lead
TM	Task Manager
VOC	Volatile Organic Compound
WMP	Waste Management Program

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1.0 INTRODUCTION

1.1 BACKGROUND

The Nuclear Rocket Development Station (NRDS) located in Area 25 on the Nevada Test Site (NTS) (see Figure E-1) was established in 1959 by the National Aeronautical and Space Administration, the Atomic Energy Commission, and the Department of Defense in a joint effort to develop nuclear rocket technology for space propulsion. One of the first buildings to support the NRDS, the Reactor Maintenance, Assembly, and Disassembly (R-MAD) building (Bldg. 3110), was constructed in 1958 and operated through 1974. The building was used to assemble and remotely disassembly reactors, and perform postmortem examinations on the reactor fuel.

There are approximately 80 rooms in the R-MAD Building with an estimated floor space of 4,632 square meters (m²) (48,930 square feet [ft²]). The rooms include, but are not limited to, offices, two assembly bays, a disassembly bay, a control room, postmortem cells, a photography room, operating and viewing galleries, equipment and storage rooms, mechanical equipment rooms, and restroom and shower facilities. Reactors were assembled in one of the two assembly bays, and installed on test cars. A railroad track was used to remotely move the test cars to one of the test cells located a minimum one and one-half miles away. After the completion of each test, the test cars were brought back to R-MAD and disassembled in the disassembly bay. These operations were done remotely and viewed through 1.8 meters (m) (6 ft) thick lead glass windows. Upon disassembly, reactor fuel and parts were passed through a hatch in the floor to the postmortem area for close visual inspection, photography, and radiography.

For a variety of reasons, Congress terminated the funding for the program in 1973. As a result, the structures and compounds associated with the project were virtually abandoned in 1973 without consideration to deactivation and decommissioning (D&D). The R-MAD facility has been used to support several other projects on a limited basis since 1973. In 1974, the TORY II-C reactor was removed from the Pluto Facility in Area 26 and stored in the disassembly bay of the R-MAD Building. It was later taken to the Engine Maintenance, Assembly, and Disassembly (E-MAD) Building for disassembly. Additionally, the R-MAD compound was used by the MX Missile program to test portions of its design, and also by Bechtel Nevada (BN) Mine Rescue Service for unspecified storage and training.

Currently, the R-MAD Building is being prepared for D&D. A review of historical records and inspection of the building show that all utilities have been shut off. In 1999, limited electrical power was supplied to the R-MAD Building through independent electrical panels and power cords to support D&D activities. The majority of equipment and office furniture has been removed in previous decontamination efforts and general cleanup activities. Between 1978

FIGURE E-1
 LOCATION OF THE AREA 25 R-MAD FACILITY ON THE
 NEVADA TEST SITE

and 1984 decontamination efforts of the R-MAD Building resulted in 90 percent of the building being decontaminated. Historical radiological surveys summarized in a report prepared by M. G. Miller (REECo, 1984) show that the remaining contamination is confined to the disassembly bay and postmortem cell area. Recent radiological surveys support these findings.

1.2 SCOPE OF WORK

The SAFER Plan for the Area 25 R-MAD Building Corrective Action Unit (CAU) 113 has been developed based on a "unrestricted release" status design. The SAFER Plan should be referred to for details regarding the closure.

1.3 PURPOSE

The purpose of the Waste Management Plan is to identify all wastes that will be generated during the closure process, describe proper sampling and management techniques (Figure E-2) for each waste, and provide recommendations for disposal. The following items are discussed in this plan:

- Segregating, containerizing, and labeling all waste types.
- Sampling the waste streams for disposal purposes.
- Tracking, controlling, and managing waste.
- Compiling analytical data.
- Coordinating disposal with the BN Waste Management Program (WMP).
- Conducting inspections and maintaining storage areas until disposal is complete.
- Providing documentation for all disposal activities.

FIGURE E-2
 LOCATION OF THE R-MAD RADIOLOGICAL MATERIALS AREAS

2.0 WASTE STREAM DESCRIPTIONS

Five waste streams are to be generated during the remediation of the R-MAD Building. These waste streams are:

- Polychlorinated Biphenyls (PCB)
 - PCB Bulk Product Waste
 - Radioactive/PCB Bulk Product Waste
 - PCB Articles
- Resource Conservation and Recovery Act (RCRA) regulated hazardous waste
 - Hazardous Debris
- Asbestos
 - Asbestos Containing Material
 - Asbestiform Low-Level Radioactive Waste (ALLW)
- Nonhazardous Radioactive Solid Waste
- Nonhazardous Solid Waste
 - Nonhazardous Universal Waste

2.1 POLYCHLORINATED BIPHENYLS

2.1.1 PCB Bulk Product Waste

Before being banned in 1978, PCBs were used by paint manufactures as pigments in high performance paints. During the operational period of the NRDS, such high performance paints were applied to surfaces that would need relatively frequent decontaminating. As contamination built up on surfaces, operators would use a high-pressure soap and water mixture to wash the contamination down the drain. When this practice no longer produced an appropriate reduction in the level of contamination, it was painted over with another layer of high performance paint. This paint would affix the contamination between the layers of paint and limit its mobility. Sampling conducted in January and July 2000 confirmed the presence of PCBs in the paint used in the disassembly bay and postmortem cells area. Samples submitted for analysis showed that the concentrations of PCBs varied from 13 milligrams per kilograms (mg/kg) to 260 mg/kg. Approximately 30 percent of the surface area that is painted with the PCB laden paint is not expected to be radiologically impacted.

This waste will be managed as "PCB bulk product waste". Title 40 Code of Federal Regulations (CFR) 761.3 (EPA, 1996l) defines PCB bulk product waste as "waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was 50 (parts per million) ppm (or greater) PCBs." Additionally, flourescent light fixtures contain ballast that have the potential to have PCBs in

concentrations greater than 500 ppm and meet criteria to be classified as PCB bulk product waste.

2.1.2 Radioactive/PCB Bulk Product Waste

Approximately 70 percent of the surface area in the disassembly bay and postmortem cell area painted with PCB laden paint is radiologically impacted with the constituent of potential concern (COPC) discussed in Section 3.3.1.2 of the SAFER Plan. Samples submitted for analysis showed that the concentrations of PCBs varied from 13 mg/kg to 260 mg/kg. Based on the selected disposal option for this waste, this paint will be managed as Radioactive/PCB bulk product waste.

2.1.3 PCB Articles

Three large overhead cranes are located in the assembly and disassembly bays of the R-MAD Building. Based on the analysis of hydraulic fluid found in a similar crane in the E-MAD building, the hydraulic fluid used by these cranes is assumed to contain PCBs above 50 ppm. The hydraulic fluid and the reservoir containing the hydraulic fluid will be managed as "PCB Articles." 40 CFR 761.3 (EPA, 1996l) defines a "PCB Article" as "any manufactured article, other than a PCB Container, that contains PCBs and whose surface(s) has been in direct contact with PCBs. "PCB Article" includes capacitors, transformers, electric motors, pumps, pipes and any other manufactured item....." The fluid from all three cranes is estimated to be less than 416 liters (L) (110 gallons [gal]).

2.2 RCRA-REGULATED HAZARDOUS WASTE

2.2.1 Hazardous Debris

Various items have been identified as having the potential of containing RCRA-regulated hazardous material. These items include pipe joints, a large storage tank, equipment, and un-recyclable lead. These items will be managed as hazardous debris based on the Land Disposal Restrictions definitions of "debris" and "hazardous debris." Title 40 (CFR) 268.2(g) (EPA, 1996j) defines "debris" as a "solid material exceeding a 60 mm particle size that is intended for disposal and that is: A manufactured object; or plant or animal matter; or natural geologic matter." "Hazardous debris" is defined by 40 CFR 268.2(h) (EPA, 1996j) as "debris that contains a hazardous waste listed in Subpart D of part 261 of this chapter (EPA, 1996a), or that exhibits a characteristic of a hazardous waste identified in Subpart C of part 261 (EPA, 1996a) of this chapter."

2.3 ASBESTOS

2.3.1 Asbestos Containing Material

Inspection and sampling by the BN Industrial Hygiene Department has identified several building materials used in the construction of the R-MAD Building as containing greater than one percent asbestos. The majority of this ACM is floor tile found in various rooms throughout the building. The asbestos tile on the ground floor is considered friable because of wear and water damage caused by flooding during the building vacancy. Other types of materials that have been identified as ACM are piping insulation and roofing material. Because of age, the piping insulation is expected to become friable when removed.

2.3.2 Asbestiform Low-Level Radioactive Waste

A small fraction of the ACM floor tile in the viewing galleries of the disassembly bay and postmortem cells is radiologically impacted with the COPC described in Section 3.1.3 of this SAFER Plan. The radiological contamination is limited to the surface of the tiles except for a few instances in which the contamination has penetrated the tile joints and is found in the mastic used to hold the tile to the floor. The fraction of ACM determined to be radiologically impacted at concentrations greater than that specified in the Area 9, U-10c Industrial Landfill Permit will be managed in accordance with L-E10.302.LRM "Management Plan for the Disposal of Low-Level Waste With Regulated Asbestos Waste" (DOE, 1999).

2.4 NON-HAZARDOUS RADIOACTIVE SOLID WASTE

Debris generated during the decontamination of the R-MAD Building that is determined to be non-hazardous and radiologically contaminated with the COPC described in Section 3.1.6 of the SAFER Plan at concentrations greater than that specified in the Area 9, U-10c Industrial Landfill Permit will be managed as low-level waste. The bulk of the material is expected to be equipment, piping, ventilation ducts, and air handling equipment associated with the disassembly bay and postmortem cell area. Compactible waste generated from the hotline disposal of plastic, tape, gloves, etc. will be combined with other waste packages of radioactive solid waste.

2.5 NON-HAZARDOUS SOLID WASTE

2.5.1 Building Debris

Debris generated during the decontamination of the R-MAD Building that is determined to be nonhazardous and not radiologically impacted at concentrations greater than that specified in the Area 9, U-10c Industrial Landfill Permit will be managed as non-hazardous solid waste. The majority of debris generated during the D&D of the R-MAD Building is expected to meet the definition of nonhazardous solid waste.

2.5.2 Universal Waste

Emergency lighting fixtures containing batteries, thermostats suspected of containing mercury switches, mercury vapor lamps, and fluorescent light tubes have been identified as being present in the R-MAD Building. These wastes will be managed as Universal Waste based on 40 CFR 273 (EPA, 1996k). Lamps, including mercury vapor and fluorescent tubes, were added to the definition of Universal Waste in 64 Federal Register 36466.

2.6 DECONTAMINATION WATER

Rinse water will be generated during the decontamination of tools and equipment used during the D&D of the R-MAD Building. Decontamination of small pieces of equipment (radiological survey equipment, hand tools, etc.) will be done inside the exclusion zone near the entry control point. Larger pieces of equipment will be decontaminated at a temporary decontamination pad setup near entry control points. The pad should be large enough to pressure wash the largest piece of heavy equipment and contain any over spray. Rinseate from these decontamination efforts may be contained and managed as potentially hazardous and radioactive waste until its status is determined by sampling and analysis. Another method that may be used is to evaporate the rinseate. Any residual sediments and plastic will be characterized for final disposal.

3.0 WASTE MANAGEMENT

All waste will be stored, sampled, analyzed, and disposed of in accordance with applicable state and federal regulations, the RCRA Part B Permit (NDEP, 1995), United States Department of Energy (DOE) Orders, and BN Procedures. Details for the management of waste containers and each waste stream identified in Section 2.0 is discussed in this section.

3.1 CONTAINER MANAGEMENT

All containers will be handled in accordance with Subpart I of 40 CFR, Part 265 (EPA, 1996f) which deals with the use and management of containers. Additional requirements for storage of hazardous waste are described in Section 4.0, "Hazardous Waste Storage Requirements." All containers must be in good condition (no rust or dents). If the container begins to leak, the contents must be transferred to a container that is in good condition. The containers must be lined or made of a material that will not react with the waste. The containers must always be closed while stored unless waste is added or removed. They must also be handled in such a manner that will not jeopardize the integrity of the container.

Waste drums will be new or reconditioned with no rust or dents and meet United States Department of Transportation requirements. Drum reconditioning must be done by a qualified vendor. All waste containers containing waste will be secured with drum locks or other tamper indicating devices to prevent the addition of prohibited materials. BN policy does not allow for a 208 L (55 gal) drum to be filled beyond a capacity of 7/8. Waste containers used for the transportation and disposal of low-level radioactive waste (LLW) will be procured through the BN Waste Management Program (WMP).

Appropriate labels and relevant information must be marked on each container, drum or roll-off, with an indelible marker and must be legible and clearly visible for inspection. Pertinent data may be written on duct tape or a blank adhesive label that is applied to the side of the container. The following information will be included:

- Unique container identifier
- Type of waste in container
- Date that accumulation began
- "Awaiting Analysis" sticker after sampling has been completed (if required)

BN Construction and/or WMP personnel are not permitted to remove drums from the site or have the contents of the drums disposed without written approval from Restoration Project (RP) personnel. RP staff will make arrangements to the disposition of the waste with WMP staff.

3.2 POLYCHLORINATED BIPHENYLS

3.2.1 PCB Bulk Product Waste

40 CFR 761.62 (b) (EPA, 1996n) allows any person to dispose of the following PCB bulk product waste in a facility permitted, licensed, or registered by a state as a municipal or non-municipal nonhazardous waste landfill: Plastics; preformed or molded rubber parts and components; applied dried paints, varnishes and waxes. With applied dried paints being specifically identified in the regulation, any PCB laden paint removed from the disassembly bay and postmortem cell area that is not radiologically impacted at concentrations above those specified in the Area 9, U-10c Industrial Landfill Permit, will be disposed of in the Area 9, U-10c Industrial Landfill. Although specifically identified in the regulations as a permissible disposal option, the permit for the Area 9, U-10c Industrial Landfill limits PCB concentrations to 50 ppm. Both BN Environmental Compliance and BN Solid Waste Operations have been notified of the elected disposal option. Both originations are working with the Nevada Division of Environmental Protection (NDEP) in an effort to gain the State's concurrence for disposal of PCB bulk product waste in the Area 9, U-10c Industrial Landfill.

It is expected that approximately 40 percent of the painted surface area in the disassembly bay is not radiologically impacted. This portion of the PCB laden paint does not create a health or safety hazard and will be left on the walls and ceiling. Provided that the State of Nevada concurs with the elected disposal option for PCB bulk product waste, the remaining paint should not impact the disposal of the rubbleized concrete in the Area 9, U-10c Industrial Landfill. The remaining painted surface area will be surveyed under an approved radiological survey plan to demonstrate compliance with the prescribed radiological limits. No further sampling for PCBs is required for this waste stream because the presence of PCBs has already been confirmed through previous sampling and analysis, and disposal is allowed under 40 CFR 761.62(b) (EPA, 1996n). The highest sample result of 260 ppm will be used as the characteristic PCB concentration for this waste stream.

3.2.2 Radioactive/PCB Bulk Product Waste

40 CFR 761.50(b)(7) (EPA, 1996m) states:

“Any person disposing of PCB/radioactive waste must do so taking into account both its PCB concentration and its radioactive properties. If, taking into account only the properties of the PCBs in the waste (and not the radioactive properties of the waste), the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a State as a municipal or non-municipal non-hazardous waste landfill (e.g., PCB bulk product waste under §§761.62 (b)(1)) (EPA, 1996n), then the person may dispose of the PCB/radioactive waste, without regard to the PCB component of the waste, on the basis of its radioactive properties in

accordance with all applicable requirements for the radioactive component of the waste.”

Based on this citation, and the elected disposal of the nonradiologically impacted portion of this waste stream, this waste will be managed as LLW. A waste stream profile is currently being developed in accordance with the Nevada Test Site Waste Acceptance Criteria (DOE/NV, 1999). An approved disposal path will be established before this waste stream is generated.

LLW will be stored in an established radioactive material area (RMA) (Figure E-2) and managed in accordance with BN Organizational Procedure OP-2151.304, “Radioactive Waste Tracking, Handling, and Management at the NTS” (BN, 2000), and all applicable state and federal regulations. Because the presence of PCBs has already been confirmed through previous sampling and analysis, and the disposal path allowed under 40 CFR 761.50(b)7 (EPA, 1996m), no further sampling for PCBs is required for this waste stream. The highest sample result of 260 ppm will be used as the characteristic PCB concentration for this waste stream.

3.2.3 PCB Articles

Hydraulic fluid drained from the three large overhead cranes will be tested with a field screening kit to confirm the presence of PCBs. Once confirmed, the hydraulic fluid from each crane will be drained and collected in a 208 L (55 gal) drum. This drum will be sampled for total PCBs, total RCRA metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), gross alpha-beta, and 20 minute gamma. Test methods and applicable quality assurance samples are identified in Section 5.0. The drum(s) will be stored in the 90-Day Accumulation Area on a spill pallet, as described in Section 4.0, until results are returned. After sample results are returned, the waste will be transferred to BN Hazardous Waste Operations for off-site treatment and disposal.

If negative results are returned from the field screening kit for PCBs, the hydraulic fluid will be drained into a separate drum. This waste will be sampled and the sample analyzed for total PCB, total RCRA metals, VOC, SVOC, gross alpha-beta, and 20-minute gamma. The drum(s) will be stored in the 90-Day Accumulation Area on a spill pallet until results are returned. After sample results are returned, the waste will be transferred to Hazardous Waste Operations for off-site treatment and disposal.

3.3 RCRA-REGULATED HAZARDOUS WASTE

3.3.1 Hazardous Debris

3.3.1.1 Storage Tank

A large storage tank, approximately 530 L (2,000 gal), is located in the north end of Room 141. This tank has pipes leading to the top that are labeled "MISC FLUIDS." A search of project records and questions directed to personnel that worked at the facility during its operational period did not reveal the purpose of the tank. A gauge on the end of the tank used to indicate fluid level, reads empty. Direct reading radiological instruments show no signs of radiation penetrating the tank, and a visual inspection of all lines leading to and from the tank revealed no additional information.

The tank will be breached under controlled work processes, and inspected. If present, samples of fluid and resulting scale will be taken and analyzed for total PCBs, total RCRA metals, VOCs, SVOCs, gross alpha-beta, and 20-minute gamma. The selected treatment and disposal option will be based upon sampling results.

If found to be empty with no residue, the tank will be declared "empty" as defined in 40 CFR 261.7(b) (EPA, 1996b) and disposed of in the Area 9, U-10c Industrial Landfill.

3.3.2 Suspected RCRA-Regulated Hazardous Waste

All items that have the potential of being RCRA-regulated hazardous waste were identified in an inspection conducted in May, 2000. The majority of items identified during this inspection are discussed elsewhere in this WMP. The remaining waste consist of approximately six 208 L (55 gal) drums that, because of safety and work process controls, have not been opened for inspection, and clear plastic tubing containing residual fluid. After safety issues are addressed, these items will be removed, containerized, labeled and placed in the 90-Day Accumulation Area to await analysis. An appropriate sampling plan will be developed and implemented. Results of this sampling effort will provide the basis for the appropriate treatment and disposal actions.

3.4 ASBESTOS

3.4.1 Asbestos-Containing Material

All ACM will be handled by a trained asbestos worker and managed following BN Company Directive CD-0444.012, "Asbestos Management" (BN, 1999). ALL ACM will be placed in appropriate containers and disposed of in the Area 9 U-10c Industrial Landfill.

3.4.2 Asbestiform Low-Level Radioactive Waste

ALLW will be stored in an established radioactive materials area (RMA) (see Figure B-2) and managed in accordance with BN Organizational Procedure OP-2151.304, "Radioactive Waste Tracking, Handling, and Management at the NTS" (BN, 2000), BN Company Directive CD-0444.012, "Asbestos Management" (BN, 1999), and Department of Energy (DOE) L-E10.302.LRM "Management Plan for the Disposal of Low-Level Waste With Regulated Asbestos Waste" (DOE, 1999). The NTSWAC profile for this waste was approved on October 26, 2000.

3.5 NON-HAZARDOUS RADIOACTIVE SOLID WASTE

All waste generated within the disassembly bay and postmortem cell area will be screened for the presence of radiological COPC identified in Section 3.1.6 of the Safer Plan. Nonhazardous solid waste that exceeds the permissible radiological surface and mass concentration for the Area 9, U-10c Industrial Landfill Permit will be classified as LLW. This waste will be managed in accordance with BN Organizational Procedure OP-2151.304, "Radioactive Waste Tracking, Handling, and Management at the NTS" (BN, 2000), and stored in the RMA (see Figure E-2).

3.6 NON-HAZARDOUS SOLID WASTE

3.6.1 Building Debris

All solid waste with residual radioactive material concentrations below the permissible radiological surface and mass concentrations for the Area 9, U-10c Industrial Landfill, will be managed as non-hazardous solid waste. All non-hazardous solid waste will be disposed of in the Area 9, U-10c Industrial Landfill.

3.6.2 Universal Waste

All universal waste will be collected on-site and stored in the universal waste collection area until transferred to Hazardous Waste Operations for off-site recycling. Lamps will be stored in fiberboard tubes, similar to the ones provided by the manufactures, to prevent breakage.

3.7 DECONTAMINATION WATER

Rinseate from the decontamination of equipment will be collected in appropriate sized metal drums. Samples will be collected from the containers and analyzed for total PCBs, total RCRA metals, VOCs, SVOCs, gross alpha-beta, and 20-minute gamma. Test methods and applicable quality assurance samples are identified in Section 5.0. Analysis results will be used to determine the proper waste classification of the rinseate and liner. Drums containing rinseate and awaiting analysis will be labeled in accordance with Section 3.1 and stored in the 90-Day Accumulation Area in accordance with Section 4.0.

4.0 HAZARDOUS WASTE STORAGE REQUIREMENTS

A large quantity generator (LQG) may accumulate hazardous waste on-site for 90 days or less without a permit or without being considered as an operator of a hazardous waste storage facility. The LQG is not required to obtain a RCRA storage permit provided that the generator complies with the following requirements outlined in Title 40 CFR 262.34 (EPA, 1996c):

- The waste is placed in containers and the generator complies with 40 CFR Part 265, Subpart I (EPA, 1996h).
- The date upon which each period of accumulation begins is clearly marked and visible for inspection on each container.
- While being accumulated on-site, each container is labeled or marked clearly with the words "Hazardous Waste."
- The generator complies with the requirements in Subparts C and D in 40 CFR Part 265 with §265.16 (EPA, 1996i) which deals with preparedness and prevention, contingency plans, and personnel training.

4.1 CONTAINER MANAGEMENT

Title 40 CFR Part 265, Subpart I (EPA, 1996h), also requires that all hazardous waste container storage areas must have a containment system. However, if the containers hold only wastes that do not contain free liquids and the containers are elevated or are otherwise protected from contact with accumulated liquid, the storage area need not have a containment system (40 CFR 264.175 [c][2]) (EPA, 1996d). Drums containing liquid wastes will be placed on spill containment pallets.

4.2 PREPAREDNESS AND PREVENTION

All hazardous waste facilities must be maintained and operated in a manner that minimizes the possibility of a fire, explosion, or any unplanned event (40 CFR, Part 265 Subpart C) (EPA, 1996f). Hazards posed by the waste stored at this facility do not require a specific kind of equipment; however, fire extinguishers will be available in most vehicles and at the entry to the storage area. Two-way radios will be available in field vehicles or as hand held type.

Aisle space between the drums and containers must be sufficient (typically 3 feet) to allow the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment to any area of the facility in the event of an emergency. NTS

Emergency Response Teams, Fire Department, and Police, must be familiar with the layout of the facility, properties of the hazardous waste, possible excavation routes, etc. Hospitals must be informed of the type of injuries or illness which could result from fires, explosions, or releases at the facility.

4.3 CONTINGENCY PLAN

Each owner or operator of a hazardous waste facility must comply with the requirements detailed in 40 CFR 265 Part Subpart D - "Contingency Plan and Emergency Procedures" (EPA, 1996g). The plan must be designed to minimize hazards to human health or the environment in the event of fire, explosion or any unplanned or non-sudden release of hazardous waste or hazardous waste constituent. The provisions of the plan must be carried out immediately after such an event and provide actions facility personnel must take. A copy of the Contingency Plan is found in Attachment A.

A copy of the plan and all revisions must be maintained at the facility and provided to the Nye County Sheriff and NTS Fire Departments, Medical Facilities, and Emergency Response Teams. There must be at least one employee either on the facility premises or on call at all time. This person must have the authority to commit the resources needed to carry out the Contingency Plan. The emergency coordinator must have thorough knowledge of all aspects of the Contingency Plan, all operations and activities at the facility, the location and characteristics of the waste handled, the location of the record within the facility, and the facility layout.

4.4 PERSONNEL TRAINING

Subpart B of 40 CFR 265.16 (EPA, 1996i) details the training required for personnel working at a hazardous waste facility. The program may be classroom instruction or on-the-job training. On-the-job training must be designed so that personnel are able to respond effectively to emergencies by familiarizing them with emergency procedures, equipment, and systems. The operator of the facility must maintain the training records at the facility (NTS) until the R-MAD Build D&D has been completed.

Title 29 CFR 1910.120 (OSHA, 1997) details the occupational safety and health requirements that will be followed for personnel supporting D&D activities. All personnel will be required to read and understand the Site-Specific Health and Safety Plan prior to working at the site. A Tailgate Safety Briefing will be conducted every morning and as needed as activities or circumstances change.

When friable ACM is being handled, only the designated and trained asbestos worker will handle the material. Once the friable portion has properly bagged, other workers will be allowed to assist in the handling of the material.

4.5 INSPECTIONS

An inspection of the areas in which the containers are stored will be conducted at least weekly. The purpose is to identify leaking or deteriorating containers due to corrosion or other factors. An inspection form is included in Enclosure B. Unusual circumstances must be reported immediately to the BN D&D Task Manager (TM) or Technical Lead (TL) so that corrective measures can be taken. Copies of completed inspection forms will be maintained in the project files.

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5.0 SAMPLING

Waste needing additional characterization will be sampled in accordance with an approved sampling and analysis plan (SAP). The SAP will be reviewed and approved by the BN D&D TM. The waste discussed in this waste management plan will be generated over several tears. The majority of this waste has sufficient characterization data to facilitate the proper disposal. For waste that needs additional characterization, the minimum sampling requirements are discussed in this section.

5.1 SAMPLING REQUIREMENTS

If waste is being characterized for radiological characteristics, the BN Waste Certification Official will review and approve the SAP. At a minimum, the SAP will address the following:

- Sampling plan objectives
- Data quality objectives (includes quality assurance samples)
 - confidence levels
 - precision
 - accuracy
 - representativeness
 - comparability
 - completeness
- Number and location of samples
- Sampling technique
- Sampling equipment
- Field decontamination of sampling equipment
- Field observations and notes

Field observations and notes will be documented in a field notebook of all sampling procedures. All entries into the logbook will be made with indelible ink. Field observations include:

- Time and date
- Sampler(s)
- Waste type and physical characteristics
- Sample locations cross-referenced to sample numbers
- Any deviations from the SAP

A copy of the field notes will be provided to the BN D&D TM or TL upon completion of the sampling event.

At present, the Environmental Service Statement of Work incorporates much of the needed information discussed above. If found sufficient by the BN D&D TM or TL, this form may replace the SAP.

5.2 QUALITY ASSURANCE

Quality assurance will be addressed in each SAP. Analytical results will be validated in accordance with the "Environmental Restoration Project Quality Assurance Project Plan" (DOE/NV, 1996).

6.0 REFERENCES

BN, see Bechtel Nevada

Bechtel Nevada, 1999. Asbestos Management, CD-0444.012, Rev. 0, Las Vegas, NV.

Bechtel Nevada, 2000. Radioactive Waste Tracking, Handling, and Management at the NTS, OP-2151.304, Rev. 2, Las Vegas, NV.

DOE, see U. S. Department of Energy

DOE/NV, see U. S. Department of Energy, Nevada Operations Office

EPA, see U. S. Environmental Protection Agency

NDEP, see Nevada Division of Environmental Protection

Nevada Division of Environmental Protection, 1995. Permit for a Hazardous Waste Management Facility Number NEV HW009, United States Department of Energy, Nevada Operations Office, Nevada Test Site.

NRC, see Nuclear Regulatory Commission

Nuclear Regulatory Commission, 1999. Screening Values for Surface Soil Contamination Release Levels, Federal Register Notice, Volume 34, Number 234, December 7, 1999.

OSHA, see U. S. Occupational Safety and Health Administration

REECo, see Reynolds Electrical & Engineering Company

Reynolds Electric and Engineering Company, Miller, M. G., 1984. NTS Area 25 Radiological Survey and Cleanup Project, 1974-1984, DOE/NV/10327-5, Rev. 1, December, 1984.

Reynolds Electrical & Engineering Company, 1995. Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste.

U. S. Department of Energy, 1999. Management Plan for the Disposal of Low-Level Waste With Regulated Asbestos Waste, L-E10.302.LRM, Washington, D.C.

U. S. Department of Energy, Nevada Operations Office, 1996. Environmental Restoration Project Quality Assurance Project Plan, Las Vegas, NV.

6.0 REFERENCES (Cont.)

- U. S. Department of Energy, Nevada Operations Office, 1999. Nevada Test Site Waste Acceptance Criteria, Rev. 2, Las Vegas, NV.
- U. S. Environmental Protection Agency, 1996a. Title 40, CFR 261, Identification and Listing of Hazardous Wastes, Washington, D. C.
- U. S. Environmental Protection Agency, 1996b. Title 40, CFR 261.7, Residues of Hazardous Waste in Empty Containers, Washington, D. C.
- U. S. Environmental Protection Agency, 1996c. Title 40, CFR 262.34, Accumulation Time, Washington, D.C.
- U. S. Environmental Protection Agency, 1996d. Title 40, CFR 264.175, Containment, Washington, D. C.
- U. S. Environmental Protection Agency, 1996e. Title 40, CFR 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Washington, D. C.
- U. S. Environmental Protection Agency, 1996f. Title 40, CFR 265, Subpart C, Preparedness and Prevention, Washington, D. C.
- U. S. Environmental Protection Agency, 1996g. Title 40, CFR 265, Subpart D, Contingency Plans and Emergency Procedures, Washington, D. C.
- U. S. Environmental Protection Agency, 1996h. Title 40, CFR 265, Subpart I, Use and Management of Containers, Washington, D. C.
- U. S. Environmental Protection Agency, 1996i. Title 40, CFR 265.16, General Facility Standards, Washington, D. C.
- U. S. Environmental Protection Agency, 1996j. Title 40, CFR 268.2, Definitions Applicable In This Part, Washington, D. C.
- U. S. Environmental Protection Agency, 1996k. Title 40, CFR 273, Standards for Universal Waste Management, Washington, D. C.
- U. S. Environmental Protection Agency, 1996l. Title 40, CFR 761.3, Definitions, Washington, D.C.

6.0 REFERENCES (Cont.)

- U. S. Environmental Protection Agency, 1996m. Title 40, CFR 761.50, Applicability, Washington, D.C.
- U. S. Environmental Protection Agency, 1996n. Title 40, CFR 761.62, Disposal of PCB Bulk Product Waste, Washington, D.C.
- U. S. Occupational Safety and Health Administration, 1997. Title 29, CFR 1910.120, Hazardous Waste Operations and Emergency Response, Washington, D. C.

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ATTACHMENT A

of APPENDIX E

CONTINGENCY PLAN

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**CAU-113
AREA 25, R-MAD
DEACTIVATION & DECOMMISSIONING
CONTINGENCY PLAN AND
EMERGENCY PROCEDURES**

Revision: 0

January 2001

**Prepared for the
U. S. Department of Energy
Nevada Operations Office
Under Contract No. DE-AC08-96NV11718**

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1.0 INTRODUCTION

1.1 PURPOSE

This document satisfies the requirements for a contingency plan and emergency procedures required by the federal hazardous waste regulations defined in the Resource Conservation and Recovery Act (RCRA). These requirements are prescribed by:

- Title 40 Code of Federal Regulations (CFR) Part 265, Subparts C and D (EPA, 1996b & EPA, 1996c) .
- Title 40 CFR 262.34 (EPA, 1996a).
- Title 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (OSHA, 1997).
- Bechtel Nevada (BN) Company Directive (CD) 0442.009, Spill Control and Reporting, (BN, 1999).
- BN Emergency Management Plan (EMP).

This plan discusses the actions that the BN Environmental Restoration (ER) and other Nevada Test Site (NTS) personnel will take in response to fires, explosions, or unplanned sudden or non-sudden releases of hazardous waste or hazardous waste constituents to the air, soil, or surface water at the Area 25 R-MAD Building deactivation and decommissioning (D&D) activities.

1.2 SCOPE

This Plan covers a variety of possible emergencies at the Area 25 R-MAD Building. This document applies to all personnel assigned to Area 25 R-MAD D&D project activities. This Plan does not cover any releases incurred by subcontractors who are under contract to remove hazardous waste from the NTS once they have physically left the Area 25 R-MAD compound.

1.3 FACILITY DESCRIPTION

1.3.1 Site Location

The R-MAD Building is located in Area 25 of the NTS, approximately 30 miles west of Mercury, Nevada (Figure E-A1).

FIGURE E-A1
 LOCATION OF THE AREA 25 R-MAD FACILITY ON THE
 NEVADA TEST SITE

1.3.2 Site Description

The Nuclear Rocket Development Station (NRDS) located in Area 25 on the Nevada Test Site (NTS) (Figure E-A1) was established in 1959 by the National Aeronautical and Space Administration the Atomic Energy Commission, and the Department of Defense in a joint effort to develop nuclear rocket technology for space propulsion. One of the first buildings to support the NRDS, the Reactor Maintenance, Assembly, and Disassembly (R-MAD) building (Bldg. 3110), was constructed in 1958 and operated through 1974. The building was used to assemble and remotely disassembly reactors, and perform post mortem examinations on the reactor fuel.

The R-MAD Building is located in the center of a fenced compound that is situated on the east side of Jackass Flat, in Area 25 of the NTS. The R-MAD Building has a floor space of 4,544 square meters (m^2) (48,000 square feet [ft^2]) on four different levels. The building is now empty of large equipment, except for three large overhead cranes. The immediate area surrounding the R-MAD is flat and paved with concrete or asphalt. Several other large structure are within several yards of the R-MAD Building. Within one hundred yards directly north of the R-MAD Building, two structures used to test components of the MX missile are still in place, along with a small concrete building used during the testing of the nuclear rockets. Directly south of the R-MAD Building are two large storage sheds which are currently being used by other agencies. Only the R-MAD Building itself will be occupied by D&D project staff.

1.3.3 Topography

The NTS is located in the Great Basin of the Basin and Range province. The R-MAD Building is located in a closed basin (Jackass Flat). The elevation is approximately 1,170 m (3,840 ft) above sea level. Figure E-A2 is a topographic map of the area.

1.3.4 Climate

Area 25 at the NTS receives approximately 15 centimeters (cm) (6 inches [in]) of precipitation annually. Annual wind patterns are characterized by strong winds in the spring. The daily cycle is generally light winds at night, increasing winds from morning to afternoon and declining wind speed in the evening. Average monthly wind speed varies from 4.0 meters per second (m/s) (13 feet per second [f/s]) in April to 2.7 m/s (9 f/s) in November.

CONTOUR INTERVAL IS IN ONE FOOT INCREMENTS

FIGURE E-A2
SITE TOPOGRAPHIC MAP

2.0 WASTE DESCRIPTIONS AND ASSOCIATED HAZARDS

The R-MAD Building contains materials that present chemical, radiological, and physical hazards. Potential routes of entry could include inhalation, ingestion, absorption, and injection. The specific hazards associated with the site are described in the following sections.

2.1 CHEMICAL HAZARDS

It is possible that Resource Conservation and Recovery Act (RCRA) regulated hazardous constituents may be encountered in the R-MAD Building. Several waste items (fluorescent tubes, mercury-vapor lamps, lead-acid batteries) contain hazardous compounds. These compounds are often strong oxidizers that may be harmful or fatal if inhaled, swallowed, or absorbed through the skin. Contact can cause irritation of the eyes, nose, and throat, fatigue, headaches, and drowsiness. Target organs include the respiratory system, eyes, liver, and kidneys.

2.1.1 Polychlorinated Biphenyls

A part of the D&D of the R-MAD building will require the removal of a high performance paint for the interior walls the disassembly bay and postmortem cell area. This paint has relatively low concentrations of Polychlorinated Biphenyls (PCBs). Additionally, three large overhead cranes are suspected to contain PCB hydraulic oil. PCB, when heated, may give off vapors which are irritating to the eye, skin, and respiratory tract. Exposure may cause liver, kidney, and lung damage. Symptoms of exposure are red, dry scaly skin, cough and wheezing, jaundice, and vomiting.

2.2 PHYSICAL HAZARDS

The hazardous material identified above are not flammable and usually will not cause an unexpected chemical reaction. Other physical hazards present at the R-MAD Building are associated with container-handling, heavy equipment operations, and working outdoors. These may include potential back injury, vehicle accidents, and heat and cold stress. Physical hazards are discussed in BN Safety Procedures and the "Generic Deactivation and Decommissioning Health and Safety Plan" (BN, 2000).

2.3 RADIOLOGICAL HAZARDS

Potential exist for workers to receive exposure to radiological material. The radiological conditions in the R-MAD Building will change on a daily basis as the result of D&D efforts. The radiological constituents of potential concern are Cobalt-60, Niobium-94, Cesium-137, Strontium-90, Uranium-234, Uranium-235, and Plutonium-239. There are no criticality concerns for this D&D work.

All work within the radiological contaminated portion of the R-MAD Building will be performed under an Radiological Work Permit which identifies the current radiological hazards and required Personnel Protective Equipment. Dose rates are expected to be below 5 milli roentgen equivalent man per hour at all time during the D&D project. The effects of radiation exposure are discussed in the radiological training required for all workers entering the contaminated portion of R-MAD.

3.0 EMERGENCY NOTIFICATION PROCEDURES

The reporting and notification procedure outlined in this contingency plan will be followed in the event of an accident, injury, or other incident. Expedient reporting and notification will be made for, but not limited to, personnel injury or fatality, toxic material release, fire, or explosion. Appendix A includes the Emergency/Contingency Plan notice that will be posted at the site. Information includes a list of the telephone numbers, emergency response procedures, waste description, etc.

3.1 DESIGNATION OF EMERGENCY COORDINATOR

The Emergency Coordinator (EC) system consists of one primary EC, one secondary EC, and one alternate EC. The ECs are on-site or on-call at all times. In the event of an emergency, the primary EC should be contacted; if not available, the secondary EC should be contacted. If neither of these are available the alternate should be contacted. The individual who is available first becomes the EC for the situation. The ECs appointed by the ER Project Manager are as follows (all generic personal information will be posted in the field):

Primary Emergency Coordinator

David D. Madsen	Work: (702) 295-7211
Home Address	Home: Home Phone
	Net 3 #764; Net 15 #814

Secondary Emergency Coordinator

Jeffery L. Smith	Work: (702) 295-7775
Home Address	Home: Home Phone
	Net 3 #760; Net 15 #816

Alternate Emergency Coordinator

Jerel G. Nelson	Work: (702) 295-5336
Home Address	Home: Home Phone
	Net 15 #826

3.2 RESPONSIBILITIES

The ECs have the authority to commit the necessary resources to implement this plan. Personnel resources will be applied consistent with the requirements of Title 40 CFR Part 1910.120. The ECs will remain thoroughly familiar with the following:

- All aspects of this Plan.
- All operations and activities at the R-MAD Building.
- The locations and characteristics of the wastes handled.
- The locations of all project records.
- The R-MAD Building layout.

In the event of an emergency, the EC will be responsible for the following:

- Stopping all operations, where applicable.
- Implementing this Plan.
- Contacting the 900 Radio Net Coordinator through the MAYDAY/911 system and making notification of the emergency.
- Notifying all R-MAD Building D&D personnel of the emergency.
- Acting as the incident coordinator.
- Attempting to stop, slow, or dike the discharge, if it can be done safely with the materials at hand.
- Providing the technical expertise necessary so that all responders (including those outside the Remediation Projects) are fully informed of the potential hazards.

The secondary EC will also be responsible for preparing, posting, and maintaining an emergency information sheet which provides the emergency response information such as telephone number

for emergency response teams. The secondary EC is also responsible for personnel evacuation. In the event the secondary EC is not available the alternate EC will conduct these duties.

3.3 NOTIFICATION

The first person who becomes aware of an emergency at the R-MAD Building shall immediately notify the proper authorities. Initial notification should be to on-site supervisor. If the emergency involves only a release of hazardous or radioactive materials, the supervisor shall contact the EC who will start the necessary notification.

When the nature of the emergency is a fire, explosion, or involves personnel injury, the supervisor shall immediately notify the 900 Net Coordinator via the MAYDAY/911 system or the Emergency Dispatch number, 295-6377. The 900 Net Coordinator shall notify the Fire Protection Services and/or medical personnel, as required. The supervisor shall contact the EC.

If the first person to become aware of an emergency is not a ER employee and there are no ER personnel in the area, that person should follow the notification instructions posted at the entry control point of the R-MAD Building.

If the emergency involves radiological material, the BN Radiological Control Manager will be notified through the NET 900 Coordinator.

3.4 RESPONSE PROCEDURES

There are two general classifications of incidents that could occur at the R-MAD Building; fire and/or explosions and a spill of potentially hazardous or radioactive materials. The initial response will be to protect human health and safety, and then the environment. The following actions will be taken:

- 1) Work in the area will cease immediately.
- 2a) For fire: If necessary, contact the Fire Protection Services by utilizing the Net MAYDAY/911 system or use the ABC-type fire extinguisher.

- 2b) For spill: Attempt to stop, slow, or dike the discharge without compromising health and safety.
- 3) Notify the EC who will obtain additional emergency response assistance as required. Evacuate area. Verify that all personnel are out of area.
- 4) Remove injured persons and administer first aid as required.
- 5) Shut down operating equipment as practical.
- 6) Complete appropriate documentation (Appendix B).

3.5 EVACUATION PLAN

Notification for personnel to evacuate the area will be received via an emergency signal. The EC will be in possession of a blow-horn that will signal all workers to leave the area and gather in the designated assembly area. All radio nets will be kept clear and be used to transmit emergency information only. The EC will be accountable for all personnel.

The assembly area for evacuated personnel will be at the entry control point for the R-MAD Building, located near the entry gate to the R-MAD compound. If cover must be taken, personnel will be instructed to use the earthen berm located directly outside the R-MAD compound entry gate.

3.6 EMERGENCY DECONTAMINATION AND FIRST AID

If a worker is contaminated with a chemical substance, direct the worker to proceed at once to the temporary decontamination pad and drench the worker with copious amounts of water. Pay particular attention to the victim's eyes and face. Do not remove personal protective equipment (PPE) until all contamination has been thoroughly rinsed off. Contact the Occupational Medicine Department for assistance and advice. Move the victim to fresh air.

If a worker is contaminated with radioactivity, radiological control technicians will preform the decontamination in accordance with applicable field manual guidelines.

3.7 CLEANUP

Cleanup of potential hazardous waste will be conducted by personnel having the appropriate training and PPE as determined by the EC. Cleanup will meet all current applicable standards and regulations.

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4.0 EMERGENCY SERVICES

4.1 ON-SITE CONDITION OF EMERGENCY SERVICES

The on-site Fire Protection and Emergency Medical Services are capable of responding to all credible emergencies at the NTS. These services are linked to the emergency communications dispatch system and have the capability to respond to emergencies involving hazardous, radioactive, or mixed waste constituents.

4.2 MEDICAL SERVICES

Emergency services are provided in Mercury during normal working hours, Monday through Thursday. During other than normal working hours, emergency services are provided by paramedic personnel only. All nurses and physicians are licensed by the state of Nevada. Paramedical qualifications meet or exceed Department of Transportation Highway Safety Program requirements for emergency medical services. Response time to the R-MAD Building is approximately 25 minutes. Services are also available at the Area 25 Yucca Mountain Project, Paramedic Medical Facility, Monday through Thursday during normal working hours.

4.3 FIRE PROTECTION SERVICES

The NTS Fire Station serves the NTS 24 hours a day, seven days a week. It is located in Area 23 and will be the primary response team. The Fire Protection Services responds to spills, explosions, fires, and non-fire emergencies involving cleanup.

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5.0 EMERGENCY EQUIPMENT

Emergency equipment includes equipment for fire control, emergency communications, spill control and cleanup, personnel protection, and first aid. The on-site emergency equipment is inspected monthly to ensure there is adequate inventory and that it is in good working order. Extra PPE and environmental monitoring equipment are available. A list of the available equipment and their location(s) are in Appendix C.

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6.0 REFERENCES

BN, see Bechtel Nevada

Bechtel Nevada, 2000. Generic Deactivation and Decommissioning Health and Safety Plan, Las Vegas, NV.

Bechtel Nevada, 1999. Spill Control and Reporting, CD-0442.009, Las Vegas, NV.

EPA, see U. S. Environmental Protection Agency

OSHA, see U. S. Occupational Safety and Health Administration

U. S. Environmental Protection Agency, 1996a. Title 40, CFR 262.34, Accumulation Time, Washington, D. C.

U. S. Environmental Protection Agency, 1996b. Title 40, CFR 265, Subpart C, Preparedness and Prevention, Washington, D. C.

U. S. Environmental Protection Agency, 1996c. Title 40, CFR 265, Subpart D, Contingency Plans and Emergency Procedures, Washington, D. C.

U. S. Occupational Safety and Health Administration, 1997. Title 29, CFR 1910.120, Hazardous Waste Operations and Emergency Response, Washington, D. C.

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APPENDIX A

of ATTACHMENT A

of APPENDIX E

EMERGENCY/CONTINGENCY PLAN

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EMERGENCY/CONTINGENCY PLAN

COMPANY: Bechtel Nevada

ADDRESS: Mercury, Nevada

LOCATION OF FACILITY: Nevada Test Site, Area 25, R-MAD, Building 3110

PRIMARY EMERGENCY COORDINATOR

David D. Madsen

Work: (702) 295-7211

Home Address

Home: Home Phone

Net 3 #764; Net 15 #814

SECONDARY EMERGENCY COORDINATOR

Jeffery L. Smith

Work: (702) 295-7775

Home Address

Home: Home Phone

Net 3 #760; Net 15 #814

ALTERNATE EMERGENCY COORDINATOR

Jerel G. Nelson

Work: (702) 295-5336

Home Address

Home: Home Phone

Net 15 #826

ALL GENERIC PERSONAL INFORMATION WILL BE POSTED IN THE FIELD

DESCRIPTION OF WASTE HANDLED

Polychlorinated Biphenyls (PCBs) in paint and hydraulic oils, radiologically contaminated PCB paint, and radiologically contaminated building debris. Wastes are contained in 55-gallon steel drums, and B-25 (4' x 4' x 7') metal boxes.

EMERGENCY RESPONSE CONTACTS

All emergency response teams can be contacted through the 900 Net Coordinator:

"MAYDAY, MAYDAY, MAYDAY" OR "911"

EMERGENCY DISPATCH: 295-6377

PRIMARY HOSPITAL:

Area 23 -- 295-6227/6224

SECONDARY AID STATION:

Area 25 -- 295-6377

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APPENDIX B

of ATTACHMENT A

of APPENDIX E

INJURY/ILLNESS/INCIDENT REPORT

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INJURY/ILLNESS/INCIDENT REPORT

The supervisor completes this report immediately after being notified of any work-related accident or incident (injury, illness, vehicle accident, property damage, or near-miss incident) and forwards it to the assigned Safety Representative or the Occupational Safety Department within two working days. Be specific. Provide enough data that anyone reading the report, who is not familiar with the incident, can understand what happened. For near-miss incidents complete Parts I and IV. For accidents, injuries, or illnesses, complete the applicable blocks in Parts I, II, III, and IV. (Instructions are listed on the back of the last copy.)

PART I

1. Company:	2. Org/Dept. No.:	3. Date of Occurrence	4. Time (Military)	5. Location:	6. Date Reported:
7. Employee Name:		Social Security No.:	Job Classification:	Age:	☐ Male ☐ Female
8. Job Being Done at Time of Incident:		9. Experience on This Job or This Equipment (Months) ☐ Under 3 ☐ 3 to 12 ☐ Over 12			
		10. Length of Present Employment (Months) ☐ Under 3 ☐ 3 to 12 ☐ Over 12			

PART II- INJURY/ILLNESS

11. Body Parts Involved:	☐ Left ☐ Right	12. Nature of Injury/Illness	13. Object/Equip./Substance Inflicting Injury
--------------------------	---	------------------------------	---

PART III- VEHICLE OR PROPERTY DAMAGE

14. Description of Vehicle/Equipment:	15. Vehicle/Property No.:	16. Nature of Damage
17. Activity in Progress at Time of Incident:	18. Estimated Repair/Replacement Cost	19. Seat Belts Used ☐ Yes ☐ No ☐ N/A

PART IV - DESCRIPTION OF EVENTS, ANALYSIS OF CAUSES, AND ACTIONS TO PREVENT RECURRENCE

(☐ Mark if additional sheets are attached to accomplish adequate detail)

20. Describe clearly how the accident/incident occurred:			
21. What acts, failures to act and/or conditions contributed most directly to this accident/incident?			
22. What root causes, basic or fundamental reasons, caused the existence of these failures, acts and/or conditions?			
23. What action has or will be taken to prevent recurrence?			Implementation Date(s):
24. Preventable ☐ Yes ☐ No	25. Witnesses 1. _____ 2. _____ 3. _____		
26. Investigating Supervisor:	Phone:	Signature:	Date:
27. Reviewing Safety Representative:	Phone:	Signature:	Date:
28. Manager:	Phone:	Signature:	Date:

Distribution: White - Occupational Safety
Canary - Originator
Pink - Safety Representative
Goldenrod - Originator Department

BN-0018 (01/96)
SUBJECT CODE: SHM3

INSTRUCTIONS FOR COMPLETION OF THIS FORM

The following information will assist in the completion of this form.

1. **Company:** Bechtel or Subcontractor.
2. **Org./Dept. No.:** As applicable.
3. **Date of Occurrence:** Date event happened.
4. **Time:** Use military time.
5. **Location:** (Examples: Bldg. 7, Area 6; Whse. A Yard, Area 233)
6. **Date Reported:** Date the incident was reported to supervisor.
7. **Employee Name, Social Security No., Job Classification, Age, Sex:** Self-explanatory
8. **Job Being Done at Time of Incident:** (Examples: Stocking shelves; installing a receptacle; cleaning equipment parts; carrying files to a desk; etc.)
9. **Experience on This Job or This Equipment:** Self-explanatory.
10. **Length of Present Employment:** Check applicable box, based on employee hire date.

ILLNESS/INJURY

11. **Body Part(s) Involved:** (Examples: left arm; right foot; back; both eyes; thumb, left hand; etc.)
12. **Nature of Injury/Illness:** (Examples: Sprain; strain; fracture; laceration; dermatitis; etc.)
13. **Object/Equip./Substance Inflicting Injury:** (Examples: Corner of shelf; point of screwdriver; solvent in dip tank)

PROPERTY DAMAGE

14. **Description of Vehicle/Property/Equipment:** (Clark forklift, warehouse roll-up door; 1987 Dodge pickup; etc.)
15. **Property No.:** Use property number on equipment or license number of vehicles. Note N/A if there is no identifying number.
16. **Nature of Damage:** (Examples: Broken window, left side; second rung of ladder bent, telephone cable cut; etc.)
17. **Activity in Progress at Time of Incident:** (Examples: Placing a pallet on a shelf; Rearranging office furniture, etc.)
18. **Estimated Repair/Replacement Cost:** Self-explanatory.
19. **Seat Belts:** Check applicable block to indicate if seat belts were used or not applicable.

DESCRIPTION OF EVENTS, ANALYSIS OF CAUSES, AND ACTIONS TO PREVENT RECURRENCE

20. **Description of how accident/incident occurred:** Include all facts surrounding the incident. Do not use one-line descriptions.
21. **Acts/failures to act, unsafe conditions contributing to accident:** Be as specific as possible in identifying the contributing factors.

The following examples are offered, but should not be considered as the only factors to be considered. Keep in mind that a single incident can involve multiple unsafe acts and unsafe conditions.

Examples of Unsafe Acts:

Used defective equipment
Used wrong tool
Took unsafe position/posture
No protective equipment used
Did not follow established procedure

Examples of Unsafe Conditions:

Inadequate or no guard/safety device
Poor housekeeping
Protruding object hazard
Defective tools/equipment
Close clearance/congestion

22. **Basic or fundamental reasons causing failures, unsafe acts, or unsafe conditions:** Include all identified root causes. Usually there are management failures.

Examples include, but are not limited to:

Inadequate employee training
Inadequate procedures
Inadequate enforcement of procedure

Inadequate maintenance or repair
Inadequate employee selection or placement
Inadequate safety rules or equipment

23. **Preventive action and implementation dates:** Describe what actions have or will be taken to prevent similar incidents. If an action has already been taken, enter the date it was completed. If an action is planned, enter the proposed date of completion.
24. **Preventable:** Determine if the employee reasonably could have done anything to prevent the accident/incident.
25. **Witnesses:** Self-explanatory.

SIGNATURE AND REVIEW PROCESS

26. The supervisor can either complete the form solely and send it to the Safety Representative for review or complete the form along with the assigned Safety Representative.
27. When the form has been signed by both the Supervisor and Safety Representative, submit it to the Manager for signature.
28. After the Manager has signed the form, his/her office will make appropriate distribution of the copies.

NOTE: Forward all photos, statements, diagrams, etc. concerning the accident/incident to the Occupational Safety Dept.

APPENDIX C

of ATTACHMENT A

of APPENDIX E

EMERGENCY EQUIPMENT

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EMERGENCY EQUIPMENT

EQUIPMENT

LOCATION

Fire Extinguishers

20 lb. ABC

Each ER vehicle
Decon Area
Entry Control Point

First Aid Kits

Each vehicle
Decon Area
Entry Control Point

Eye Wash Station

Decon Area

PPE

Tyvek
Nitrile Gloves
Surgical Gloves
Rubber Boots
Rain Suits (3)
Hard Hats
Face Shields
Safety Glasses

RCT Support Vehicle

Portable Net 15 Radio (2)

With charger.

Site Supervisor Vehicle

Spill Response Materials

55-gallon drums
Spill Kit
Absorbent Pads

90-Day Hazardous Waste
Accumulation Area

Miscellaneous

Garbage Bags
Buckets
Brushes
Soap
Kimwipes
Plastic
Sandbags
Duct tape

RCT Support Vehicle

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ATTACHMENT B

of APPENDIX E

FIELD INSPECTION FORM

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Location and Name of 90 day pad: _____

Owner/Inspector (Print Name): _____ Date: _____ Time: _____

Yes ✓ No

1. ☐ ☐ Is the facility posted with appropriate signage?
2. ☐ ☐ Are the gates and fences adequately maintained?
3. ☐ ☐ Are container labels and markings intact and readable?
4. ☐ ☐ The Accumulation Start Date is marked on containers as applicable?
5. ☐ ☐ Have all containers been accumulated less than 90 days?
6. ☐ ☐ Are all materials properly segregated?
7. ☐ ☐ Are containers free from leaks, deterioration, or other damage?
8. ☐ ☐ Are containers of liquid (including lab packs) placed completely on spill pallets?
9. ☐ ☐ Are containers in good condition and lids secured?
10. ☐ ☐ Is the emergency equipment available? (The contents and amounts may vary depending on material matrix. The following are examples:
 - a) Absorbents
 - b) Empty Salvage Drums
 - c) Gloves
 - d) Face Shields
 - e) Tyvek Coveralls
 - f) BootiesSpill equipment for the 90 Day Pad in Area 5 is located at the A5 HWSU.)
11. ☐ ☐ Is there adequate aisle space to view for leaks?

Number of containers assigned: _____

Total containers at the 90 Day Pad: _____

Describe conditions for each box checked "No":

Corrective Action required for each box checked "No":

Inspector Signature: _____

Corrective Action Completed:

Signature: _____ Date: _____

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APPENDIX F

NDEP COMMENT RESPONSE

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DOCUMENT REVIEW SHEET

Document Title/Number: Draft Streamlined Approach for Environmental Restoration for Corrective Action Unit 113: Reactor Maintenance, Assembly, and Disassembly Building, Nevada Test Site, Nevada

Document Date: November 2000

Revision Number: 0

Originator/Organization: Jeff Smith/Bechtel Nevada Environmental Restoration

Date Comments Due: December 29, 2000

Reviewer/Organization: John Wong, Bureau of Federal Facilities, Nevada Division of Environmental Protection

Comment Number/ Location	Type ^a	Comment	Comment Response	Accept
1. Pages 15-19, Table 2	M	Need to change table number to match table of contents.	The text has been modified as requested.	Yes
2. Page 20, Sec. 2.3.1, 2 nd paragraph	M	Indicate which parameters the equipment fluids will be field screened for.	The text has been modified as requested.	Yes
3. Page 20, Sec. 2.3.2, last sentence	M	Provide a description of the activities performed in the Gallery Viewing Area which caused "sporadic and limited contamination."	Section 2.3.2.4 Gallery Viewing Area, has been added to the text.	Yes
4. Page 21, Sec. 2.3.2.3, 2 nd paragraph	M	First sentence. "Preliminary....failed,utility rooms", does not make sense; please modify.	The text was modified to read as follows: "Preliminary investigation sampling has indicated that..."	Yes
5. Page 38, Sec. 3.1.5	M	In the event that oils, greases, and fluids cannot be removed from equipment and analyzed, indicate the manner in which the equipment will be managed.	Based on process knowledge and on-site inspection, no equipment reservoirs are sealed units. All equipment reservoirs have at a minimum a fill port.	No

DOCUMENT REVIEW SHEET

Comment Number/ Location	Type ^a	Comment	Comment Response	Accept
6. Page 41	M	A discussion on ACM as a COPC in Chapter 3.0 is appropriate.	Section 3.1.7 ACM, has been added to the text as requested..	Yes
7. Pages 43-44, 54, & 55	M	Why a subsection heading (3.3.1, 3.3.2, 3.4.1, 3.4.1.1, and 3.4.1.3) if no text? Add text or delete subsection.	These subsections are necessary as they provide a framework for the subsequent subsections. Text has been added to these subsections.	Yes
8. Page 43, Sec. 3.3.1.3, 2 nd sentence	M	On what basis will decisions to salvage equipment be made? During the the DQO kickoff meeting, BN indicated that no equipment will be salvaged.	The text has been modified to indicate that no equipment will be salvaged.	Yes
9. Appendix E Page E-5, Sec. 2.1.1	M	Complete or revise last sentence which has been cut off.	The text has been modified as requested.	Yes
10. Appendix E Page E-10, Sec. 3.2.1	S	Though PCB bulk product waste generated during the R-MAD D&D which meets the waste acceptance criteria may be disposed in the Area 9, U10C Industrial landfill per 40 CFR 761, NDEP would like to emphasize that future PCB bulk product waste streams will be handled on a case-by-case basis.	N/A	N/A

DISTRIBUTION LIST

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